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Travels and Trials of Climate Knowledge in Finnish Municipalities

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Abstract

We examine why implementing climate aims has proven challenging for municipalities. Recognising that climate policy research identifies 'barriers' to the forward motion of environmental knowledge, we use STS tools to dismantle 'barrier thinking' and analyse the dynamics of climate knowledge in municipal organisations. The primary data are 21 interviews with climate change and risk management experts in Finnish municipalities. We employ the idea of 'trials of strength' to analyse not mere barriers but gatherings, translations, and implementations of environmental knowledge. We argue that four kinds of trials are crucial in transforming climate knowledge so it can cohere with ongoing processes: it is gathered and condensed at the organisation's borders; climate experts embody and transmit the knowledge; meeting tables form obligatory passage points for its implementation; and road maps draw actors together to circulate knowledge. While traveling around municipal organisations, climate knowledge is often sidetracked but can sometimes become unexpectedly effective.

Keywords: climate change, environment, knowledge, trials of strength, road maps, organisations

Introduction

Why are the globally recognised initiatives of climate change adaptation and mitigation difficult to implement in local practices? Knowledge of climate change and its acuteness is hardly lacking; indeed, climate information that can be used across various scales and institutions abounds. Yet much of local climate governance and sustainability centres on how different indicators and 'best

practices' are followed, how this affects performance, which policy instruments are effective, and how climate goals are implemented locally (Hsu et al., 2020; Terama et al., 2019). Knowledge is seen to travel from top to bottom, from abstract to concrete, and from scientific research to international organisations, states, and finally municipalities. Such a technocratic, top-down process alone does not suffice: it is not enough to come up with the right kind of policies and indicators (e.g. Knox, 2020; Terama et al., 2019). A particularly pressing problem of taking on climate change adaptation and mitigation lies rather in 'the transfer, receipt and integration of knowledge across participants' (Weber and Khademian, 2008: 334).

We approach the problem from an STS point of view to contribute to the topical field of climate governance and sustainability studies. By putting forward classical STS concepts to the study of climate knowledge in municipal governance organisations, we draw up an approach for STS research to reassemble the organisational formation and momentum of knowledge in a new way. Our line of inquiry has practical pertinence to the field of climate policy and its study as well, as municipalities arguably have incentives to produce and circulate knowledge about climate and environmental change and to maintain such expert practices. They seem to falter in two key aspects, however: in in the 'interessement' and 'enrolment' (Callon, 1986: 221) of other actors in efforts to find adequate 'coherence' (Law, 2002) with other practices in the organisations. Instead, established core practices seem to truncate and filter down climate knowledge.

We inquire into these processes in detail by tracing the travels of climate knowledge through municipal organisations in Finland and by analysing transformations of the knowledge during these travels. As research questions we ask: what kind of knowledge is gathered, condensed, and implemented in the Finnish municipal organisations; how does this knowledge become tested and transformed in organisational practices; and what kinds of frictions emerge in these processes? To answer these questions, we employ the idea of 'trials of strength' (Callon, 1986; Latour, 1987). Four key trials are identified by focusing on environmental experts' daily work on climate issues: organisational borders, the experts themselves, meeting tables, and road maps.

In the following, we first elaborate on previous research and present our theoretical outlook. This section is followed by a description of the research process, data, and methods. We then present our results and analysis in four subsections. The conclusion discusses our findings vis-à-vis previous research.

Respecifying transfers of climate knowledge as trials of strength

Climate work requires both integrating and mainstreaming knowledges and strategies (Keskitalo and Andersson, 2017). Accordingly, the role of intermediary organisations has received attention as a prospective solution (Kivimaa et al., 2019). For example, the HINKU network of aspiring 'carbon-neutral' Finnish municipalities is thought to be crucial for local mitigation efforts as it both acts as a "vertical intermediary" and facilitates "peer support" (Karhinen et al., 2021).

Yet both the transfer of knowledge and the intermediary work it requires encounter obstacles in the governance of climate change adaptation (e.g. Eisenack et al., 2014; Intergovernmental Panel on Climate Change, 2014). Between the input of abundant knowledge on climate and environment and the output of effective policy measures and emission reductions are 'barriers', extensively diagnosed clogs in the flow of knowledge (e.g. Amundsen et al., 2010; Biesbroek et al., 2013; Lehmann et al., 2015). What constitutes a barrier to climate knowledge is a lack or a deficiency of optimal conditions: communication breaches, organisational stovepipes and silos, dysfunctional leadership, or flawed institutional arrangements (Clar et al., 2013; Eisenack and Stecker, 2012; Moser and Ekstrom, 2010). In this line of thought, knowledge is treated as an enabling resource that actors transport from one policy phase to another. Barriers, then, are disruptions of what would otherwise be an optimal flow of knowledge across governance organisations.

Since intermediary 'knowledge-brokerage' between research and policy practitioners (Clar et al., 2013) and successful interventions into climate governance both remain wanting, the

kind of 'barrier thinking' described above has been called into question (Biesbroek et al., 2015). At issue in climate adaptation should be not so much the diagnoses of removable blockages in otherwise smoothly running pipelines but a fine-grained understanding of these very governance processes, particularly the complexities of decision-making (Biesbroek et al., 2015), or the practices of coordinating climate strategies and actions in governance organisations (e.g. Clar, 2019). What remains uncomplicated even in this problematisation is, however, the knowledge itself.

We aim to sidestep the gridlocks of both barrier thinking and the constant need for more and better intermediary coordination of levels and processes of governance. For this, we respecify the transfer of knowledge in governance organisations by using the science and technology studies (STS) framework. In the spirit of classic works by Michel Callon (1986) and Bruno Latour (1987), who built on Michel Serres (1974), and contemporary STS-inclined approaches to policy organisations and knowledge (e.g. Freeman, 2009; Voß and Freeman, 2016; Lehtonen, 2003, 2017), we approach knowledge as a practical achievement that requires *translation*, an operation in which both the issue at hand and the relations between the translator, the translated, and other actants involved are transformed (Callon, 1986; Latour, 1984, 1999). The travel and translation of knowledge across organisational practices is thus not only a matter of transfer but also of transformation (Gherardi and Nicolini, 2000).

With these classic STS ideas, we respecify the notion of transferring knowledge in three ways. First, knowledge becomes translated and transformed in the process of being taken up in different kinds of organisational practices. Second, the same object or mode of knowledge can be taken as data, information, or knowledge, depending on context (Latour, 1999: 24–79). Third, knowledge can be treated as tacit and personified, documented and inscribed, or put into practice in different ways as it moves across policy processes (Freeman and Sturdy, 2014). In sum, we approach climate knowledge not as discrete resource objects at the mercy of extraneous, dysfunctional conditions but as situational: contingent on the practices of its uptake and interwoven with material arrangements.

To become established in municipal organisations, such local arrangements of knowledge must be made stable enough to fit the bill. To capture these crucial waypoints, we operationalise our respecification through the concept of *trials of strength*, developed in Latour's (1987) and Callon's (1986) early works on science and knowledge. According to Latour (1999: 311), trials are "experiments of various sorts in which new performances are elicited." Practical elicitations of knowledge are not neutral but require strength. We use the idea of trials to focus on the tests in which climate knowledge is put as it travels through municipal organisations.

The trials appear at junctures where the knowledge and expertise of climate specialists meet with those of other organisational branches (technical management, zoning, forestry, etc.) and policymaking. We therefore follow the efforts of environmental and climate experts in Finnish municipalities to make environmental and climate knowledge travel through their organisations and become effective. During these travels and trials, modes of knowledge on climate adaptation and mitigation tend to gain and lose traction and often become sidetracked. Our approach thus stands in substantial contrast to the problematisation of ineffective climate measures of much policy research and practice. Put bluntly, a trial is not a barrier. The cause of a lack of sufficient knowledge or its coordination and communication cannot be extraneously identified and remedied. Rather, a trial is the locus at which the course and mode of climate knowledge become transformed. How this happens is an empirical question that lends itself to inquiry only in particular situational practices. Whether a trial serves to block or accommodate certain kinds of expertise and knowledge is not a question of yes or no but of degrees and forms of their transformation.

Research process, materials, and methods

We began our research work at the beginning of 2018 by mapping resilience gaps and blind spots in the governance of and preparedness for climate change-related risks in Finland. The work was car-

ried out as part of a multi-disciplinary research consortium focusing on wicked socio-environmental disruptions and comprehensive resilience in Finland. The body of Finnish national-level documents taking account of these issues and their impacts was both wide and scattered, but we detected that this corpus of literature – including policy documents, directives, and grey literature – addresses climate change predominantly within an established national administrative discourse, especially regarding issues of security strategy, risk assessment, and crisis management. Recently, there have also been attempts to broaden these framings in terms of comprehensive security, resilience, and preparedness and a consequent emphasis on the role of non-governmental organisations and citizens in tackling these challenges. Nonetheless, national security and risk management framings predominate the discourse on resilience, while successful efforts to include long-term climate change and sustainable development issues have thus far remained sparse (Hakala et al., 2019a, 2019b; Ministry of Interior of Finland, 2019; Reinekoski et al., under review; Räisänen et al., 2021).

This initial finding led us to expand our understanding of the barriers to mitigating and adapting to climate change. Instead of nationally established security and risk-driven policies, we targeted a rather patchy corpus of policy documents, such as public environmental and municipal climate strategies, guidelines, and road maps, to pinpoint gaps in the seams between municipal organisations and national scales of governance. This second stage of our mapping work further directed our selection of informants.

Access to the interviewees was gained by contacting municipal administrations and asking who was responsible for climate change mitigation and adaptation. In the five municipalities we approached, few people had been formally recruited for these tasks. Instead, we found experts who had a wide variety of responsibilities that often had to do with not only climate change but also environmental issues more broadly, public enlightenment, and the administration of natural resources in the municipal area. We ended up recruiting interviewees to represent various branches around environmental climate issues and working on both fixed-term and permanent contracts in municipalities of different sizes and administrative structures.

Eventually, a data corpus consisting of transcriptions of 21 expert interviews of 52–90 minutes with people working in five Finnish municipalities was gathered. Nine informants worked as environmental or climate specialists and twelve as experts of risk management and preparation. The smallest municipality employed only one climate expert, while the large cities had several. The semi-structured interviews were carried out during a seven-month period in 2018 at the informants' offices. The themes touched upon in all interviews included environmental and climate threats and the preparations to respond to them, responsibilities, knowledge, and technology and communication. All informants were also asked to reflect on their own expertise, tasks, and responsibilities and describe an ordinary day at work. The 21 environmental and climate experts offered rich reflections on and characterisations of how they gather and process data, frictions in the implementation of climate knowledge, and the tools and devices at play in everyday organisational realities.

We conducted the analysis in two interconnected phases: data-driven coding work conducted by the corresponding author, Virtanen, was followed by a theoretical interpretation carried out by the whole research team. In the first phase, the raw data from the interview transcriptions were coded using the Atlas.ti software. In the coding work, particular attention was paid to epistemic issues and knowledge tools and objects, such as emission calculations, numerical indicators, maps, and air quality measurements, and to the software and devices used in making these calculations. Challenges related to these issues were also highlighted at this stage. Then, grounded on cross-coding and merging the codes and by conducting a constant comparison between different codes, four general themes were identified to classify and summarise the data: *tools, devices, and instruments* (280 coding occurrences in the data); *data and knowledge* (277); *goals and efficiency* (265); and *expertise and resources* (250). These themes are not mutually exclusive, as each utterance could contain several

codes. During the analysis, quotations pertaining to each theme were also compiled.

In the second phase, the entire research team read the interview transcripts, gathered remarks, and made notes about issues relevant to the research task at hand. We then brought our findings together and interpreted the thematised data jointly by using the conceptual idea of trials of strength. Interviewing a diverse group of experts working on environmental and climate issues in their everyday contexts allowed us to trace multi-directional paths that climate knowledge appeared to travel in municipal organisations. These traces led us to discover situations of trial in which different practices met each other with friction. We identified four key trials through which environmental and climate knowledge must pass during its travels in municipal organisations to be able to cohere with ongoing processes:

1. gathering and condensing knowledge at the borders of the organisation;
2. the expert as the embodied transmitter of knowledge;
3. meeting tables as obligatory passage points for implementing knowledge; and
4. road maps for drawing actors together and circulating knowledge.

We trace the travels of environmental and climate knowledge through these trials to answer our research questions.

Analysis and results

Context: Expertise not yet established

The daily work of our interviewees emerges as both multifaceted and organisationally unestablished. The environmental specialists in Finnish municipalities are "working a field that does not exist," as a planner in sustainability issues evocatively puts it. She positions herself implicitly outside the core of the municipal organisation where she works. She also considers the issues on which she is working to be novel and not yet comprehensively recognised outside her daily tasks in the wider organisational practice. Another interviewee, an environmental planner, summarises this view:

> It's been a completely new thing for the waterworks, when they drag pipelines [on their screen], that they must consider where the pipelines are dragged. Based on natural values, I mean, and not only where they are easiest to pull based on engineering science.

The interviews reveal that the specialists' everyday work appears to be a bricolage of multiple tasks; their responsibilities stretch horizontally and vertically across sectors and units and from the grassroots to the highest levels. The interviewees connect environmental and climate issues with what the organisation is "already doing," as one climate specialist puts it. Two consequences are immediately notable: first, as environmental and climate expertise is yet to be established as a stable field in Finnish municipal organisations, it appears to be intertwined with various sectors and other issues; second, the interviewees are not passively fulfilling tasks assigned to them but make themselves and their knowledge actively heard. At the same time, they constitute their own expertocracy. In this context, the category of knowledge is not internally homogeneous but heterogeneous, traveling through diverse paths and crossing various thresholds – in our term, trials of strength – to become embedded in organisational practice and decision-making.

The first trial: Gathering and condensing heterogeneous information and climate knowledge at organisational borders

The first trial of strength centres on the way in which heterogeneous information and the types of climate knowledge that are relevant for municipal organisations can cross the borders around and within them. We highlight the ways in which relevant information is filtered and tried out before it is assumed by the organisation and, especially, by the person in charge of gathering and disseminating the information within the organisation. Various gatekeeping practices in which experts welcome and develop information that could become useful knowledge to the organisation emerge in our analysis.

The experts gather, condense, and transmit heterogeneous information in their everyday work while opening paths for it to become

meaningful as knowledge in terms of organisational conditions. To bring knowledge inside an organisation requires multiple skills. Even though the educational backgrounds of the interviewees varied from a degree in natural sciences to engineering education, all had duties that required technical skills and knowledge, such as emissions accounting. In addition to technical data gathering and processing, they also attend workshops and seminars and follow academic and organisational discussions around environmental themes, seeking to gain new information by reading research articles and grey literature. The interviewees also discuss these issues with their peers, and municipal residents often reach out to them.

Even though there are multiple sources of environmental and climate information, condensing it into knowledge is predominantly limited to numerical and software-assisted forms. Finnish municipalities measure, quantify, monitor, and chart their environmental and climate progress in multiple ways. Numerical indicators are pivotal in this data gathering and condensing. For example, one environmental specialist describes the development work of indicators, which are connected to a data service based on the goals of the United Nations 2030 agenda for sustainable development and piloted in some municipalities in Finland, Sweden, and Great Britain:

> Under these 17 sustainable development goals, around 50 indicators have been gathered. Now the service is to be developed further to double the amount of the indicators, so during the next year there will be about one hundred indicators.

Another interviewee, an environmental planner, says there are "a good 30 indicators of ecological sustainability" currently in use in her municipality…

> … from greenhouse gas emissions to the amount of green areas and protected areas, to the increase in private car use, amount of public transport and the city's own procurements and environmental perspectives on them.

These kinds of indicators are important as numerical formulae of data handling; they enable standardisations over changes in time and place. Thus, they not only make it possible to compare one municipality with others but also allow environmental and climate information to pass the trial at the border of the organisation without friction, to begin to travel inside the organisation, and to be implemented in its practices.

Mere data gathering fails to pass the trial, however. Standardised indicators are crucial not only for condensing environmental and climate information but also for linking it smoothly outside the experts' own fields and expertise. In this regard, indicators are further scrutinised, combined, and merged to enable comparing them both within and between municipal organisations. For these purposes, the interviewed experts draft reports based on the technical information that they gather and possess. A yearly carbon dioxide report is based on systematic greenhouse gas emission calculations, for instance, and "at intervals of four years, a comparison is made" between similar municipalities, an environmental planner says. Various indicators gathered and reports drafted based on them connect environmental and climate work both inside and between municipal organisations and, at the same time, integrate it over space and time.

Work on indicators and other forms of data processing is coupled to the use of knowledge tools and devices. Environmental and climate experts both gather and handle data with various applications and computer devices; they further manipulate and shape the data to fit into other apparatuses and process it to create numerical indicators and visualisations. A sustainable development coordinator, for instance, manipulates cartographic and location data on her desktop with a practiced hand:

> I'm able to overlap the carbon sink map, the biodiversity map and the demographic map. So, there are already many kinds of possibilities available, and we try to come up with the ones that are the most informative and important for the adaptation plan, for example.

Combining different kinds of environmental maps is a technical issue and a relatively easy one for this interviewee. Moreover, cartographic data are amply available in the organisation or, as the

interviewee puts it, "on tap in the cartographic system" and ready to be used anytime on a desktop. Software tools also come in handy both when "updating the data" and in gathering and drafting reports:

> The [reporting] system generates different kinds of diagrams and graphs which can be used by the municipality. We then update the data and make sure that the newest information is at hand there. (Environmental and climate specialist)

Thus, the tools help knowledge to travel, as another interviewee says:

> A reporting tool [is used], so a municipality can choose which indicators it would like to report, based on which year, and whether it would like to juxtapose its indicators to the ones of other cities and to generate a report like that. (Environmental specialist)

By applying tools and devices, the experts condense the environmental and climatic data into numerical and visual information. They also draft reports based on this tool-mediated condensation. Reports are stabilised knowledge-objects: their standardised form allows them to smoothly connect beyond the experts' desktops, both within and outside the municipal organisation. Therefore, reports are crucial in the trial of becoming part of the organisations' activities.

Despite the prevalence of tools and standardised indicators, not all environmental and climatic data are gathered technically or compressed into numerical or visual forms. An interviewed environmental planner, for instance, describes her daily ecological data gathering by contrasting it to desktop work on software tools and computer devices. She goes into the wild to chart …

> … which natural values are prevalent now, and after that take[s] part in the land use planning to get the natural values safeguarded as the land use planning proceeds. And then, [she conducts] different evaluations of natural effects related to the city's plans. And then, planning the municipality's protected areas and choosing new ones, and kind of overseeing plans and activity … to plan how diversity values can be considered.

As a trained biologist employed by a relatively small municipality, she works "in the field a lot," especially during the summer months. Her work is primarily "nature conservation in practice" conducted as an "all-terrain biologist." Moreover, she implements fieldwork findings into organisational practice on her own. Consequently, her work is attuned to both the "goings-on" in nature and the practices of different stakeholders in the municipality.

An inventory of natural values in certain areas that the environment planner has compiled, for instance, has recently been taken up in land use planning. Instead of drafting reports based on indicators and other standardised forms of information to link the environmental and climate information with organisational practice, she makes sure that the information becomes adapted at face value, without ancillary arrangements. In so doing, she not only collects and condenses knowledge but also roots it in the organisation through her own initiative. The first trial of strength of environmental and climate knowledge, which takes place at the organisation's external borders, is passed because of her individual effort. This kind of transmitting work is at the core of the second trial.

The second trial: The expert as the embodied transmitter of knowledge

The second trial of strength in the travels of environmental and climate knowledge turns the experts themselves into the embodied representatives of knowledge. We go through the connections and situations in which experts hope to mediate environmental and climate knowledge with and in the organisation. The mediation takes place either in direct encounters with other individuals or by gradually establishing ways in which the information generated would habitually be taken into consideration by the appropriate individuals and departments of the organisation. Both forms of these mediations test the environmental expert's capability, first, to make others in the organisation understand that they need new information and, second, to translate and provide the relevant information to those who need it in a form that is both intelligible to and operable for them. These translations mould the expert, the recipient, and the mediated information.

All the interviewed experts describe the processes of data gathering and handling at length and point to them as important part of their daily work. They also use software-based data tools with a practiced hand and routinely draft reports based on measurements, indicators, and visualisations. Consequently, the difficulties in taking account of environmental and climate issues lie deeper than a general lack of knowledge; rather, as one climate specialist puts it, what surfaces as more important is friction in the "connections between things."

A development coordinator explains: "We have the carbon sink and carbon stock map available as cartographic data, but in a way, we don't have any kind of instructions or measures related to them." In other words, for her it is not clear how to use these data, and how others could put them to use. Similarly, an environmental planner indicates that there are ample data available on environmental and climate issues, much of which are processed into indicators and reports, but she is dubious about their actual impact:

> As we gather indicators, there are of course loads of data, [but] to make them effective in terms of decision-making has been quite challenging. The data we gather, I don't know whether they serve the purpose. The city always has an enormous amount of information [but] does it have impact on anything? Is it all just unconnected reports? Can someone really make use of them in projects and decision-making?

Moreover, even though indicators and reports stabilise the understanding of the environmental and climate data relevant for the municipalities and enable juxtapositions between different time spans and organisations, the indicators' relevance can be short-lived. One informant describes how environmental reports are connected to more wide-ranging strategies and evaluations and how the reports change accordingly:

> We have been doing our own report for some five years now and connected it to our environmental policy evaluation, but all this is changing now because we have a new strategy, new outlines for environmental policy, which were just today processed at the city council, in fact.

She then continues by saying that, for example…

> … the comparison of social sustainability indicators was dropped a couple of years ago, as every municipality has these welfare reports that say similar things. Then there are some [indicators] which might be nothing more than gathered only for one particular purpose.

Her reflection is eventually rounded off with a rhetorical question followed by an immediate answer: "And have they been brought up when making decisions? Maybe not."

There are thus abundant data and tools to process that data, but there is no overarching awareness of how to use, combine, and transmit different forms of data and make environmental and climate knowledge effective in the organisation. First, even though data are gathered, condensed, and made available, their actual implementation is not guaranteed.

> It's up to the awareness of the planners whether they take out the [forest biodiversity] map when they're drawing the planning map,

as one development coordinator puts before continuing with scepticism:

> So, recently I have been saying to land use people that the baseline is not to mess up these carbon sinks. But it hasn't really affected the practice.

The interviewee tries her best to use visual cartographic data to concretise the issue at hand and tackle the frictions in its implementation: "The red spots [on the forest biodiversity map] could point out that it would be possible to protect that spot." However, the red spots do not affect the ongoing organisational processes unless she takes on an active role. Consequently, she thinks her tasks make up "a kind of multi-professional job."

In practice, she cannot stick to her own area of expertise but is obliged to understand what everybody else in the organisation is doing and to intervene – if she wants to achieve any results: "I have made jokes that my work is to meddle in everyone else's jobs."

Second, environmental and climatic issues are also wide-ranging, long-term, and complex, and

the measures used do not capture them in their entirety. A sustainable development coordinator highlights such a discrepancy between traffic and air quality measurements. The current calculation tool captures only a part of emission issues: "There is some legwork to be done here as some activities […] are not visible in the calculation, and it has to be told somehow that this has an impact indeed." The tool at hand enacts and stabilises emissions as particular kinds of objects and, at the same time, steers attention away from other possibilities of object-making. Consequently, other types of measuring are needed to shed light on important aspects of the issue – and at scales that are currently neglected. She goes on to describe how, besides current calculations, it is also indispensable to "make visible somehow, for instance, that other factors of air quality have been improved. Nitric oxides, particles, and the like dwindle at street level."

Both examples highlight the frictions of environmental and climate knowledge implementation and the ensuing need for the experts to transport, transmit, and translate the knowledge into the organisational practice themselves. The data will not do the work automatically; they must be translated, and the experts take care of these translations in person. The interviewees mediate between as yet unestablished environmental and climate knowledge and already established organisational practices. These translations are not specific tasks to be taken care of occasionally but the core work of the interviewed experts. An environmental specialist, for instance, describes her work as mediating "natural values and the city's ventures."

As these ventures follow their own logic and pace, they can often appear incommensurate with climate aims. The interviewees refer to, for example, slowness of change in policies and attitudes and a general complacency in local politics and municipal bureaucracies. An environmental specialist describes her frustration in terms of not being heard. She represents the highest level of knowledge of climate change and extinction mitigation in her organisation, but she feels that she is made to languish on the outer circle of her organisation, "detached from strategic management":

> Looking at the organisation, there in the box [where the strategy managers work, concretely and metaphorically], inside which we are not, but where strategic development, budgetary planning, human resources development, information management and then risk management and the ownership steering of our big companies are. There they have apparently good conversations, but you are not with them.

She and her colleagues do not have direct access to the inner core of the organisation, so the climate issues in which they specialise are not sufficiently considered in organisational practice. This interviewee tries her best to tackle this by being active, which means that her efforts to be heard take up a large part of the working day:

> I meet people from other parts of the organisation a lot. We try to get to the right meetings and to the right discussions and discussion threads. Yes, we are curious, and we read the agendas and we are all ears because our presence is not remembered, even though we would have something to say and provide. This is also kind of detective work.

Another interviewee, a sustainable development planner, describes similar frictions by illustrating how she tries "to muscle into all kinds of work groups and bring forth these issues."

In this kind of mediation work, experts become human embodiments of climate change knowledge. This mediation is a two-way process between the experts and the organisation. The interviewees are not only active mediators themselves but are also called upon when environmental questions are to be discussed in the organisation:

> A lot of my time goes into answering questions from other branches of the city bureaucracy. A town planner will call to ask whether there is a question of conserving a path for a flying squirrel [an endangered and protected species in Finland] and what that would mean in practice. And then I look at the map and tell them that in areas like these, suburban areas with small houses, you should always leave enough green spaces. And then they either will or will not make changes in their zoning plans. And then I will get an email from forestry, someone telling me that they're planning

> some clearings there and wanting to know if there are some environmental values they ought to think about. Consultations like these take a lot of time. (Environmental specialist)

Besides mediating branches inside the municipal organisations, the interviewees also work as links "between civil society and the city organisation" on environment and climate issues, as another environmental specialist phrases it. In encounters inside and outside the organisation, the expert is tested. For environmental and climate information to become embedded in the organisation, she must transport, transmit, and translate it, which requires both socio-communicative skills and awareness of organisational processes and practices. In the words of a climate specialist, "you have to be able to speak, be brave enough to go out there and talk to people" and, ultimately, learn "how the city works." Knowing the organisation thoroughly enables these experts to be with the right people at the right time, sitting at what the informants call "the right tables."

The third trial: Meeting tables

To succeed in making environmental and climate knowledge effective, it is of utmost importance to be at the right tables at the right time and with the right people. It is at the meeting tables where decisions are made and where all the heterogeneous things of which a municipality takes care are brought together, amalgamated, and incorporated into – or dropped from – the city's agenda; these tables are 'obligatory passage points' (Callon, 1986; Latour, 1984) for getting any climate knowledge implemented. The best tables are those that are permanently occupied because the stability of positions enables moving agenda items along. However, it takes a lot of effort to be allowed to be present as the embodied climate knowledge representative. The meeting tables make thus up the third trial of strength. Environmental and climate expertise is put into practice in municipal organisations by successfully undergoing these trials.

At the meeting tables, there is in principle no incommensurability, as everything is negotiable; in practice, the structures and path dependencies of the city become readily apparent to the environmental experts. To begin with, it is difficult to get a place at the right table; this is the effort required to become the embodied climate change knowledge representative in a group of people who present and represent many other concerns and interests in the municipality. Moreover, seats at these tables are not permanent; environmental and climate issues can be swept away, and the tables themselves can be dismantled altogether. This is because environmental and climate work in Finnish municipalities is largely externally funded and operates as projects. When an individual project is finished, the tables where these concerns are made to matter most are folded up and put away.

When asked about the structure of her daily life at the office, one energy and climate specialist responds by saying that, "well, very much meetings, it's like that; discussion is maybe the most typical work task I do." These meetings are frequent and important. To affect the choices made in cases where environmental and climate issues are introduced to the organisation's "traditional" way of making decisions, active discursive mediation is needed: "We now implement [the climate plan] in the organisation by just discussing what it means with different units' management groups." Knowledge is mediated by social encounters in a discursive fashion and shaped around meeting tables. Therefore, the experts dare not risk not being at the tables; they are constantly seeking "to be in the right place at the right time," as the interviewee describes it.

Keeping track of all the proper times and places becomes frustrating at times, and insuperable frictions surface as a result of that effort. These are evident in the descriptions of facing barriers blocking the possibility for active mediation work and, at the same time, the translation of environmental and climate issues into organisational practice. Being socially active and having "big ears" are not always enough, as important decisions are often prepared in chains of preliminary meetings in which a preselection takes place in choosing who "gets a seat at the table," as a climate specialist put it. Another interviewee, an environmental expert with a fixed-term contract, recounts a chain of frustrating events of trying to

insert a climate mitigation perspective into the city's procurement plans:

> I went to see the head of procurement and asked whether I could join the committee, since, anyway people in the executive council had said that I should see the plans and bring some environmental perspective into it. But I never got to see the plans. So, I went and asked what the situation is. And he says, oh yeah there's this committee. Can I join the committee? Complete silence. Then I asked my friend who's got a permanent post whether she could play dumb and ask about the situation, so she does. And gets one reply. And then nothing. So the next step is I go to see our branch director [Environment and Sustainability] and tell him, "Here's the thing and I think we need to be on this committee, but we're not getting any answers, and it's like maybe some people just don't want too many people in so things don't get too complicated and messy and too time consuming so they can't get the plan ready for the city council." So, the branch director must go and play dumb and say, "Hey I just heard there's this committee and could we possibly get on it?" Finally, I get on the committee, but of course at that point it's June and they've been working on the plan since January. In the end I got to give them the comments I had, but I'm not sure whether they can do anything about them because there's big pressure to get the plan finalised. It's all a bit problematic.

A project worker like this informant might have crucial expertise for incorporating environmental and climate plans and actions into the procurement plan. However, she cannot appoint herself a permanent member of a committee and can only get onto the committee through social footwork and being on good terms with the people capable of having impact on procurement.

No matter how active and skilful the experts are, the doors of the boardrooms close the moment whatever project they are working on ends. Environmental experts are often project workers, so their points of view are only temporarily present in the organisation. By contrast, the best tables are those that are permanently occupied:

> The people that get invited into meetings, they usually have permanent positions, which of course makes sense in terms of continuity, because projects end, and project people come and go. (Environmental specialist)

This precariousness has concrete effects on the organisation's everyday work, as environmental and climate knowledge is porous and not thoroughly established. Even when the experts' points of view appear to have been established during a longer tenure, they can be suddenly bypassed. Another interviewee, working as a project-based environmental expert, provides an example:

> I've been working with the city planning people for years now on many projects and then, out of nowhere, someone there may say, "Yeah, we talked about this, but we can't really help with any emission reductions, you know, because there will always be some emissions when there's new zoning". And I'm like, "What just happened?"

Stringing discrete projects together does not help if the translations fail in stabilising environmental and climate knowledge and rooting it into the organisational structure. The knowledge remains tied to each project and to the employees recruited to work on it. To put this another way, the experts' precarious working conditions block the establishment of environment and climate knowledge and tie the implementation of that knowledge to social contacts and personal activity. Fortunately for the environmental experts, some of the things they are able to present at the meeting tables do move forward and are stabilised into new forms and new objects that can have more staying power than the project workers' employment contracts. We round off our analysis by concentrating on one such object, the road map.

The final trial: Climate knowledge on the road (map)

Environmental and climate knowledge does not easily reach the most important table, budget negotiations, but all is not lost. As the fourth and final trial of strength, we examine the tables that environmental and climate knowledge does reach easily; among these, the road map table is central. It is in fact made based on climate knowledge and for climate knowledge. The aim of translat-

ing climate knowledge is to make an intervention, but interventions are not tied to contributing to established, straightforward processes like budgeting. Other channels are available or can be created instead and perform different kinds of interventions.

When asked about how environmental and climate knowledge is implemented in the everyday operations of the municipalities in which they work, the interviewees highlight diverse communication processes like meetings, workshops, informal discussions, and 'road maps.' These maps of environmental and climate issues make up one part of the motley patchwork of future-oriented policy forms, short-term campaigns, medium-term plans, and long-term development programmes, strategies, and scenarios.

The environmental and climate road maps are loosely coordinating positionings and near-future plans, typically gathered in an ad hoc manner by a multi-stakeholder network. Once a road map is created, it is not used in a straightforward fashion as an implementation tool for a set of initiatives and goals. Instead, the status and function of road maps appear to be impermanent and diffuse. They chart initiatives and outline plans and serve the municipality as compilations of activities, measures, and aims: "The idea [of the road map] has been to put together everything we do to see what kind of things are currently going on", a climate and energy specialist describes the purpose of road maps. Thus, they are also used as a means for an organisation to monitor itself. The maps function as framing devices and checkpoints for ongoing processes: "We can observe [with road maps] whether we are on the right development path." But because they are diffuse, road maps also spread out easily to various branches within the organisation. In so doing, they affect organisational practice in uncoordinated and unpredictable ways. Besides coordinating organisational activities for the near future, the road maps mentioned in the interviews share other features. First, they are guidelines drafted through a multi-stakeholder effort and are accordingly connected to a wide web of plans and future policies. Second, their role is ultimately ambiguous in organisational practice, and they are depicted predominantly as loose, fragmented, and unbinding by the interviewees. However, third, the road maps are not insignificant in establishing environmental and climate issues.

In general, road maps figure as stabilised points of reference for coordination of future-orientated environmental and climate initiatives. Diverse road maps on themes such as resource wisdom, carbon neutrality, economic development, and transport and the environment were pointed out in this vein during the interviews. For example, a Carbon Neutrality Road Map has the ambitious yet broad aim of comprehensive carbon neutrality of the municipalities at issue. It is created not only to steer but also to compare climate actions in many Finnish municipalities of similar size. However, the map is not implemented into organisational practice in a straightforward fashion, but rather it provides a general framework for a decade-long process.

The experts discussed road maps at length in the interviews, but their actual role in implementing environmental and climate knowledge and in managing the ensuing activities remains unresolved. The porous status of the maps becomes evident even in their inception phase. Even though the road maps were used by the municipal organisations, they were "not created inside the city hall," as one head of development puts it. Instead, their creation processes are connected to wide networks spanning outside municipalities and involving various partners, both public and private. For example, the Resource Wisdom Road Map used in one of the studied municipalities was created by a network of diverse stakeholders, "including the consultants of The Finnish Innovation Fund Sitra." Besides this fund …

> … there were some fifty quarters involved, roughly half of them enterprises and the rest public administration and the university and the like. And in a similar vein, the city has an urban strategy, and there is a separate programme that contains a section focusing on the environmental side of things. Also, the city's own strategy was drawn up in cooperation with enterprises and the university. (Head of development)

Another interviewee sheds light on the multiphase creation process:

> It was workshopping where these steps were outlined. There were experts and non-governmental organisations and others talking, so [they were] that kind of facilitated workshops. (Environmental specialist)

A sustainable development coordinator refers similarly to "stakeholder workshops," and a climate and energy specialist describes a recent process of road map drafting as "stakeholder work" with "many participants outside the city to reflect on these measures."

When asked about the methods used in creating road maps, the interviewees report that "there are no standard procedures," in the words of a head of development. Although the networks are wide and the creation processes multistage and time-consuming, the maps are drawn up anew every time, "depending on the situation." The interviewed manager speaks of an "orienteering map" which is created in multi-stakeholder work, "and when everyone is brought up to speed […] the map is discarded, and everyone clears off." These kinds of processes of creation were also pointed out as challenging, and the implementation of the maps as frictional:

> It was planned to be carried out in a certain way and then, when I was not at work when it was created, things maybe didn't go as they were supposed to. So, the idea was kind of to think up actions which would fit [the city], and as there were these groups taking part, there would be the people ready to really carry out the actions. But the thinking kind of stayed on the upper level, so details and specifics always remain a bit loose.

These challenges, highlighted by a climate and energy specialist, are further connected to the general ambiguity of road maps. They do not appear to have a binding coordinating role in getting environmental and climate activities across in the municipalities, as an environmental planner describes: "the plan has to be made, and then no one says who's going to implement it." A climate specialist laments the looseness of the maps with similarly frustrated overtones:

> It's not enough that we have these road maps and plans; these actions must take place. And the process is usually such that you must go through the same things over and over again.

When the interviewees discuss the actual effectiveness of different measures it becomes evident that roadmaps lack binding strength in environmental and climate action. Instead of loose road maps, suggestive plans, and numerous chains of workshops and brainstorming sessions, they call for binding procedures that would "really implement responsibilities to different actors," as an environmental planner puts it. According to her, the implementation of the contents of the road maps would be completely different if appropriate responsibilities were written into regulations of the Centre for Economic Development, Transport and the Environment that in Finland manages regional planning issues, or simply enacted into law.

The interviewees depict the road maps as too loose and porous to be able to guide and implement environmental and climate knowledge and activities inside Finnish municipal organisations. Yet from the point of view of travels and trials of knowledge, their role appears central. First, the road maps channel environmental and climate knowledge into routes leading outside the core processes of municipal organisations. Instead of budget and planning tables, environmental and climate knowledge is *steered to* the road map tables; alternatively, these multi-stakeholder and ambiguous tables are *made for* environmental and climate knowledge and *based on* that knowledge. Thus, second, tying these modes of knowledge to road-mapping does not push them entirely outside organisational practice. The pivotal aim of translating knowledge is to achieve change in organisational practice. Even though this aim is hard to reach directly – by translating the knowledge into the budget, for instance – there are still multiple channels available for this, each of which performs different kinds of interventions.

For instance, climate road maps can be taken up at the tables where the marketing of a city is planned. In the efforts to draw in new taxpayers, both individual and corporate, environmental and

climate knowledge is translated into a marketing strategy through which the municipality can make itself known as a successful green city. Once the road map for a green, sustainable, and clean brand for the municipality is created, it is also connected to essential organisational processes. Carbon neutrality, for instance, does not drift unattached but is mentioned everywhere from municipal websites to agendas for global city networks.

The travels of climate knowledge thus can take surprising turns and become effective in unexpected ways. The bids for the European Cultural Capital for 2026 (ECOC) by Oulu and Tampere, two of the three Finnish cities that have advanced to the second round of competition, provide an example. Both bids attempt to connect climate awareness and action to a transformative programme for making the cities flourish as places of cultural production, social and environmental justice, and sustainability (Oulu, 2020; Tampere, 2020). While climate knowledge is often shunted off to the periphery in municipal decision-making processes, the evaluation processes in ECOC bids connect the knowledge to the centre in completely new ways. At the same time, research-based measures behind the sustainability aims are pointed out and made visible, which, in turn, keeps these activities going in the everyday worlds of the interviewed experts.

It is also significant that the Tampere bid is regional and involves numerous smaller municipalities in the surrounding region, which facilitates the travels of climate knowledge between them. Furthermore, if either city wins the ECOC nomination, this could have far-reaching consequences by opening up new input slots for climate knowledge in different departments of the city organisation, in other Finnish and European cities, in cities involved in climate action networks such as C40 and the Covenant of Mayors, and in the Finnish state itself. During the bidding process, the travels of environmental and climate knowledge reached a new and completely unforeseen venue.

Despite the experts' scepticism, environmental and climate knowledge can make a difference in the municipal organisations, but that difference is not achieved with the most important target – the budget – in sight. Differences develop through detours instead (Latour, 1999). Detours are not dead ends, and the knowledge is not lost during detouring; rather, it is translated into municipal processes in unpredictable ways. We return here to the beginning of the story: drawing up the road map, no matter how porous or unbinding it may be, is able to translate new knowledge in and for the municipal organisation. The road-mapping process has enrolled actors to seek and produce information consisting of new kinds of indicators and new kinds of comparisons and to draft future visions. Environmental and climate knowledge is at the core of the road map and thus at the core of the organisation's future, when visualised and imagined this way. Moreover, when the road map is drawn, more information becomes available and condensed into a form that is easily circulated. During its travels, the new information is translated into the municipal organisation, not in a forthright manner but in roundabout ways.

Conclusion and discussion

We have made an intervention into the field of climate governance and sustainability studies by respecifying the transfer of knowledge in governance organisations with STS tools. This new outlook provided us an opportunity to answer two different calls. First, in climate policy research, a need to understand the provenance and dynamics of barriers, instead of diagnosing where to remove the clogs from the policy pipeline, has been pointed out (e.g. Moser and Ekstrom, 2010; see also Biesbroek et al., 2013; Eisenack et al., 2014). We shifted the focus on the appearances of frictions and hindrances that climate knowledge encounters in the everyday work of climate experts. By following the travels of environmental and climate knowledge in Finnish municipalities, we explored, first, what kind of knowledge is gathered, condensed, and implemented, and, second, how these modes of knowledge are transported, transmitted, and translated in organisational practices.

Second, to advance STS's own techniques of knowledge production, we have presented a research design to both unpack current understandings of frictions of climate knowledge adoption and to reassemble the organisational formation of climate knowledge and its routes

of impact in a novel manner. To make sense of what happens during the travels, we employed the classical STS idea of trials of strength. Instead of stopping and checking a box at the sight of a possible barrier in our interviewees' accounts, we interrogated further. As frictions emerged in the unsettled "connections between things," we focused on what enables climate knowledge and experts to proceed and what comes of them once a trial is surpassed.

We identified four key trials through which knowledge must pass: (1) the practices of both gathering heterogeneous information about environmental and climate issues and instilling it in municipal organisations; (2) the experts themselves as personified reservoirs of knowledge; (3) the various meeting tables where knowledge is both condensed and made to travel farther; and (4) climate road maps, which work not only to curtail environmental knowledge but also allow it to be circulated and implemented in unpredictable ways.

We encourage future studies focusing on modes and movements of knowledge to put these four trials to test. In our own analysis, they show how fully functional organisational practices work to regulate, compartmentalise, and filter climate knowledge in several interwoven ways. To understand what is at stake in these dynamics of administering climate change actions in municipal governance, we conclude by discussing our results together with STS-inclined approaches to knowledge translations in policy organisations.

Climate and environmental knowledge must first find its way into the organisation and its practices: it must cross the outer borders of the organisation and further negotiate internal boundaries. The experts do this kind of boundary crossing, intermediary work in at least two respects. Their discursive efforts connect sectors and make complex climate issues meaningful to the municipal organisation. With their tools and devices, the specialists condense environmental information into translatable forms; the organisation recognises and takes in especially numerical information and reports in duly drafted forms. Devices like air quality measurements and carbon dioxide reports frame and tame manifold climate issues into technical and numerical forms by mimicking the organisational input slots already in place.

Together, the intermediary functions of discursive work and knowledge devices reveal how climate knowledge is kept in check by deeply ingrained organisational structures in the municipalities. Once the trialling frictions between established, and precarious practices become manifest, climate knowledge meets organisational boundaries. On the one hand, knowledge devices appear as boundary objects that can ease in the 'local' knowledge of the climate specialists into the municipal organisation (Bechky, 2003; Star and Griesemer, 1989); on the other, the trials demarcate the organisational core from the periphery (cf. Yanow, 2004). While allowed to enter the organisation's practices through certain devices and strenuous communicative effort, climate knowledge remains on the outskirts, failing to enrol other sectors and actors.

The specialists themselves, indeed, personify and embody a trial for environmental knowledge. Instead of being institutionalised in and distributed across organisational practices, the knowledge is cultivated and sustained in and through the experts (cf. Freeman and Sturdy, 2014). While our informants represent the peak of environmental expertise in their organisations, they remain dispensable or auxiliary at best. The organisation will keep on operating without climate knowledge, which, however, needs the organisation to sustain itself.

The trials that determine whether climate knowledge is allowed to diffuse in the organisation also put climate experts and their knowledge in their precarious place. Meetings materialise as 'tables' around which crucial decisions are made. The right meeting tables, or just knowing how to get a seat at them, prove to be a decisive testing ground. It is there that the tasks of including and excluding relevant actors and parties in the organisation are performed and where sense is made of what the organisation knows and does (Freeman, 2019; Schwartzman, 1989). Trials at meeting tables filter climate knowledge, and what passes the sieve transforms into new kinds of devices: climate and sustainability road maps.

Drafted as multi-stakeholder efforts, road maps figure as stabilised points of reference for future-

oriented processes related to environmental and climate issues. Road maps provide the means for a municipality to make sense of "where we are going" as an organisation that wishes to project effective climate actions. Road maps work as mediators in Hennion's (1993) and Latour's (1999) sense, and drafting the maps translate existing knowledge in different sectors into the organisation's prospects. Road maps mediate between things that the organisation is "already doing" and its future aims.

But road maps have had to go through a trialling transformation (cf. Gherardi and Nicolini, 2000) before they can be "distributed differentially" (Freeman and Sturdy, 2014: 16) in the organisation. Direct translations of climate knowledge into the organisation's core knowledge practices, especially those involving budgeting, fail. These modes of knowledge are thus steered onto sidings and the peripheries of the organisation, from where they can assume new unpredictable forms.

Road maps reappear, for example, in the marketing and branding in cities' efforts to promote themselves sustainable and ecologically progressive. Green marketing is more tightly coupled to the organisational core, especially to budgeting, than climate knowledge in its initial forms. But as these modes of knowledge are translated into marketing road maps, they also eventually become attached to organisation processes. Climate knowledge is not translated into the municipal organisation in a forthright manner but in roundabout ways such as marketing detours.

Our travels and trials approach reveal conflicts in knowing how to do climate governance: by translating climate knowledge so that it conforms to their established practices, municipalities can defer a transformation of their purpose. Still, it is through these very trials that municipal governance organisations come to know how and what they ought to know in order to function – and with what kind of knowledge they "make do" (Voß and Freeman, 2016: 22). The pressing practical implication for municipalities is to recognise and reassemble the structural, path-dependent practices that steer climate knowledge onto organisational peripheries.

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The Mutual Enablement of Research Data and Care:
How Newborn Babies Become a National Research Population

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Abstract

Public health research depends on access to population data. This article is a study of the practices and the work enabling data collection for public health research. In Denmark, a blood sample is taken from practically every single newborn baby through a national screening programme. These samples can be combined with other health data and used for research purposes without explicit consent from those giving the samples. With an ethnographic approach, I study the practices, the work and the workers of the Danish NDBS samples, and explore how newborn babies come to serve as an important national research resource. From these studies, I argue that the making of national research resources in this way is 'mutual enablement' of research data and care. The work of both health professionals and researchers mutually enables professional care and opportunities for collection of samples and data for research. It is through this mutual enablement of research data and care that newborn babies become a national research population.

Keywords: data, care, research population, public health, newborn dried blood spots

Introduction

Public health research depends on access to population data. This article examines the practices and the work enabling data creation for population research. It asks, "How do babies become data?" and explicitly in this case, "How does a national population become a research population for genetic research?" Using the case of Danish 'newborn dried blood spots' (NDBS) samples, I explore how these samples come to serve as national research data. In many ways, the collection of Danish NDBS samples represents something of a 'data heaven' for researchers, adding a biological component to the general idea of Denmark as "an epidemiologist's dream" (Frank, 2000, 2003). Moreover, studying the NDBS samples serves as the continuation of the social science work by other STS-inspired scholars. This work has focused on the labour and management of the NDBS samples as a political commodity (Lindee, 1982) and on how the consequences of newborn

screening can have a major impact on the life of the child and parents (Timmermans and Buchbinder, 2013). Timmermans and Buchbinder (2013) end their inspirational book with five "omens" on the future of newborn screening, the fifth focusing on the retention and future use of NDBS samples for research. This fifth omen is where I initiate my studies. The object of this article is to elucidate practices in how a population of newborn babies in a socially embedded, and often emotionally tense, care situation, becomes research-friendly data.

The Danish NDBS samples serve as a unique case study in this context because of their national collection process. These samples have been taken from almost all children born in Denmark since 1982 (Nørgaard-Pedersen and Hougaard, 2007). Consequently, the samples are considered nationally representative. The samples are a part of the Danish newborn screening programme and therefore has a primary clinical purpose of screening. Through cryopreservation, it is possible to store the samples and later re-use them for research purposes. Using NDBS samples has caused controversy internationally (Couzin-Frankel, 2009), for instance more than 5 million NDBS samples have been incinerated due to lack of parental knowledge and consent for research in court cases across several US states (Waldo, 2009; Lewis, 2015). In Denmark, there are legal exemptions in place to facilitate not only use of these samples for research, but also to link the Danish NDBS samples with register-based data on health, education, employment, and various other data throughout the lifetime of each individual. The Danish legislation allows for the NDBS to be re-used for research purposes without explicit consent from either the child that gave the sample or from their parents, regardless of how old the sample is (Folketinget, 2020). Consent for the sample being stored and possibly used for research purposes is embedded in consenting for the sample to be taken. In a recent research project, for example, more than 80,000 samples were aggregated and genetically sequenced in order to carry out research on the genetics of psychiatric disorders in children and adolescents (Pedersen et al., 2017). Studies like these are only possible if population data are available for research.

In the studies of this article, I focus on the practices that enable newborn babies to become a national research population. Here I am particularly inspired by the term 'populationisation' introduced by Holmberg, Bishof and Bauer (2012), as "a process that encompasses the enrolment of the individual into a segment of a population through the compilation and transformation of individual data into population data" (Holmberg et al., 2012: 401). I therefore study the work and the practices when an individual newborn baby has an NDBS sample taken at the hospitals and when these samples are compiled into a population at the Danish Neonatal Screening Biobank.

From these studies, this article argues that the creation of research populations is a case of what I call *mutual enablement* between research data and care.

Enablement, data and care

In this section, I will briefly introduce the three main terms that shape this article: enablement, data and care.

As to the first term, 'enablement', I use this term as a part of my argument of 'mutual enablement'. According to the Cambridge English Dictionary, 'enablement' is "the process of making someone able to do something, or making something possible" (Cambridge, 2020). This definition allows for the consideration of mutualism involved in how samples are enabled as an object in the practices, as well as the study of what the samples enable for the actors involved. In earlier studies, the term 'enablement' has been used as the central theoretical concept in disability studies (see e.g. Rapp and Ginsburg, 2001; Whyte, 2014). In these studies, enablement was viewed as a (measurable) bodily function of a human being, or as a focus on patient enablement through the process of treatment (Howie et al., 1998; Mead et al., 2002; Desborough et al., 2017). Enablement has also been used in Science and Technology Studies (STS) literature to describe how 'enabling arrangements' can explore independence as a sociomaterially distributed, negotiated and continuous accomplishment in older people (Bødker et al., 2019) and how patient engagement with technology can enable the production of measure-

ments (Langstrup et al., 2013). Still, 'enablement' as theoretical concept is not as recognised in STS scholarship as the term 'enactment', which focuses on how an object is performed or implemented through different activities (Mol, 2002). A recent study has proposed that 'enablement' and 'enactment' are in fact intertwined (Carusi et al., 2018). However, as 'enactment' focuses on the object, it has a tendency to leave the actor vague (Mol, 2002). I will argue that the health professionals handling the Danish NDBS samples are not vague, but that they actively use the space to enable possibilities for themselves, and in a larger perspective they, in turn, enable population research. Not only are the data enabled through their hands, but the health professionals mutually enable different possibilities of care through the same process.

As to the second term, 'data', the recurring question discussed internationally by researchers and policymakers is often, 'What are data?' (see for instance Edwards et al., 2011; Kitchin, 2014; Maurer, 2015). In this era of 'big data', when the desire for more data of better quality and on more people permeates health systems (Hoeyer, 2016), social science research has focused on understanding data – how they are identified, produced, circulated and with what implications. Data transform our social relations as well as our working conditions. However, this focus on better understanding existing data leaves a research gap of how these data become data in the first place. This article fills this gap in research with an empirical study of the practices and the actors who enable NDBS samples from newborn babies to become research data. Previous studies on the production of data have found that data do not just exist but are structured through processes of transformations (Denis and Goëta, 2017). Etymologically, the term 'raw data' is a contradiction in itself, as introduced by Bowker (2006) and elaborated by several scholars in "Raw data" is an Oxymoron with an argument that data do not simply exist as a resource, but are the outcome of a process of work: collecting, entering, sorting. It is not 'raw' (like a vegetable from the ground), rather it is 'cooked' (like ratatouille) (Bowker, 2006; Gitelman, 2013; Biruk, 2018). These notions have been crucial for my understanding of the creation and the existence of data. Here, I extend this work by describing the data work that goes into making a population of NDBS samples into a population of research data. Data work encompasses the sociotechnical practices of producing and using data (Møller et al., 2020) and refers to "any activity related to creating, collecting, managing, curating, analyzing, interpreting and communicating data" (Bossen et al., 2019: 466). Moreover, data work attends to the question of who creates data – i.e. the data workers. Data workers seldom work alone. Rather, they are a part of a larger network together with other data workers. Together, they form an infrastructure for data (Møller et al., 2020). In this article I therefore study both the data work and the data workers: who does what kind of work, and what kind of work goes into each of the practices when the blood from a newborn baby's heel becomes available as data for new research. In contrast to other studies focusing on one kind of work or one kind of worker in data making (see for instance Pine and Bossen, 2020), by studying several practices and actors, my goal is to balance the different perspectives throughout an infrastructure of practices as one larger study. Social and cognitive distance often separates those who create data and those who make use of them (Espeland and Stevens, 2008). As a result, those who use data tend to take the existing data for granted and have little interest in their origin, overlooking the meticulous work of collecting, storing and preparing data. Finally, this article therefore attempts to elucidate the perspectives and experiences of both data creators and data users.

As to the third term, *care,* it is essential to the study of the Danish NDBS samples. I recognise that the definition of what and when something is 'care' can be slippery, and any attempt to actually define 'care' risks becoming insufficient (Martin et al., 2015). 'Care' is a word filled with dependencies. How one defines 'care' is dependent on the context and perspective, and the term 'care' is often used in both scholarly articles and in everyday interactions. When expressing care for someone or something, it often implies an interest or concern (Merriam-Webster, 2021). In the context of newborn babies, care is often associated with motherly or parental care. However,

in this case of the Danish NDBS samples, I argue that the care produced by data might not be the care expected. As this article will show, the actors – such as midwives, postnatal nurses, biomedical laboratory technicians and researchers – who engage with the NDBS samples, express and enable care in multiple ways and directions. These are examples of care in practice. Care in this case is multiple and selective, and a study of what constitutes good care from the perspective of the actors involved is very much dependent on their professional attention and expertise (Mol et al., 2010; Davies and Horst, 2015). They care for institutional goals as well as individual babies. Moreover, this practice is something that is done actively (Mol et al., 2010). Unlike a concern, it is not something they have. It is something they do. They care.

Studying the Danish newborn dried blood spots samples

This article is based on qualitative methods and was conducted as inductive ethnographical research (see e.g. O'Reilly, 2012 on ethnographic methods). Thereby, even though I set out with an initial focus, my analytical perspective was shaped and reshaped by the observations I made and the relations I formed.

Studying practices and work(ers)

As mentioned, the Danish NDBS samples are taken from almost all children born in Denmark within 48–72 hours after birth. This article builds on fieldwork carried out in two hospitals in Denmark in the spring of 2017. Access to fieldwork in healthcare often relies on gatekeepers (O'Reilly, 2012). Through a collegial connection to a midwife involved in research, I was able to approach two senior managers at a Danish hospital with one of the largest maternity wards in the nation. Following an initial meeting with one of the managers (a senior midwife who was also a principal at the Midwives and Postpartum department), I was given access to all areas of the NDBS sample collection process. At this department, my observations stretched over four days. I visited two different maternity wards and spend one of the days following a midwife on home visits. Subsequent to the observations at the first hospital, I was able to gain access to another hospital with a smaller maternity ward, as a comparator for my initial observations. Here, the fact that I had gained access at the first and larger hospital, was enough for them to also grant me access to their hospital, and I spent two consecutive days observing NDBS sample collection processes at the second hospital. In total, I carried out 25 observations of NDBS samples being taken from newborn babies.

During my fieldwork, I sought to understand who does what kind of work and where with the Danish NDBS samples. Here, I became aware that the sampling happened in various spaces and was conducted by various health professionals. I first observed samples being taken by midwives and maternity nurses at a maternity ward. Later in my fieldwork, when carrying out observations at the hospital ward where mothers were hospitalised due to complications in their pregnancies or at birth, I found that biomedical laboratory technicians were in charge of taking the sample on their daily rounds. These samples were taken either in the rooms where the mother had been admitted or in a shared room for nursing babies and sample-taking. Some parents were fortunate enough not to have to go back to the hospital, but instead have the midwife come to visit them in their homes. When conducting participant observations during my fieldwork, I would introduce myself and briefly explain my research aim, and ask the parents if they would mind my observing. All of the parents I encountered were willing to be a part of my project. After the sample had been taken, and the parents had left the room, I would write down notes on my observations and conversations. In cases where I visited the family's home, I would write my notes in the taxi between one home and the next. In general, I felt very welcomed during my fieldwork. Reflecting on my own role, I believe it has to do with being 'at home' (Madden, 2010, 45–46) in my field. I experienced a 'familiarity' with the mothers and to some extent also with the health professionals. This is probably because at the time of my fieldwork I was also the mother of a young child, and not long before this time I had been in the very same position as the mothers I encountered. Moreover, I have a background in public health, giving me a basic understanding of the health issues of newborns.

I was thereby able to follow along and engage in the clinical conversations between midwives and nurses. The familiarity of being 'at home' in my field thus allowed me often to be welcomed as more of an insider than an outsider.

During my fieldwork, I would engage in short conversations with the health professionals about the NDBS samples. In order to gain a deeper understanding of their perspectives, I subsequently interviewed seven of the health professionals I encountered during my fieldwork including three midwives, two nurses and two biomedical laboratory technicians. The interviews focused on their experiences with, and reflections on, the NDBS samples.

At the end of the working day, all of the NDBS samples are gathered together at the hospital and subsequently sent to and kept at the Danish Centre for Neonatal Screening at the State Serum Institute (SSI), a state-governed institute under the Danish State Ministry of Health, responsible for the screening and storing of the samples (Statens Serum Institut, 2020b). After the screening, the samples are stored in the Danish Neonatal Screening Biobank, a part of the Danish National Biobank (Statens Serum Institut, 2020a). I therefore continued my research by carrying out observations at the Danish Centre for Neonatal Screening, to gain an insight into the work with the samples there—e.g. how the samples arrive, what happens during the screening, and how the samples are handled when being put into the freezer. I visited the laboratory at the Danish Neonatal Screening Biobank twice and interviewed one of the senior researchers there who is also the principal investigator of several research studies utilising the Danish NDBS samples.

All interviews were transcribed, pseudonymised and thematically coded (Attride-Stirling, 2011), focusing on the practices of the samples, the work of the actors involved and what it enabled[1].

Studying NDBS samples

The NDBS samples are taken on filter paper, designed to absorb blood for later screening and storage. The filter paper is approximately 10 cm x 5 cm with three printed circles the size of a small coin. When the sample is taken, each of the three small circles have to be filled with blood. The filter paper is attached to two information sheets. One can be torn off and given to the parents. The other is to be filled out with information about the mother and the newborn, as well as information about when the sample was taken and by whom. This information is based on the Danish Central Person Register (CPR) number. The CPR number is a unique 10-digit number assigned to all Danish citizens either at birth or on migration to Denmark, and is used in almost all contact with public (and many private) services. Information from the individual's CPR number can be used for register-based research (Mortensen et al., 2006; Sortsø et al., 2011; Thygesen et al., 2011)where all persons alive and living in Denmark were registered. Among many other variables, it includes individual information on personal identification number, gender, date of birth, place of birth, place of residence, citizenship, continuously updated information on vital status, and the identity of parents and spouses. METHODS: To evaluate the quality and completeness of the information recorded on persons in the CRS, we considered all persons registered on November 4, 2005, i.e. all persons who were alive and resident in Denmark at least one day from April 2, 1968 to November 4, 2005, or in Greenland from May 1, 1972 to November 4, 2005. RESULTS: A total of 8,176,097 persons were registered. On November 4, 2005, 5,427,687 (66.4%. Besides being an effective identifier for clinical purposes, the CPR number therefore also serves as a major contributor to the Danish research infrastructure. Today, there are over 2 million Danish NDBS samples in the neonatal biobank at SSI. Following the primary purpose of screening, researchers can use the samples for research projects. All research projects using Danish NDBS samples must be approved by both the national research ethics committee and by the steering committee for the neonatal screening biobank (Nørgaard-Pedersen and Hougaard, 2007; The National Committee on Health Research Ethics, 2020). The estimated use of the Danish NDBS samples for research purposes has been documented earlier (Nordfalk and Ekstrøm, 2019).

Care for families, quality and professions

In this section I will give an account of my fieldwork at the two hospitals, and how the practices I observed and the health professionals I interviewed shaped my understanding of how data and care are mutually enabling.

Professional care for families

One day during my fieldwork at the first hospital, Marie (a midwife) and I arrived at a trendy apartment in one of the fashionable areas in Copenhagen to visit a baby girl, Ella, and her parents, Anna and Martin. After being offered coffee, Marie asked about the birth and how they were all doing. "What was it like to come home as a family of three? And how are we doing on getting some rest?" Anna answered that they were surprisingly relaxed and that the first days had been going well. I looked around their open kitchen, and wondered if they had done a lot of cleaning just prior to our visit or if this was just their standard home maintenance level. Marie later told me that she thought Anna looked more exhausted than she was admitting to being. This made Marie wonder if she should call her in a few days to make sure Anna was settling into her new role and learning how to rest with a newborn. Anna and Martin left the hospital the same day as Ella was born. As the NDBS sample has to be taken between 48–72 hours after the birth, some families are visited by the midwife after the birth, instead of their having to return to the hospital. A team of midwives will have a day away from the hospital for visiting a round of approximately five families, all of whom will have had a newborn two days previously. Therefore, the clinical aim of Marie's visit was the screening of the newborn. While observing Marie taking the NDBS sample, I was struck by the level of compassion and care that was expressed. Marie asked Anna to sit with Ella in the bed and breastfeed while she took the sample. Marie then crawled over the bed and placed herself in the corner besides the queen-sized bed. She squatted down in the tiniest space between the edge of the bedframe and the end of a radiator. Here she reached for Ella's foot without disturbing mother and child. After making a small pin-prick in the heel with a special instrument, Marie gently placed Ella's foot on the filter paper, allowing the drops of blood to fill the circles. While taking the test, Marie was simultaneously observing the breastfeeding and talking to Anna. After the circles on the paper were filled, Marie crawled back over the bed, and put the sample in her midwife bag in the kitchen. During this visit with Anna and Martin the atmosphere that filled the rooms was not one of clinical purpose or of collecting samples as a tool for screening and research, but one of care. Care for the child and care for the family. As mentioned, the care the midwives provide is not something they have, it is something they do.

What I learned here was also that the aim of Marie's visit really was twofold: the midwives are interested in keeping up with the family and making sure they are doing well. As a profession, midwives are trained in pregnancy, labour, birth and the post-birth period. However, in recent years, there have been major budget reductions to the work of the midwives in all areas, and particularly for the post-birth period. Today, mothers of newborns who have had what is called an 'unproblematic birth' are expected to leave hospital within a maximum of six hours after giving birth. Much to midwives' chagrin, they are most often no longer in contact with the newborns or their families after they leave the hospital. Instead, a nurse specialised in newborns and childcare (in Danish: 'sundhedsplejerske') takes over the care of the family and visits them a number of times within the first year of the child's life. Therefore, the aim of the midwife's visits is both the actual clinical screening of the newborn baby, but very much also a professional aim of protecting and caring for the new families in this, their last, chance to see the family and the newborn. The midwives consider one of their finest tasks is to ensure not only a safe birth, but also a safe start as a new family. Therefore, the NDBS samples also play a more political a role. As another midwife, Emilia, stated:

> And I think there's a huge value in them [the families] coming to us to have the sample taken. Because there are many conversations you can have in that exact period of time. While taking the sample, you can ask, 'How is the breastfeeding going?' Or in some way it's an occasion where they come to us and you can talk to them about

> other things at a very vulnerable time in their lives. Otherwise there isn't anyone asking, 'Wait, you look really tired, have you even slept after the birth? Or why are you sitting so unevenly on the chair—is it a haemorrhoid or what?' Because it is not anyone else's job. So in that way it's also an occasion for connecting. (Emilia, midwife)

As the quotation from Emilia reveals, the care is evidently directed at the parents. From my observations I continuously experienced health professionals, especially midwives and nurses, going out of their way to make sure the parents and the newborn were cared for. One example is midwife Marie, crouching in small corners to take a sample without disturbing mother and child during breastfeeding; another example is health professionals patiently answering new parents' anxious questions about every aspect of life with a newborn, or having conversations to help support both mothers and fathers in their new roles. Yet in what Emilia says in the above quotation, another form of care is also expressed – a care for her profession. Midwives (and in this, some of the maternity nurses too) are uniquely trained in talking to mothers of newborns about the physical and emotional experiences just after having a child. And if they were to no longer be responsible for taking the NDBS sample, the midwives would no longer have a systematic reason for seeing the family after the birth. It appears that the care the midwives are eager to give the families does not constitute a legitimate reason for being involved after the birth, but the clinical purpose of screening does. Even though this aspect of the sampling of the NDBS is in many ways political, for Emilia and many other midwives it is also personal. Caring for the new families is sometimes the reason they became midwives (I was surprised at the number of midwives I encountered who did not have a desire to be in the actual delivery room). Having to take the NDBS sample therefore enables health professionals like Emilia both to care for the families and to care for their profession. The midwives thereby enable the NDBS samples as clinical and research data, and at the same time the sample mutually enables an access to the families, where the midwives can practise their profession while collecting the sample. The enablement is mutual.

Professional care for quality

The midwives are not the only profession responsible for taking the sample. As explained, biomedical laboratory technicians also take NDBS samples on their daily rounds in hospital. For them, the NDBS samples enable another kind of care. As the biomedical laboratory technician, Sarah, said:

> Let me put it this way. The newborn screening samples are nicer [Danish: hyggeligere] somehow, because it's small children and relatively healthy children for once (…). Because the parents are often these sweet people and they are happy because now they have their baby. In a way, it's nicer compared to the other parents, who are nervous and don't know if their child is ill, and [are worried about] all the tests they have to go through. (Sarah, medical laboratory technician)

Sarah expresses how the sample enables a small but enjoyable space for herself and her peers. Being a laboratory medical technician implies taking samples from all sorts of patients from all around the hospital. They encounter many people who are ill, and in cases where there are children involved, a lot of anxious parents, who are dealing with the (potential) disease of their child, and meeting Sarah for a test could be the answer that they are fearing or hoping for. Even though an NDBS sample is in many ways 'just another sample' for the medical laboratory technicians, for Sarah it enables a small space of joy. Another laboratory medical technician whom I observed during my fieldwork, a young man named Phillip, had a different approach to taking the sample than that I had seen when observing the midwives. He did not express the same level of care towards the newborn children or their parents. It was not that he did not care, but the care he was providing was directed at the sample. If an NDBS sample is not correctly taken –the circles are not complete, or there is not enough blood in each sample for it to soak through to the other side – the sample will be returned from the SSI and a new sample will have to be obtained. And I have to admit: the samples collected by Phillip were the most complete samples I witnessed. He was so careful that every step of the practice was done perfectly; and each of the samples he took (one day he did eight in a row) was done to a very high level of accu-

racy. This was his way of caring. A care for both the quality of his own profession and for the newborns, as he thereby ensured they did not have to have the sample taken again.

Enabling care and enabling data

Studying the health professionals taking the NDBS sample, I found that care was enabled in several ways. Who or what was cared for, was highly contextual and actor-dependent. The midwives, nurses and biomedical laboratory technicians I encountered were unaware of the research conducted using the NDBS samples they were creating. Before I started my fieldwork, I would have expected that the health professionals who take the sample would be knowledgeable about what happens to the samples afterwards. After my fieldwork I now understand why so little attention is given to the afterlife of a sample. At times there is barely enough time to give the right amount of attention to those who need it the most – the parents and their newborns. Therefore, the health professionals here would not consider themselves 'data workers'. They are 'care workers'.

Yet, from the viewpoint of the samples being used as data for research, this is where the newborn children become 'data subjects' –and in this case, a preceding state for becoming a 'research subject'. At the hospitals, data were nowhere to be found. None of the health professionals ever mentioned data in relation to the newborn or the sample, neither in conversations with the parents, each other or with me. One explanation for this could be the distinctive detachment between the hospital setting where the samples are taken and the State Serum Institute, where the samples are screened, stored and possibly re-used for research purposes.

At the end of every day, the NDBS samples, no matter who took them or where, are gathered in a specialised envelope marked 'Samples from newborns.' I consider this the first step in the 'populationisation' (Holmberg et al., 2012) of the samples. Despite having their blood and thus their DNA on their sample, the individual newborns are no longer a 'part' of the samples. The only thing still attaching them to their sample is the CPR number listed next to their sample. The blood has been transformed from being a part of a newborn human to a few drops on a filter paper. Through the caring work of the health personnel, they are now a segment, specified by the day they were born, on the way to becoming a part of a larger population of NDBS samples in the freezer.

Care for screening and populations

Each night, a car drives from the most northern region of Denmark through the country, stopping at specified pick-up locations to collect patient samples from several Danish hospitals. Some of them are the envelopes with the NDBS samples. Other samples are collected by special service cars, sent by mail or flown in from Greenland and the Faeroe Islands. The Danish Centre for Neonatal Screening screens the NDBS samples from every day of the week except Sunday, thereby screening an average of approximately 210 samples a day. A team of biomedical and chemistry technicians open the envelopes in a laboratory at the Danish Centre for Neonatal Screening. The first procedure is to detach the sample from the paper with information on the child and mother to ensure anonymity. Then each sample is given a sticker with a code and the piece of paper with the CPR number is given a sticker with an identical code. The code is a mix of the date the sample was received and a randomised number. The paper with the information about the child and mother is then taken upstairs from the laboratory, where the data on the child and mother are entered into a computer and connected to the code on the sticker. From that point, the sample can only be identified through the code. The actual filter paper with the blood sample stays in the laboratory, where five small puncture holes are made in the first of the three circles of blood for the primary screening procedure. Each puncture hole is 3.2 mm diameter. Taken together the five holes correspond to about half of one circle. These small punctured pieces of sample-paper are what the technicians use to run the primary screening tests. In the case of a sample being screen-positive for one of the 18 disorders the children are screened for (Statens Serum Insitut, 2019) a secondary test is performed. It may be either a more advanced test or a repeat of the primary test for that particular disorder. The primary screenings are performed as biochemi-

cal tests, whereas some of the secondary tests are genetic testing focused on the gene relevant for the disorder.

During my fieldwork, I visited the laboratory where the samples were screened twice. Especially the first time, the technicality of the screening amazed me. Here I gained the impression that the biomedical and chemistry technicians in the laboratory were very pleased with the machinery. They enthusiastically explained to me what each machine was able to do and what it meant for the screening process – often in phrases where one abbreviation did something to another abbreviation so I had to ask how to understand it in lay terms more than once. And they would kindly explain how the coating of the glass in the 96-well plate would make specific proteins stick; and, moreover, how that could help detect some of the diseases in the screening programme. I got a sense that they were proud of their work and genuinely cared about the newborn screening programme and securing the health of the newborns. This care was not directed at the actual newborns who delivered the sample. Rather these workers cared that the screening programme and the tools they applied were the most optimal. They too cared for the quality of their work.

Afterwards, the samples, which are now the three circles on filter paper with five holes from the screening, are gathered up with other samples from the same day, and put in a freezer in the lab. Observing this practice and seeing the samples being put together with an elastic band around them was a very visual representation of 'populationisation' (Holmberg et al., 2012). It was a recognition of the process where one individual sample was now enrolled into a segment of what was not yet a population, but would become one in the future. Finally, the samples gathered in the freezer in the laboratory are taken to the larger freezer in the Danish Neonatal Screening Biobank where they are stored indefinitely, according to current practice. This is the endpoint for the majority of samples. It is also where the 'populationisation' is done – the transformation of individual items of data into population data with over two million samples in the neonatal screening biobank: this is where the 'population' rests. Furthermore, if the current practices of the NDBS samples continue, this 'population' of NDBS samples will continue to grow and within the next 80 years cover every living person born in Denmark, as well as a part of the deceased population. Thus, this biobank 'population' in effect represents a synthesis of being both complete, and yet still growing.

As to the samples in the freezer, some are used for research projects. It is also possible to do research on the samples in conjunction with the screening, even before they are put in the freezer. However, the majority of samples are frozen before being used for research (Nordfalk and Ekstrøm, 2019). In that case, the first step for the researcher is to gain approval to use the samples from the national research ethics committee as well as by the steering committee at the neonatal screening biobank. In order to obtain approval for the research project, a detailed description of the diseases, biomarkers and genes necessary for the project as well as clear estimates of the number of samples that will be used are required. After approval, the researchers are expected to hand in a list of CPR numbers to the SSI who will identify and supply the samples required. However, there is a maximum of how much of each sample can be used for research. A part of the sample must always be saved for the person whose blood is on the filter paper. Today, the use of samples for research is registered. Yet, as this register has not been updated with previous research, every sample is still manually checked to see if there is enough left in each sample to be a part of potential future research. If there is enough blood left for the sample to be used for research, a new punched hole will then be made in the second circle of the sample. The research analysis can either be carried out at the Danish Neonatal Screening Biobank, at other Danish institutions or in approved countries abroad, depending on the type of analysis and the research needs. The analysis will lead to new information, new data. When this information is handed over to the researchers, they can begin their study. For the researchers ready to start working on the data, the practices described, the actors involved and the care the data have enabled is not relevant. To them, the data are 'raw' and ready for new research. I interviewed one of the senior researchers at the Danish Neonatal Screening Biobank about the use of the samples

for research purposes. In his answers, he focused on the importance of population, as he explained to me:

> With genetic variations, there is really a lack of these population-based studies, where you say you have a completely normal population and then some that are sick. Then, what is really the difference? You might say there is a fifty-times greater risk if you have this genetic variation than if you don't. However, if you do not have a population-based control group, you risk getting the wrong number. […] You really need to have some population-based controls. (Senior researcher, Danish Neonatal Screening Biobank)

As one of the senior researchers at the Danish Neonatal Screening Biobank and chief managers of the Danish Centre for Neonatal Screening, he clearly cares for the health of newborns. In the rare cases where they do find a positive test in the screening process, it is extremely important that the individual child is quickly identified, contacted and given accurate treatment. This is at the heart of a screening programme. However, as a researcher, he cares for the *population* of newborns. Without the population, it would not be possible to produce valid and significant estimates on risk. Without the population of Danish NDBS samples, a unique research project like the iPsych project, which studies the genetic variations in newborns and how these relate to mental disorders (Pedersen et al., 2017) would not be a possibility.

Finally, if all of this begins with a newborn, then where does it end? There is no one answer. The physical materiality of the sample, besides the puncture holes for screening and possible research, ends up in the freezer at the Danish Neonatal Screening Biobank in Copenhagen. If the sample is a part of a research project, then where does it end up? In one respect, it ends up as knowledge; knowledge derived from the research done using the NDBS samples; knowledge that contributes to the progress of public health. Finally, the data that come out of the research projects with genetic sequencing are currently stored on a supercomputer called Computerome (National Life Sciences Supercomputer Center, 2020). On this computer, the blood from newborn babies is now considered data and the newborns have become samples that have become population research data.

Conclusions

In this article, I have shown *how* newborn babies become research populations: the practices, what kind of work is required, and what is enabled through the careful work of multiple actors in a complex, yet functioning, infrastructure. During my fieldwork, I found that the link between newborn baby and research data was much more my academic interest than it was an interest of the actors involved. For the medical staff taking the samples, there are no data: just newborns, parents and patients. For biomedical and chemistry technicians screening the samples, the focus is on the efficiency of the screening. While for the researchers using the sample for research there are no individual babies: only multiple samples and data. The physical, professional and ontological distance between them separated their understanding of the work they were doing as part of a larger infrastructure. However, this disparate and distant organisational data work does not hinder either care or an efficient creation of data. On the contrary, even with this fragmentation of care, the infrastructure is effective. Moreover, it is in the best interests of the newborn babies to be considered as individual newborn babies when the samples are taken; but not to be considered individual newborn babies when their samples are used as research data. In both cases, it ensures that the babies are cared for either through physical and emotional care, or through the anonymity of a population.

I argue that creating a national research population from newborn babies is possible through the mutual enablement of research data and care. Research data are enabled through care and conversely, with a mutuality, data enable care: care for families; care for professions; care for screening programmes; and care for population research. The notion of healthcare as an enabler for research data is well known. Nevertheless, in this case, the care enables more than just *some* research data. It enables a national population of research data. Creating population data from newborn

babies at a national level depends on the existing work, practices and infrastructures of newborn screening. National screening programmes enable the makings of a national research population of samples and 'populationisation' enables samples to become data. For newborns to become data, a population of newborns is needed. The sample of just one newborn is not data. However, the 'populationisation' of newborns with other newborns through their samples creates population data.

Mutually, the creation of population data enables care. The practices of taking the NDBS samples enables the midwives to systematically care for the newborns and the families after birth. The given timing of the NDBS samples, two to three days after the birth, enables the midwives to practise 'professional care' for families in the postpartum period. For the medical laboratory technicians, the samples enable them to care for the personal and professional quality of their work when handling the samples. Finally, the samples enable researchers to care for the population by creating new knowledge that can improve our public health. Thus, it is in the mutual enablement of research data and care that newborn babies can become national research populations.

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Notes

1 This type of research (interview-based and without biological material) is not subject to ethics approval in Denmark.

Why do Environmental and Ecological Economics Diverge? Comparison of the Ideological, Institutional and Scientific Backgrounds of the Main Actors

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Abstract

Environmental economics and ecological economics became established scientific fields as a result of the growth and the success of the environmental movement in the 1960s and 1970s. Using the strong programme in the sociology of scientific knowledge and the general theory of scientific/intellectual movements, this article compares four pairs of scholars (two pairs of scholars appropriated for these fields and fields' founders during the emergence and establishment of the fields). The article depicts how their institutional, ideological and scientific backgrounds contributed to the divergence of these fields. Practitioners of environmental economics and ecological economics were influenced by different strands of the environmental movement. Environmental economics has epistemological and institutional links with environmentalism and ecological economics with ecologism. Different types of interdisciplinarity were used in these fields—a bridge building type of interdisciplinarity in the case of environmental economics and a restructuring and integrative in the case of ecological economics.

Keywords: environmental economics, ecological economics, environmental revolution, green ideology, interdisciplinarity, scientific fields

Introduction

When in the 1920s the Nobel laureate chemist Frederick Soddy made inroads into the study of economics, he was met with strong resistance from leading economists. Soddy's use of the laws of thermodynamics in the study of economics remained unknown to future economists who applied the laws of thermodynamics (Daly, 1996). After Nicholas Georgescu-Roegen in the early 1970s published his work emphasizing the significance of the second law of thermodynamics in understanding the place of the economy in the natural system, this became one of the starting points for the emergence of a new field of ecological economics in the following decade and a half.

Also in the 1920s, another prominent scholar wrote about the need to tax the negative consequences of building a factory and of erecting buildings which tend to "injure the health and efficiency of the families living there" (Pigou, 1920: 162). Unlike Soddy, the author of this proposal was an influential economist, Arthur Cecil Pigou. His tax proposal, now known as the Pigouvian tax, is one of the founding tenets of environmental economics and it reached its institutional climax in

1975 when it became the basis of the OECD's environmental policy (Pearce, 2002). This fifty-year time span demonstrates how ideas that had limited relevance at the time of their construction (i.e. in the early days of social interest in environmental problems and interdisciplinarity) became far more influential in another period. The relevance of these ideas grew with profound political and social changes, which were the consequence of the 1960s environmental revolution. Nevertheless, their initial placement in early 20th century economics influenced their different trajectories and distinct places in the realm of contemporary scientific knowledge. Soddy is analysed here as the harbinger of ecological economics and Pigou of environmental economics.

Environmental economics and ecological economics are two scientific fields with, at first glance, a rather similar basic goal of combining the study of environmental degradation with the analysis of economic systems. However, they are often at odds with each other as the different ideological backgrounds and scientific cultures of some of their protagonists have prompted them to analyse relations between the economy and environment through different perspectives and with different policy recommendations. Environmental economists are primarily involved in determining the value of nature, while ecological economists concentrate on placing the economic subsystem within the very limited ecological boundaries of the Earth. The core of environmental economics are negative externalities and "the environmental problem is cast in terms of an interaction between people (economic agents), that is, nature and environment are only implicitly described" (van den Bergh, 2001: 15). On the other hand, ecological economics "generally assumes a longer time horizon (…) and (…) pays more attention to cause-effect chains, interactions and feedback between natural and human-economic system" (van den Bergh, 2001: 15).

It is argued here that environmental economics and ecological economics both became established scientific fields as the result of the growth and the success of the environmental movement, although they were influenced by different strands of this movement. Despite considerable differences, both fields developed out of the same historical context of the 1960s environmental revolution and the subsequent greening of socio-political, scientific and economic spheres. At first there was a good deal of cooperation and common ground among scholars of the emerging fields during the end of the 1960s and beginning of the 1970s. However, as both fields became established and institutionalized, scholars, who were influenced by disparate ideological and epistemological backgrounds, became more involved in drawing boundaries between the fields. The establishment of two separate scientific fields gives evidence to the importance of environmental revolution, its diversity and the new scientific landscape.

The developments of these two fields have rarely been compared without taking sides in their debates. When they have been compared, it is usually by protagonists of one or the other field, which usually implies a critique of the opposing field. Turner (2002) rather neutrally compared both perspectives; regarding their ideological backgrounds, he noted a collectivistic perspective in ecological economics and an individualistic one in environmental economics. Turner (2002: 1001), moreover, called for a joint pluralistic approach which could lead to interdisciplinary insights. Historical comparisons encompassing ideological positions and institutional and epistemological contexts in which some of the most prominent predecessors and founders of these fields worked are missing.

Theoretical framework

The emergence of new ideas in economics and the outline of the history of ecological and environmental economics are analysed here from the perspectives of science and technology studies (STS) and ideology studies (for a combination of these two perspectives see Bud, 2017). Ecological economists invoked some of the central concepts of STS such as the Kuhnian scientific revolution (Daly, 1980, 1996) and Funtowicz and Ravetz's post-normal science (Munda, 1997) when arguing for their field. While defending their field's dominant position, environmental economists have argued for a different, less radical, understanding of science.

A comprehensive analysis relying on STS theories was given by Røpke (2004, 2005)

who analysed the development of ecological economics using Whitley's theories of research fields and concluded that ecological economics is a fragmented adhocracy. Pearce (2002), on the other hand, wrote about the intellectual history of environmental economics in which he analysed the history of major concepts of that field and the influence of different economics fields on its emergence. Røpke's and Pearce's different approaches to the analysis of knowledge creation also imply different roads to the establishment of each field and the present article draws on these texts. To present the establishment of ecological economics, Røpke demonstrated how a small number of very loosely connected economics mavericks and ecologists devoted to systems thinking formed a completely new field. To understand the establishment of environmental economics, one has to understand how a growing concern for environmental issues popularized the concept of externalities and expanded the scope of already, more or less, established economic fields such as welfare economics and natural resource economics.

It is argued here that the scholars' social and ideological backgrounds contributed to the emergence of new ideas that form the bases of both fields' theories. Social causes of the emergence of both fields are analysed through external and internal causes. External causes relate to ideological, political and economic changes that played out in a broader social setting, namely the environmental revolution. Internal causes were profound changes affecting the organization of science during the last hundred years.

The individual scientific endeavours of actors who created both fields happened in social contexts and had strong political and ideological backgrounds that steered the development and reception of new theories. Bloor's (1991) tenets of the strong programme in the sociology of scientific knowledge are followed in order to analyse how new ideas that form the bases of the two fields emerged. The analysis is causal and explores social causes that brought about new states of knowledge in the field of economics.[1] Also, the analysis is impartial as equal weight is given to both fields since both of them require explanation. Neither is considered to be true or false, rational or irrational, not least while economics is a multi-paradigmatic science. Bloor (1991: 53) claimed that "ideologies rather than the totality of our real social experience (…) control and structure our theories of knowledge".

Ideological discourses of some of the most influential authors of both fields are therefore analysed here. Ideologies are treated here as an indispensable element of political but also of social and scientific life as they enable a coherent understanding of the world, and they also guide social actors towards action (Freeden, 1996). The latter feature was important in the development of environmental and ecological economics as scholars from both fields gave strong policy recommendations. The emphasis in this research is on the analysis of concepts of green ideology that steered the development of new fields. Freeden (1996: 527) argues that variants of green ideological discourse have common core concepts such as nature becoming "an overriding factor in guiding human conduct" or "the *valued preservation* of the integrity of nature and of forms of life (…) usually associated with a recognition of the finiteness of resources and the irreversibility of some kinds of intervention in nature". Freeden also mentions adjacent concepts of green ideology such as community, decentralization and direct democracy, and equality regarding equal access of the South or future generations to global resources. However, Freeden sees green ideology as a thin ideology, i.e. it does not offer answers to all of the questions of social and political life and can be incorporated in other ideologies. On the contrary, Humphrey (2013) emphasizes more policy oriented core concepts, such as radical democratization, ecological law (which can be contrary to conventional laws) and non-violence, in order to claim that green ideology is more than just a thin ideology and that it has the potential of being a thick ideology, i.e. an ideology that can provide most of the guidance for social and political life.

Especially useful here is Dobson's (2016) differentiation of ecologism and environmentalism, because it coincides with the differences between ecological and environmental economics. Dobson states that "*environmentalism* argues for a managerial approach to environmental problems,

secure in the belief that they can be solved without fundamental changes in present values or patterns of production and consumption". On the other hand, "*ecologism* holds that a sustainable and fulfilling existence presupposes radical changes in our relationship with the non-human natural world, and in our mode of social and political life". Dobson argues further that "environmentalism is more easily incorporated into other ideologies. So we can imagine a 'liberal environmentalism' or a 'socialist environmentalism', but it is harder to imagine a liberal or a socialist *ecologism*" (Dobson, 2016: 37). Thus, environmentalism is a thin ideology and ecologism is a thick ideology that radically challenges other ideologies. Moreover, the scope of both fields' engagement with broader social challenges is quite different. The breadth of ecological economics' policy proposals by some protagonists resembles the morphology of thick ideologies.

Methodology

Group and personal ideologies are reflected in the ideas and actions of scholars, but these ideas are also under the influence of changing social and institutional contexts in which scholars act. It is in these complex interactions that new ideas emerge, so similar ideologies and similar institutional and social contexts are not mechanistically translated into similar ideas. Different social, political and institutional contexts in which both fields developed will therefore be presented.

Social causes are analysed through the cases of individual scholars compared with their counterparts (see Table 1). Pairs of scholars represent two fields in the same development phase and in a similar historical period, but each scholar belonged to different milieus that influenced their ideas. The comparison of scholars appropriated for fields (i.e. identified as significant predecessors) can indicate the ideological preferences of the authors of fields' prehistories. These authors were interested in drawing boundaries between the two fields through narrating communities (Hodgson, 2006). Boundary-work "imprints the formation and institutionalization of disciplines, specialties, and theoretical orientations within science" (Lamont and Molnár, 2002: 179). The works of Martinez-Alier (1987) and Sandmo (2015) are used as prehistories of ecological economics and environmental economics, respectively. Sergei Podolinsky and Soddy received the most coverage in the history of the roots of ecological economics written by Joan Martinez-Alier, one of the leading ecological economists. Sandmo linked Pigou with the foundations of environmental economics and Dupuit is the earliest scholar mentioned by Pearce (2002). These four scholars are accordingly analysed here. These prehistories projected the self-image of these fields to earlier scholars (Hodgson, 2006: 175), as often authors of canonical histories fuse "their own perspectives with those of their subjects" (Fuller, 1991: 309). These examples from prehistories helped draw boundaries between the fields as none of these scholars are appropriated for the other field.[2] Comparing pairs of scholars during the emergence (John Krutilla and Georgescu-Roegen) and foundation (Pearce and Herman Daly) of fields can help explain divergences between the fields, as both pairs exemplify the influence of different ideological and epistemological backgrounds on the emergence and institutionalization of ideas.

Certainly both fields have many more examples of influential scholars, but the ones presented here are chosen as some of the most typical representatives of their fields, celebrated by their heirs. The scientific practices and discourses of some of the most influential authors of both fields are examined in order to discern why studying the nature-economy nexus has produced two distinct fields. The methods of comparative intellectual history are used here as they focus on "how ideas became meaningful in a particular cultural milieu" (Christie, 1989: 90) and "differentiate cases (…) capturing similarities and differences across a limited number of instances in order to understand the cases under discussion" (Pollock, 2010: 191).

The growing trend of interdisciplinarity influenced the scientific practices of the scholars analysed. Bloor (2011) has demonstrated that belonging to subculture either of science or engineering can influence the development of rival theories. Different versions of interdisciplinarity interacted with the different ideological backgrounds of the scholars and thus contributed to

the divergence of the two fields. Calls for interdisciplinarity have been on the rise since the 1970s. The 1970s also saw the formulation of two types of interdisciplinarity:

> The first, 'bridge building', takes place between complete and firm disciplines. The second, 'restructuring', involves changing parts of several disciplines … is more radical and often embodies a criticism of not only the state of the disciplines being restructured but, either implicitly or explicitly, the prevailing structure of knowledge. (Thompson-Klein, 1990: 27)

Also, the third type of interdisciplinarity, integration of knowledge, is important here, as it was the goal of Kenneth Boulding and other proponents of general systems theory, who were influential for the emergence of ecological economics. Integration of knowledge is a search for a new overarching theory, close to transdisciplinarity, which had the ambition of "comprehensive unity of knowledge" (Thompson-Klein, 1990: 28).

Frickel's and Gross' general theory of scientific/intellectual movements (SIMs) is particularly useful for understanding interdisciplinarity and making of interdisciplines of which ecological economics is a good example (Jacobs and Frickel, 2009; Frickel, 2004).[3] Frickel (2004: 273) studied the emergence and establishment of genetic toxicology and concluded that for "interdisciplines, key boundary problems involve perforating existing boundaries and/or inventing porous ones". However, with a competitor in sight (i.e. environmental economics), ecological economics' boundary-work was more complicated. Frickel's and Gross' general theory is likewise instrumental in understanding the divergence between these fields, as it analyses the presence of grievances and opportunity structures, which were quite different in each case. Grievances against dominant intellectual approaches are taken as "a necessary condition for the emergence of a SIM" (Frickel and Gross, 2005: 210). The first proposition of the general theory is that "a SIM is more likely to emerge when high-status intellectual actors harbor complaints against what they understand to be the central intellectual tendencies of the day" (Frickel and Gross, 2005: 2009). In the case of ecological economics, a small number of prominent economists developed grievances towards the dominance of neoclassical economics and towards its inadequacy when dealing with environmental issues. The strength of grievances depended on the ideological backgrounds of scholars. Those that understood and practiced green ideology as a thick ideology were more likely to have stronger grievances.

However, once the key ideas of scientific/intellectual movements "are formulated, they must be orchestrated, coordinated, and collectively produced. For this to occur, opportunities for gaining access to resources are imperative" (Frickel and Gross, 2005: 214). The process of the use of opportunity structures will be described in the section on the establishment of both fields. Although the theory of SIM also deals with micromobilization contexts, primary interest here is in the emergence and establishment of ideas in a broader social context.

First, key representatives of more or less constructed roots of both fields are presented. The emphasis is on those authors that contemporary environmental and ecological economists see as the ones who created milestones for economic thought and their respective fields, and why they are perceived as such. Second, the links between the emergence of the environmental movement and the emergence of both fields are analysed through portraits of two economists and of the institutional and social contexts in which they worked. Both Krutilla and Georgescu-

Table 1. Compared scholars during different development phases of environmental and ecological economics

Development phase	Environmental economics	Ecological economics
Appropriated 19th and early 20th century scholars	Jules Dupuit (1804-1866) Arthur Cecil Pigou (1877-1959)	Sergei Podolinsky (1850-1891) Frederick Soddy (1877-1956)
Emergence of the field	John Vasil Krutilla (1921-2003)	Nicholas Georgescu-Roegen (1906-1994)
Establishment of the field	David Pearce (1941-2005)	Herman Daly (1938)

Roegen were established economists as the environmental revolution erupted and subsequently changed the emphasis of their work. Their influence on the emergence of a particular field is still referenced and celebrated (for Krutilla see Smith, 2015; Banzhaf, 2019; for Georgescu-Roegen see Bonaiuti, 2011; Kallis, 2011). Third, using the examples of two economists prominent in establishing these fields, the rising influences of environmental and ecological economics' actors and theories on international organisations and political movements are discussed. Pearce and Daly were initiated into the emerging fields during the environmental revolution and became prominent economists as environmental issues were internationalized. With concepts of market-based incentives and steady-state economy they further established their fields.

Appropriated 19th and early 20th century scholars

Environmental and ecological economists often search for unsung heroes who provided these fields with their epistemological and methodological tools and, not less importantly, possessed similar ideological and scholarly profiles to the authors who appropriated them for their fields. Dupuit and Pigou were early contributors to concepts crucial for environmental economics: cost-benefit analysis and externalities, respectively. Podolinsky and Soddy both used the second law of thermodynamics in their understanding of the economic world. They were also all inspired by proto-ideologies that resembled environmentalism and ecologism.

Jules Dupuit (1804-1866) and Sergei Podolinsky (1850-1891)

Neither Dupuit nor Podolinsky are mentioned in Kula's (2003) comprehensive history of environmental economic thought. It could be argued that Pearce (2002) and Martinez-Alier (1982, 1990), two important establishers of environmental and ecological economics, while writing about lesser-known 19th century scholars tried to construct deeper historical roots of their fields.

The practitioners of environmental economics in the formative years of their field and thereafter traced the roots of environmental economics to a French engineer (Kneese, 1986; Pearce, 2002). Jules Dupuit was an inspector general of bridges and highways. In 1844 Dupuit introduced the concept of cost-benefit analysis. Ekelund and Hébert (1999: 39) argue that the specific French national context and "the ideology of the state engineering corps served to justify a strong educational focus on mathematics". State engineers' views of economics were influenced by their liberal professors, and the engineers combined liberal ideas with a belief in state intervention. Dupuit was a strong believer in markets and he went on a mission to expand the realm of economic thought. As an engineer he saw the influence of new technologies on the market and institutional change (Ekelund and Hébert, 1999). In this context, Dupuit created microeconomic concepts, which resembled those of future neoclassical economics, and contributed to the mathematization of economics.

The strong influence of proto-interdisciplinarity and ideology emanating from the national context also shaped Podolinsky who arises as ecological economists search for their roots in the 19th century. A Ukrainian socialist educated in the natural sciences and medicine, Podolinsky is strongly promoted by Martinez-Alier as a "Marxist-Narodnik Precursor of Ecological Economics" (Martinez-Alier, 1997: 231). In his 1883 article, Podolinsky mentioned both the second law of thermodynamics and "the danger that we will suffer one day a scarcity of transformable forces on the surface of the Earth" (cited in Martinez-Alier and Naredo, 1982: 211), although he saw this as a very distant danger. Podolinsky's attempt was criticised by Engels, who thought that there was no need for calculating energy values and that expressing economic relations in physical measures is impossible (Martinez-Alier and Naredo, 1982). Engels' criticism of Podolinsky's ideas at the beginning of the 1880s meant that Podolinsky's name was relegated to the fringe of the Marxist movement and was incorporated in the history of economic thought only in the 1980s during the establishment of ecological economics.

Indicative in Podolinsky's biography are his heterodox ideological motivation and his broad interdisciplinary knowledge, characteristics that were present in many ecological economics

pioneers. The *Narodniki* movement, which originated in the 1860s Russia and promoted the ideals of self-governed peasant communities, influenced Podolinsky's thought. In his 1883 article, Podolinsky was writing from an agricultural perspective and was using examples from agricultural statistics to show how solar energy is transformed by the work of humans and animals. His idiosyncratic leftist position, different to that of scientific socialism in already industrialised countries, is something that could have shaped Podolinsky's new perspective on relations between the economy and nature. Thus, in Podolinsky's last writings, he was less optimistic regarding nature's capacities than Marx and Engels who were also interested in the natural sciences but tended to see the peasantry as mostly a counter-revolutionary force.

Apart from their ideological differences, the main difference between Dupuit and Podolinsky was the way they used their interdisciplinary knowledge. Dupuit applied knowledge from two disciplines in order to solve practical problems and expand economic theory. Podolinsky, on the other hand, sought a holistic understanding of social and economic processes, with crucial insights from the natural sciences, with the goal of creating a just society.

Their diverging perspectives, the natural sciences perspective in the case of Podolinsky and the engineering perspective in the case of Dupuit, are still present in some of the debates between the two fields, so it is not surprising that these two scholars are invoked in the search for fields' roots. The engineering perspective is connected with problem solving and improving on prior knowledge that is not deemed as wrong, but as no longer useful (Aslaksen, 2013). The natural sciences perspective involves trying to give answers to ultimate questions and rejecting old theories and paradigms.

Another difference between these two scholars is that one can find relative continuity in the expansion of Dupuit's ideas during the marginalist revolution of the 1860s, while Podolinsky's ideas remained on the margin of social thought. This could be explained by their respective social positions which shaped the institutionalisation of their ideas, as Dupuit's endeavours were backed by the French state and Podolinsky's ideas had little influence even on socialist authors. Although Dupuit's attempt to mathematise economics were not an outright success, his ideas survived and later became part of the neoclassical economics, which became prominent after the marginalist revolution (Ingrao and Israel, 2015).

Arthur Cecil Pigou (1877-1959) and Frederick Soddy (1877-1956)

Pigou, one of the heirs of the marginalist revolution, succeeded Marshall in the position of professor of Political Economy at Cambridge. Apart from Marshall, Pigou was strongly influenced by another of his Cambridge teachers, a universalistic utilitarian philosopher, Henry Sidgwick. What is most significant here is Sidgwick's discussion of various divergences between private and social interests (Aslanbeigui and Oakes, 2015). Pigou was a devout follower of Marshall's neoclassical economics, although he "was ready to refine or innovate if the results promised to strengthen economic analysis" (Aslanbeigui and Oakes, 2015: 101). Pigou had a negative stance towards scientific revolutions, especially towards the Keynesian revolution which was the most threatening to his own and neoclassical economics' legacy. His position is interpreted as the opinion that "economics progresses not by (…) destroying or demeaning the work of others, but by building on past knowledge" (Aslanbeigui and Oakes, 2015: 102).

Pigou's view of economics was that it should be value-neutral and analyse the consequences of economic policy proposals coming from different ideological camps. Nevertheless, he espoused liberal views as he argued for the benefits of free trade on the prosperity of all British people. Another topic that concerned him were the negative consequences of the 19th century urbanization in Britain and his influential proposal to tax the negative consequences of new buildings is a logical consequence of this interest. Pigou remains important for environmental economics because he developed and promoted the concept of externality or "a detrimental (…) effect to a third party for which no price is exacted" (Pearce, 2002: 58).

Soddy, Pigou's ecological economics counterpart, received a Nobel Prize in chemistry for 1921

for his contribution to the chemistry of radioactive substances. Already in 1912 he expressed concern about the limits of major energy sources of that time, but he saw hope in the development of atomic energy (Soddy, 1912). After the First World War Soddy began to doubt that political development could follow advances in science and he turned to writing primarily on economic problems. This transition happened during a public backlash against science. Science was already in the course of the war blamed for "contributing to the horrific character of modern industrialized warfare" (Agar, 2012: 117). Soddy was one of the pioneers of introducing the second law of thermodynamics into the study of economics. This can be traced to his 1921 speech where he gave the following warning: "You cannot permanently pit an absurd human convention, such as the spontaneous increment of debt, against the natural law of the spontaneous decrement of wealth" (Soddy, 1921). As a natural scientist involved in the study of economics, Soddy was developing a view on interdisciplinarity that could be labelled as the restructuring of economics.

Soddy's contributions to economic thought were strongly influenced by his ideological profile. Soddy was worried that atomic energy, to whose development he had contributed, under existing economic conditions could destroy civilisation. Soddy (1921) praised Marx's understanding of natural processes. However, Soddy was not a socialist, although his criticism of contemporary science coincided with ideas of the socialist-oriented scientific humanists around John Desmond Bernal with whom he collaborated. Contrary to them, Soddy did not see socialism or communism as the solution and saw the battle between socialism and capitalism as one that misses the real target. He criticised the monetary system led by private bankers and called for more democracy (Trenn, 1986). Soddy emphasized that he had a different perspective than most other economists and politicians. He espoused a rather independent ideological position, emphasizing an agricultural perspective (Soddy, 1921). Not belonging to established economics schools allowed him to pursue new ideas such as that true wealth is energy and not money.

As in the Dupuit-Podolinsky comparison, Pigou's and Soddy's ideas were characterized by the influence of different worldviews and different receptions. Soddy moved from his established discipline and became engaged in the quest for a new society, while Pigou was expanding neoclassical economics so it could respond to new social problems. Although Pigou's role in the history of economics was overshadowed by the Keynesian revolution, his ideas were important in the already established fields of neoclassical economics and welfare economics in whose institutionalisation and promotion he was heavily involved. The theory of externalities, which he created, was reborn in the 1950s and particularly in the 1960s with the emergence of environmental economics (Medema, 2017).

Similar to Podolinsky, Soddy's ideas, although far more visible than those of the Ukrainian *Narodnik*, remained on the fringe of social and economic thought. The questioning of the market as the main tool for understanding economic life and replacing them with energy was ideologically unpopular for free-marketeers and this was most pronounced in Hayek's criticism of Soddy (1943). Already before the end of the Second World War, i.e. twenty years before the environmental revolution particular scientific ideas resembled ideological constellations that are still shaping the environmental debate: liberal environmentalism (in Pigou), anti-environmentalism of free-marketeers (in Hayek) and ecologism (in Soddy).

The emergence of environmental and ecological economics during the environmental revolution: John Vasil Krutilla (1921-2003) and Nicholas Georgescu-Roegen (1906-1994)

The Second World War, especially the use of the atomic bomb, had a profound influence on the rise of environmental and techno-pessimistic values, although it had a rather delayed effect on the creation of a strong environmental movement. The rise of this movement during the 1960s coincided with the transition of two major economists towards building environmental and ecological economics' theoretical foundations.

However, the Second World War's more immediate impact on environmental economics was reflected in the concern of the United States' political elite about the availability of resources essential for the US to preserve its post-war global role. Hence, Resources for the Future (RFF), the first think-tank dedicated solely to resource and environmental issues, was founded in 1952. It became a key organization in the establishment and promotion of resource and later environmental economics with major figures such as Krutilla and Allen Kneese working there (De Steiguer, 2006).

The environmental revolution, which started with Rachel Carson's 1962 book *Silent Spring* and peaked with Earth Day demonstrations in 1970 (McCormick, 1995), gave a new significance to the inclusion of environmental issues in the science of economics. The debate that started in the second half of the 1960s was influential for the establishment of both fields, because it gave even more prominence to environmental issues but was also crucial for their divergence. Interdisciplinarity was paramount for this period that witnessed the emergence of ideas that were intensively questioning the concept of infinite economic growth (McCormick, 1995). The best-selling books were Paul Ehrlich's *The Population Bomb* (1968) and *The Limits to Growth* (Meadows et al., 1972), which featured scenarios of the coming collapse of human civilization and caused a big debate. Regarding the period before this sort of books, both environmental and ecological economics could claim that they have been influenced by Carson's book. Both Røpke (2004) and Pearce (2002) see *Silent Spring* as a watershed moment and eye-opening for economists in understanding the scope of environmental degradation and its connection to economic processes. However, the following years brought political polarisation as the radical countercultural movements of the 1960s began questioning the industrial capitalist foundations of Western society. These movements were particularly influential in the US, starting with the escalation of the Vietnam War in the mid-1960s, which also raised the issue of global North-South inequalities, and subsequently influenced the character of Western academia. The difference between the traditional approach of the conservation movement present in natural resource economics and the newer emphasis on limits to growth and criticism of industrial society is visible with the two scholars analysed here.

Distinct institutional and ideological backgrounds

Krutilla, one of the founders of environmental economics, worked at RFF from 1955 until 1988. Prior to that, he worked for the Tennessee Valley Authority, the United States government agency dealing with the exploitation and natural-resource management of the Tennessee River and its surroundings. Both the Tennessee Valley Authority and RFF were products of the conservation movement. The conservation movement was oriented towards the rational use of natural resources and its influence was visible in Krutilla's first major works such as *Multiple Purpose River Development* (Krutilla and Eckstein, 1958). This book "was motivated by the Eisenhower administration's policy advocating a larger private-sector role in river basin development" (Smith, 2015: 4).

Another strand of the early American environmental movement, a more eccentrically oriented preservationist movement called for the protection of nature for its intrinsic value. The late 1960s were marked by the fight for "the rejection of multiple-purpose river structures in favor of free flowing rivers" (Hays, 1982: 17). It was, therefore, a defining moment for environmental economics when Krutilla (1967) in his seminal article *Conservation Reconsidered* took account of the perspectives of both conservationists and preservationists in giving value to nature. Krutilla opened the article with a quotation from Pigou, developed the notion of non-use value of nature, and introduced the concept of existence value, while arguing that "the existence of a grand scenic wonder or a unique and fragile ecosystem (…), its preservation and continued availability are a significant part of the real income of many individuals" (Krutilla, 1967: 779). In a footnote Krutilla specified these individuals as "the spiritual descendants of John Muir, the present members of the Sierra Club, the Wilderness Society, National Wildlife Federation, Audubon Society and others to whom the loss of a species or the disfigurement of a scenic area causes acute distress and a sense of genuine relative impoverishment"

(Krutilla, 1967: 779). Thus, Krutilla adopted one of the core concepts of green ideological discourse that Freeden described: the valued preservation of nature and the irreversibility of some interventions in nature. Krutilla's revision of conservation and acknowledgment of the preservationist perspective was happening during the 1960s environmental revolution, which was centred in the US. However, adjacent concepts of green ideology were not present in Krutilla's work, as he went on to develop his ideas on projects of limited scope regarding local and national regulation. He did not deal with broader global and political issues, which became prominent in new strands of the environmental movement and with ecological economics practitioners.

Georgescu-Roegen, one of the founders of ecological economics, was educated as a mathematical statistician in Paris and London. He was politically active in the Romanian National Peasant Party in the 1930s after he returned to his native Romania. Poporanism, a Romanian version of *Narodnik* ideology, influenced the National Peasant Party. Some of the party's ideologues argued that there was no need for a predominantly agrarian Romania to industrialise and resemble Western societies, and they favoured small peasant holdings (Daskalov, 2014). Vivien (1999) gives a comprehensive account of Romanian influences on Georgescu-Roegen's worldview, mentioning even the problem of exhaustion of Romanian oil resources since the late 1930s, but he does not mention these ideological links. Vivien deals solely with epistemological links, citing Chayanov, an influential Soviet agricultural economist, but fails to mention the Romanian National Peasants Party. Virgil Madgearu, an economist and one of the most prominent party ideologues, was influenced by Chayanov. But Madgearu took Chayanov's positive assessment of traditional peasant subsistence economy even further, while Chayanov was not able to promote it in the Bolshevist Soviet Union, at least not publicly. Madgearu argued in the 1920s that "the peasantist 'third way' between capitalism and socialism had to lean on this type of economy" (Daskalov, 2014: 317). Although in the 1930s this radical peasantist ideology was subdued in the National Peasant Party, Georgescu-Roegen was certainly aware of it.

Georgescu-Roegen wrote important contributions to econometrics and neoclassical economics during the first decade and a half of his stay in the US after his exile from communist Romania in 1948. However, in his 1960 article he began dealing with the problem of agrarian economics while using the example of interwar Romania to present the problem of agricultural overpopulation (Georgescu-Roegen, 1960a). He stated that neither Marxian nor neoclassical economics can help in understanding the problems of an overpopulated agricultural economy. Georgescu-Roegen (1960a: 10) invoked the *Narodniki* ideology which negated both capitalism and socialism. Georgescu-Roegen thought that there is a need for a different economics and different ideological perspectives when analysing the problems of the agrarian economy. His dismissal of capitalist and socialist worldviews was in accordance with Madgearu's peasantist ideology, but also with future green ideology positioning itself as an ideology beyond left and right.

In the same article there was a critique of Western social scientists that have contempt for the rural perspective, small-scale production and "any idea that is not presented through a mathematical model" (Georgescu-Roegen, 1960a: 10). The same year Georgescu-Roegen (1960b: 231) published another article where he mentioned entropy and wrote that the economic process "must obey the universal laws of matter and energy". However, he did not give it a central position in the article, nor did he sound any warnings about the Earth's limited resources. Tellingly, he did not develop its use in economic analysis into a full-fledged theory until the environmental revolution came into full swing (see Georgescu-Roegen, 1976: 20). His 1966 book *Analytical Economics* contained an epistemological preparation for his revision of economic knowledge and included both of his 1960 articles. Georgescu-Roegen (1966: 42) was discarding his neoclassical heritage and even the dominance of numbers in modern science, as he intended to study change.

Georgescu-Roegen's quest for a different analysis of economics resulted in the book *The Entropy Law and the Economic Process* (1971), which has a cult-like status in some ecological

economists' circles (Daly, 1980: 482; Bonaiuti, 2011: 27). In it, he stressed the irrevocability of the entropic process, an emphasis that was most probably the result of the environmental revolution. Favourable institutional context could have played a part in this new emphasis as Georgescu-Roegen enjoyed the "relative openness of US academia as compared to that of Europe" (Martinez-Alier, 1997: 226). Vanderbilt University, where he worked from 1949 until his retirement in 1976, was an organization that in the 1960s encouraged the voicing of contentious opinions (Heard, 1995). At the end of his official academic life, Georgescu-Roegen (1976: 33-34) added a list of policy proposals to his core concept of the irrevocability of the entropic process such as: "(1) the production of all instruments of war, not only of war itself, should be prohibited completely. … (2) the underdeveloped nations must be aided to arrive as quickly as possible at a good (not luxurious) life …. (3) mankind should gradually lower its population to a level that could be adequately fed only by organic agriculture". He therefore introduced adjacent concepts of green ideology such as equality and non-violence to his core theoretical concept; thus, his scientific endeavour started to resemble the demands of countercultural movement and a thick ideology of ecologism, as defined by Humphrey.

Diverging scientific practices

Georgescu-Roegen (1976: 356) also formulated the fourth law of thermodynamics applying the second law of thermodynamics on macroscopic matter and concluding that "recycling cannot be complete". This provoked debates in which natural scientists were also involved, criticising Georgescu-Roegen's use of physical laws (Bianciardi et al., 1993). Georgescu-Roegen's texts indicate that in the foundations of ecological economics a restructuring interdisciplinary approach was strongly present and it aimed not just to restructure economics, but sometimes also the natural sciences.[4]

Environmental economics has a completely different approach to the natural sciences, as the roles of the sciences are well known, in accordance with bridge building interdisciplinarity. The strict division of labour between the natural sciences and economics is evident in this quotation from Krutilla's *Conservation Reconsidered*:

> Only after there is developed an adequate system of classification of aquatic communities will it be possible to identify distinct environments, recognize the needed reservations, and, then, estimate the opportunity costs. Classification and identification of aquatic environments demand early research attention by natural scientists. (Krutilla, 1967: 785)

As the environmental revolution came and began exerting stronger influence on national and global policies, environmental and ecological economists were in different positions. Welfare and natural resource economists were ready to apply their analysis of themes such as externalities and market failure to new societal demands (Cropper and Oates, 1992). On the other hand, heterodox economists had to first translate the new understanding of social and natural processes into full-fledged scientific theories. The environmental revolution created opportunities for the emergence of a scientific/intellectual movement in which high status thinkers (Georgescu-Roegen and Boulding) shared grievances towards dominant approaches in economics, articulated their program and did "the intellectual or scientific work that comes to be seen as the hallmark of the movement" (Frickel and Gross, 2005: 212).

A comparison of Krutilla and Georgescu-Roegen's bibliographies indicates the different levels of specialisation upon which scholars of emerging fields could build. Krutilla published one of his early contributions in *Land Economics* (Krutilla and Peterson, 1956), a journal which was founded in 1925 as the *Journal of Land and Public Utility Economics* but eventually became an outlet for environmental economists (Spash, 1999). Krutilla (1966) also published in the *Natural Resources Journal*, founded in 1961, a primarily environmental law journal, which during the 1960s "developed concerns about the political economy of environmental issues" (Spash, 1999: 266). Georgescu-Roegen had no such specialised outlets at his disposal and questioned throughout the 1960s neoclassical mainstream theories in general economics journals such as the *American Economic Review* or *Oxford Economic Papers*. These

different starting positions were reflected in the time lag of ecological economics' institutionalisation through journals and professional societies. The most important environmental economics journal, the Journal of Environmental Economics and Management (JEEM) published its first issue in 1974. The Association of Environmental and Resource Economists (AERE) was founded in 1979 in Atlanta with a strong institutional and financial backing from RFF, and the AERE started overseeing the JEEM (Spash, 1999). Ecological economics saw its first society, the International Society for Ecological Economics, and its major journal, Ecological Economics, founded synchronously in 1988 and 1989, respectively (Costanza, 2003).

The establishment of both fields was a result of two processes. First, the rise of the environmental movement put environmental issues high on the social agenda, prompting explanations of environmental crises from all sciences. Economics in particular was invited to provide answers as economic activities were singled out as the main cause of the crisis. In the case of environmental economics, this resulted in a prominent natural resource economist such as Krutilla and his younger colleagues at RFF such as V. Kerry Smith, Anthony C. Fisher and Charles Cicchetti, adopting preservationist ideas and applying them in real-life cases (Banzhaf, 2019). Ecological economists were, on the other hand, challenging well-established economic theories, primarily the benefits of economic growth.

Second, the growth of science after the Second World War opened possibilities for interdisciplinarity and the establishment of new fields, think-tanks, scientific societies and journals. Rapid growth in higher education was an especially important breeding ground for the establishment of ecological economics. The surge of radical student movements of the 1960s, especially influential in the US and France, provided both a public for the ideas questioning the workings of contemporary society and a contingent of radical students for future ecological economics practitioners. Georgescu-Roegen's ideas were well received by the French post-1968 non-communist left, which was looking for new ideas upon which it could build its resistance to the capitalist economy.

The establishment of environmental and ecological economics after the internationalization of the environmental movement: David Pearce (1941-2005) and Herman Daly (1938)

Arguably, even more important than their starting positions for the current unequal prestige of the two fields was the way they were translated into public and economic policies. This is evident from the careers of two representative scholars, analysed here as important promoters of these fields.

Their agency should be put in the context of the emergence of international environmental organizations represented through the build-up to the 1972 Stockholm Conference (McCormick, 1995). The conference pushed governments to act and create various regional and global organizations such as the European Environmental Bureau or the United Nations Environment Programme. This sort of organization became the breeding ground for the institutionalization and promotion of environmental and ecological economics. Opportunity structures were created in forms of employment for SIM participants and "additional prestige above and beyond that which they currently possess" (Frickel and Gross, 2005: 215).

One of the contributions to the Stockholm Conference was the OECD's (1972) report on key aspects of environmental economics. A young British economist David Pearce was a member of the small group of economists that produced this report (Barde, 2007). Pearce devoted his whole scientific career to issues of environmental economics and wrote numerous important contributions to environmental economics theory and practice and also two of the early textbooks (1976; Pearce and Turner, 1990).

Diverging perspectives on solutions to environmental crises

Especially indicative of the rising influence of environmental economics is the policy scope of Pearce's work. Pearce's 1970s cost-benefit analy-

ses mostly dealt with British case-studies (1970). At the end of the 1980s he was the main author of the *Blueprint for a Green Economy* (Pearce et al., 1989), an environmentalist best-seller introduced as "a logical outcome of the UK government's initial response to the Brundtland report" (Pearce et al., 1989: xv). More precisely, it was an outcome of the Thatcher government's embrace of environmentalism in the late 1980s. The book argued that environmental problems should be tackled with an approach that would establish *market-based incentives* (Pearce et al., 1989: 155). Then came the *Blueprint 2: Greening the World Economy* (Pearce et al., 1991), which focused on global environmental policy and contributed to the Intergovernmental Panel on Climate Change report in 1996.

Pearce's global solutions were also based on the use of markets and thus well suited for the ascent of neoliberal ideology that started in the end of the 1970s. Although Pearce contributed to the rising marketization of society, he was not a Tory and he even took part in the early meetings and the founding of the journal Ecological Economics during the process of ecological economics institutionalisation in the late 1980s (Barrett, 2005; Røpke, 2005). Pearce's ideological and scientific position can be traced to his reaction to the early 1970s British debate on *The Limits to Growth*. The University of Sussex Science Policy Research Unit (SPRU) scholars attacked *The Limits to Growth* models as being too simplistic and ignorant of innovation and technology as variables that could diminish resource depletion (Cole et al., 1973). Pearce bypassed siding either with *The Limits to Growth* pessimism or with the techno-optimism of SPRU. The conclusion was that we are faced with uncertainty and there is a need for the optimal strategy in this situation (Pearce and Rose, 1975: 20).

This reflected debates at the OECD during the late 1960s and early 1970s between more ecologically oriented functionaries who founded the Club of Rome and economists promoting high economic growth, which was the main goal of the organization during the 1960s.[5] Liberal environmentalism, which did not discard the concept of economic growth and tried to reconcile it with environmental protection, eventually took over the OECD after the 1973 economic crises (Schmelzer, 2012). Throughout the 1980s and 1990s, liberal environmentalism became "a mainstay of how international organizations and states understand their role in promoting action" (Bernstein, 2001: 71). Pearce remained an important part of OECD's environmental expertise throughout his career (Barde, 2007). His technocratic strategy included bridge building interdisciplinarity; i.e. he tried to find links between the disciplines of economics and ecology (Pearce, 1976: 31). It was also shaped by British scientific culture "producing skepticism about claims that appear to go beyond the observable facts of nature or society" (Jasanoff, 2005: 263).

Ecological economics promoter Daly, on the other hand, saw economics as in need of a new paradigm and he expressed this straightforwardly. When writing about discovering Soddy as the predecessor of ecological economics, Daly quoted (1986: 199) Kuhn's characterization of scientific revolutionaries: "Almost always the men who achieve these fundamental inventions of a new paradigm have been either very young or very new to the field whose paradigm they change". While Daly saw the emergence of ecological economics as a scientific revolution, Pearce and Turner (1990: 5) did not "view changing economic doctrines over time in terms of Kuhnian 'scientific revolutions'. Rather it is more fruitful to think of clusters of interconnected theories or 'scientific research programmes' which compete against each other". It was Lakatos who was the order of the day for environmental economists and this was followed by further discarding of revolutionary economics: "Rather than looking for some 'different economics', we are seeking to expand the horizons of economic thought" (Pearce and Turner, 1990: 31). Daly (1996: 191), on the other hand, classified Georgescu-Roegen's contributions to economics "into two categories (…): normal science and revolutionary science".

Daly was Georgescu-Roegen's student at Vanderbilt University while he was doing his PhD. The importance of contingency is apparent in the story of the emergence of ecological economics. Daly did not know of Georgescu-Roegen before he arrived at Vanderbilt University to study economic development in Latin America. But he became influenced by Georgescu-Roegen's

critique of neoclassical economics and he would later steadily promote his teacher's ideas. He was also much more open to cooperation with other scientists than Georgescu-Roegen was. Daly's collaboration with the ecologist Robert Costanza was especially formative for the institutionalisation of ecological economics (Røpke, 2004). That Daly was Georgescu-Roegen's student and Costanza a student of the prominent ecologist H. T. Odum confirms Frickel's and Gross' (2005: 211) conclusion that "older intellectuals who occupy prestigious positions (often in prestigious departments) as well as their younger protégés (…) will be in the best position to lead a SIM".

But there was more than just contingency in the forming of relations between the founders of ecological economics. A growing interest in developing countries during the 1960s at Western and especially US universities, combined with rising environmental concern, was an ideal breeding ground for a radical restructuring of economic thought. Similar to Georgescu-Roegen's interest in Romanian agricultural overpopulation, the issue that shaped Daly's economic thought was the problem of under-developed countries, his point of reference being overpopulated Northeast Brazil. This sort of global engagement and the inclusion of the perspectives of under-developed countries were missing during the emergence of environmental economics. This does not mean that environmental economics is a parochial discipline or even predominantly concerned about the West. But there was a difference in how the perspective of developing countries was used in developing new ideas. Pearce, for instance, had a broad knowledge of and significant concern for the environmental problems of developing countries. He co-authored a book chapter with Indian economist Ajit Kumar Dasgupta (1972) on flood control in the Damodar Valley in West Bengal. However, this was the application of a Western type of cost-benefit analysis on an Indian case-study and it was not epistemologically different from the one analysing the Tennessee Valley.

Daly (1970) used his knowledge of Northeast Brazil firstly, to emphasize that almost all of the economic growth was taking place in the upper-class per-capita income and that population growth was taking place in the lower class, thus diminishing their per-capita income. Secondly, he concluded that neither the Brazilian oligarchy nor the Brazilian Marxists wanted population control for the lower class. The former because this provides them with a source of cheap labour and the latter because they see the pauperized and numerous lower class as the reservoir for future revolution. These kinds of problems implied that there was a need for a radical change of the social and economic system and for a new ideological and scientific paradigm that would go along with it. As in Georgescu-Roegen's case this change was neither Marxist nor capitalist-oriented and could be, thus, connected with the emerging ideology of ecologism. Daly soon envisaged a steady-state economy that could be achieved only through radical changes and he called for the creation of institutions that would be responsible for "stabilizing population", for "stabilizing physical wealth and keeping throughput below ecological limits", and for redistribution of wealth in order to decrease inequality (Daly, 1974: 19).

Adjacent concepts of future green ideology obviously influenced Daly: the equal access of the South to global resources. From an early age, Daly was appalled by poverty, especially in Mexico, which neighboured his home state of Texas, and later in the whole of Latin America (Daly and Kunkel, 2018). The issue of inequality became an important part of the global framing of environmental issues as developmental problems of the Global South featured prominently at the Stockholm conference. Since the late 1970s, traditional conservationist and preservationist American environmentalism had faced the rise of the environmental justice movement, which protested against the hazardous health and living conditions of the lower classes and minorities (Dowie, 1995). Thus, social equality became one of the core concepts of green ideology and some strands of ecological economics.

Daly tried to apply some of his ideas in the World Bank, where he worked from 1988 to 1994. However, contrary to Pearce, he was not successful in the implementation of ideas of ecological economics and ecologism in public policies as the World Bank's staff was predominantly educated in neoclassical economic theory (Daly, 2008).

The social impact of the fields and their positioning in the scientific landscape

The 1990s and early 2000s saw the growing need for interdisciplinary research in order to tackle the issue of climate change (Weszkalnys and Barry, 2013) making both fields more relevant, although during the 1990s neoclassical ideas dominated climate policy (Meckling and Allan, 2020). It could be argued that the presence of environmental and ecological economists in global institutions raised the stakes of belonging to one of the fields, because it meant that their ideas were no longer confined to academia, but had real-world implications. This created rifts between them, as they had different degrees of success regarding the application of their knowledge.[6]

The doyens of environmental economics Kneese and Ralph d'Arge, founding editors of JEEM, had a similar perspective on relations between the economy and nature as Daly in the early 1970s (Røpke, 2004). They were present in early ecological economics meetings, but eventually drifted away from ecological economics. This was also evident in Pearce's case who, after the success of his *Blueprints*, was less involved in ecological economics and became the target of criticism by some ecological economists (Røpke, 2005). Environmental economists contributed to widely used policy tools such as environmental taxes and emissions-trading schemes adopted by different national and global ideologies that had a liberal, social democratic or centre-right profile. These processes meant that environmentalism was incorporated into other ideologies. Ecological economics provided the theoretical basis for movements and political parties that espoused ecologism and, similar to the founders of ecological economics, wanted to overcome what they saw as the false dilemma between liberalism and socialism. Especially influential in the sphere of political movements were Georgescu-Roegen's ideas which helped establish the degrowth movement (Bonaiuti, 2011). The degrowth movement developed in France in the early 1970s and was resurrected again there in the early 1990s (D'Alisa et al., 2014). Environmental and ecological economics influenced institutions and political movements and this was a sign of both fields becoming fully established.

The divergence in the social influence of environmental and ecological economics was also reflected in their scientific developments. In 2007, the AERE launched the *Review of Environmental Economics and Policy*, a new journal for more popularly written and policy-oriented articles. On the other hand, the European Society for Ecological Economics provides for its members free access to the journal *Environmental Values*, founded by the environmental philosopher Allan Holland and now edited by the social ecological economist Clive Spash. *Ecological Economics* has often been a venue for debates on values and ideologies underlying this field (Söderbaum, 1999), the feasibility of the concept of degrowth (Kallis, 2011) or more recently for a special issue on the prospective alliance of environmental justice and degrowth movements (Akbulut et al., 2019).

The growing opportunities initiated a strong competition for intellectual prestige between the two fields. Opportunities of ecological economics' for amassing prestige were hindered by environmental economics' dominance in scientific and policy institutions. However, this does not automatically translate to failure or hindered scientific/intellectual movement (Frickel and Gross, 2005: 217). Under certain conditions, in this case the profound greening of academic and policy institutions, both movements can gain, although there are considerable differences in the levels of institutional stability of these fields. Environmental economics had origins in state administrative and research bureaucracies, therefore it belonged to "'stealth SIMs', which pursue change while emphasizing continuity" (Frickel and Gross, 2005: 227). It soon became an established field within numerous economic departments. Ecological economics was more connected to environmental movements and its intellectual leaders (on different origins of SIMs see Jacobs and Frickel, 2009: 57). It used the opportunities created by the consequences of environmental revolution and of the popularity of interdisciplinarity to establish itself in interdisciplinary research institutes and non-economic departments (e.g. Institut de Ciència i Tecnologia Ambientals in Barcelona or Maryland International Institute for Ecological Economics) and to be involved in various networks comprising activists and scholars.

Conclusion

This outline of some of the main founders and ideas of both fields presents only a small segment of their corpuses of knowledge. Ecological economics, in particular, consists of several strands and positions and involves both social and natural scientists, as it cherishes methodological and ideological pluralism. Ecological economics as a fragmented adhocracy truly features "intellectual variety and fluidity" and does not "exhibit a stable configuration of specialized tasks or of problem areas, nor (…) strong co-ordinating mechanisms which systematically interrelate results and strategies" (Whitley, 2000: 168). Ecological economics encompasses social scientists, philosophers, and activists criticising market economy and imagining the future relations of humans with nature, but also approaches which are closer to mainstream economics. This roughly reflects differences between more radical European socio-economists and more mainstream US ecological economists around Costanza (Røpke, 2005). For example, an approach taken by Costanza, which included using a monetary valuation of the Earth's ecosystem services, indicated a potential convergence with environmental economics (Costanza et al., 1997). This kind of reasoning prompted debates about whether economic valuation is appropriate for ecological economics (Norgaard and Bode, 1998).

Environmental economics became a different type of scientific field, as it could draw its methods and resources from already established fields. Its bridge building type of interdisciplinarity (sometimes more resembling multidisciplinary research practices than true interdisciplinarity), was in line with characteristics of neoclassical economics, which Whitley termed as being a partitioned bureaucracy. Environmental economics possessed "strong consciousness of the boundaries of economics and what are, and are not, economics problems, a highly rule-governed set of research practices (…) and a highly formal symbol system for communicating and co-ordinating task outcomes" (Whitley, 2000: 184).

The main goal of this analysis, however, was to compare several crucial actors and characteristics in the emergence and establishment of both fields, which could explain their divergence (see Table 2). Both fields can draw upon a long history of particular framings of relations between the economy and the environment, which are similar to contemporary worldviews of these fields' protagonists. However, institutional continuity and social relevance of these framings was quite different. This is reflected in the fact that concepts such as cost-benefit analysis and externalities, developed by economists incorporated in the history of environmental economics, became part of mainstream economics. Likewise, economics journals dealing with related topics were easily transformed into a venue for an emerging discipline of environmental economics.

Using the second law of thermodynamics in explaining economic processes, which became one of the key concepts of ecological economics, did recur among various authors in the 19th and early 20th century, as Martinez-Alier (1987) demonstrated. But it was rarely used by mainstream economists and certainly not as an integral part of an established school of economics. Only with social change i.e. the rise of the environmental movement did theories that underpin contemporary environmental and ecological economics become significant enough to provide the bases for established and independent fields. As demonstrated here, those narrating environmental and ecological communities interpreted concepts such as externalities and entropy as key concepts in the works of appropriated scholars such as Pigou and Podolinsky, respectively. On the other hand, prominent scholars experiencing environmental revolution made little used concepts the focal points of their scholarly activities: entropy in Georgescu-Roegen's case or non-use value of nature in Krutilla's case.

Ecological economics was late to the game, as it lacked an organizational heritage and also possessed an ideological outlook that was more radical and included broader societal and political goals than environmental economics. This outlook was a product of an interaction between the emergence of radical environmental movements and the ideological backgrounds of some of the founders of ecological economics. For example, Georgescu-Roegen and Daly anticipated green ideology positioning itself as an ideology beyond left and right ideology and criticised both Marxist

Table 2. Outline of the main divergences between environmental and ecological economics

	Environmental economics	**Ecological economics**
Ideological predecessors	Universalistic utilitarianism, Conservationists	*Narodniki*, Preservationists
Ideological co-travellers	Environmentalism (liberal, social democratic)	Ecologism, Environmental justice movements, Degrowth movement
Adjacent concept of green ideology becoming core concept	-	Non-violence, Global North-South equality
Earlier journals becoming an outlet for the field	*Land Economics* (1925) *Natural Resources Journal* (1961)	-
Establishment of the eponymous journal	*Journal of Environmental Economics and Management* (1974)	*Ecological Economics* (1989)
Establishment of a major association	Association of Environmental and Resource Economists (1979)	The International Society for Ecological Economics (1988)
Type of scientific field	Partitioned Bureaucracy	Fragmented adhocracy
Types of interdisciplinarity	Bridge building	Restructuring, Integrative
Key concepts	Externalities, non-use value of nature	Energy, Entropy
Type of scientific/intellectual movement	Stealth SIM: low levels of grievances and high levels of institutional stability	Genuine SIM: high levels of grievances and low levels of institutional stability

and capitalist worldviews, aiming to produce a new economics paradigm. Subsequently, ecological economics' profile was then reinforced by the rising importance of radical environmental movements. Therefore, ecological economics was a scientific/intellectual movement in a true sense.

Environmental and ecological economics are, crudely speaking, results of but also contributors to two ideologies: environmentalism and ecologism. Similar to environmentalism, the analysed environmental economists perceived contemporary society as being able to adapt to ecological crises through piecemeal improvements, thus echoing liberal and social democratic approaches. The analysed ecological economists, on the other hand, saw the need for a radical transformation of industrial society as ecologism does, thus going beyond debates between established right and left ideologies and providing a new understanding of the world and new guidelines for action. Ecologism, being a far more radical ideology, prompted more radical types of interdisciplinarity and scientific/intellectual movements.

Restructuring and integrative types of interdisciplinarity present among ecological economics' founders meant that they strongly challenged the neoclassical paradigm. Ecological economics as a genuine scientific/intellectual movement was more concerned with historical narratives (Frickel and Gross, 2005: 223), which allowed them to draw boundaries towards environmental economics. Scholars founding and establishing ecological economics perforated existing boundaries towards the natural sciences. However, as the competition with environmental economics became ever more important, more radical practitioners of ecological economics built firm boundaries towards environmental economics, while others opted for a more cooperative approach. This is in line with Lamont's and Molnár's (2002: 180) conclusion that boundary-work in science involves "the presence of relational (and often political) processes operating across institutions and contexts". Environmental economics was less concerned with boundary-work, because it could emphasize continuity with mainstream economics and thus gain access to resources.

The stories of environmental and ecological economics demonstrate how specific ideas such as the use of entropy in studying economic processes and treating pollution as an externality were recurring in the history of economic thought without being an inspiration for a school of thought or a scientific field. During the early years

of economics' professionalization, several scholars possessed appropriate combinations of ideological backgrounds and scientific practices that brought about the key concepts of both fields. But due to a lack of social demand and the insufficient proliferation of institutions of economic science, these theories were not developed and institutionalized. The impact of the environmental revolution on the establishment of environmental and ecological economics emphasizes the need for studying the effects of major social changes on the establishment of scientific fields, but also on their divergence.

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Notes

1 Social causes are not primarily causes of the emergence of new ideas. Natural causes in the form of environmental crises, although also caused by social causes such as industrialisation and globalisation, and internal developments in the scientific ability of tracking and analysing environmental deterioration were crucial for their emergence. However, the focus here is upon social causes, which can help explain the divergence of these fields.

2 This was not the case, for instance, for William Stanley Jevons who has a significant role in both fields' prehistories (on Jevons's importance for both environmental and ecological economics see Missemer, 2012).

3 Ecological economics is often deemed as a transdiscipline by its practitioners (Colander et al., 2004) and this also indicates boundary-work towards mainstream economics, which is often accused of being far less open to other disciplines.

4 Another crucial text for ecological economics was Boulding's essay on Earth as a spaceship i.e. as a closed system (1966). Boulding's venture into environmental issues can be interpreted as one stop on his journey towards creating a transdisciplinary and integrative system of knowledge. However, the integrative type of interdisciplinarity mostly embodied in general systems theory and the work of Odum did play an important role in the establishment of ecological economics (see Røpke, 2004).

5 The OECD was also highly instrumental in promoting interdisciplinarity (Thompson-Klein, 1990).

6 In the history of environmental thought and protection similar divergence happened at the end of the 19th century. Pinchot and Muir, at first allies in the fight against laissez-faire treatment of nature, argued acrimoniously how to practically proceed with the protection of wilderness (Banzhaf, 2019).

Insect Affects: A Study on the Motivations of Amateur Entomologists and Implications for Citizen Science

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Abstract

With increasing interest in citizen science, this paper discusses how amateur naturalism, especially amateur entomology, is placed within citizen science discourses. Through a case study of amateur entomology in Finland, the paper discusses amateurs' diverse motivations for engaging with nature. The paper discusses especially the affective and ethical aspects of amateur entomology and its implications for citizen science. The discussion is based on an ethnographic study of an entomologist society. The paper suggests that amateur naturalism cannot be reduced to any single definition of citizen science, but amateur entomologists enact different epistemologies as knowledge producers and active citizens. The amateurs are often motivated by an ethical 'first contract' with nature. The rich amateur culture may democratize and 're-enchant' science, provided the scientist worldview of superior data is not allowed to conceal the diversity of amateur motivations.

Keywords: amateur entomology, citizen science, entomological societies, affect, ethics, Finland

Introduction

With increasingly urban lifestyles and decreasing contact with nature, the common knowledge on nature has deteriorated to the point researchers have called 'extinction of experience' (Soga and Gaston, 2016). The lack of contact may have an impact on how we value nature. During the last years, the 'insect apocalypse' has captured public attention and may provide pathways for increased interest in amateur entomology and reconnecting with nature. The 'extinction of experience' is paralleled by a loss of expertise, especially in fields such as invertebrate taxonomy. Lester et al. (2014) have described this 'taxonomic impediment' as a worldwide phenomenon. Taxonomic data, such as species occurrences, are the 'ammunition for conservation' (Hopkins and Freckleton, 2002). Taxonomic research has significant input from amateur researchers. Within the landscape of extinction of experience and loss of expertise, citizen science has emerged as an approach to tackle the dual problem. There are differing understandings of what citizen science encompasses, and its relationship to amateur naturalist tradition is unclear.

For citizen science to deliver the dual promise of engaging people with science and educating them on nature, it is necessary to understand the different motivations of people participating in science. This paper discusses the driving moti-

vations of amateur entomologists, focusing primarily on the affective side of amateur entomology. Empirically the study draws on an analysis of the amateur entomology scene in Finland, and more specifically, the active amateur entomologists in local entomological society in Tampere, Western Finland. What makes the Tampere Entomological Society particularly interesting is that the society, established in 1967, functions purely on an amateur basis. While the active members of the society are well networked with professional scientists, the society's activities are not organized around institutionalized entomological research as in many other entomological societies.

The contributions of the paper are threefold. First, I provide a description of modern amateur entomology through the example of Finland and a case study of one amateur entomological society in particular. Second, I explore how amateur entomology relates to different types of citizen science. Third, I focus on amateur entomology's affective qualities and ethical dimensions and discuss their implications for citizen science.

The paper begins with a discussion of the research literature on the emergence and different understandings of citizen science and its critique. I then discuss the tradition of amateur naturalism, amateurs' role in taxonomy, and, more specifically, amateur entomology. Next, I provide further reasoning for focusing on the affective aspects of amateur entomology before presenting the materials and methods used in the study and moving on to the analysis and conclusions.

Before we continue, an etymological note. The word 'amateur' is often used in opposition to 'expert' or 'professional,' as someone less knowledgeable, 'dabbling' in science or other activity. However, the roots of the word can be traced to the Latin verb 'amare,' 'to love.' An amateur entomologist is someone passionate about insects. "Amateur" is a quality also of many professional entomologists.

Citizen science and its critique

The Oxford English 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." The definition does not capture the diversity of citizen science as a field (Bonney et al., 2016). It leaves out all kinds of projects where volunteers participate beyond data collection and work independently from professional scientists.

There is no single definition of citizen science that would cover the normative, epistemological, and structural differences among the citizen science approaches, and at the same time, capture the diversity of participatory research (Kasperowski and Kullenberg, 2019; Schrögel and Kolleck, 2019). There are roughly two main paradigms, one emphasizing the 'citizen' part and public participation in dialogue about science, and the second emphasizing the 'science' part, i.e., public doing science in diverse ways (Schrögel and Kolleck, 2019). Vohland et al. (2019) have called citizen science a hybrid object, belonging to the worlds of both science and civil society.

Current citizen science efforts range from individual to institutional level and from limited projects to lifelong interests (Vohland et al., 2019). The projects may be initiated by individual laypeople, civil society groups, scientific institutions, or public administration. Citizen science projects have been classified in different ways, based on the project goals (for instance, conservation, investigation, or education) and the depth of citizen participation (Acorn, 2017; Eleta et al., 2019; Schrögel and Kolleck, 2019). As Bonney et al. (2016: 3) write, "citizen science functions in a variety of disciplines, each of which has its own culture, norms, and expectations."

Kimura and Kinchy (2016) have identified seven virtues appointed to citizen science: 1) increasing scientific data, 2) increasing citizens' scientific literacy and awareness, 3) building community capacity for environmental protection, 4) building an equal relationship between scientists and citizens, 5) filling knowledge gaps and challenging official accounts, 6) driving policy change, and 7) catching polluters. These virtues cast the citizen scientists in different roles as epistemic and societal agents. In addition to advancing scientific understanding and opening new pathways for doing research, citizen science projects may combine education, community development, and conservation outcomes (Oberhauser and Prysby, 2008) with positive social and ecological

impacts (Eleta et al., 2019). Irwin (1995) writes how opening science to a broader set of knowledge and sources of inquiry is necessary for crafting sustainable environmental responses and calls for a restructuring of existing institutional knowledge structures. Strasser et al. (2019) think participatory research could transform how knowledge is produced at a deep epistemological level, which could result in a different kind of science. Similarly, Wylie et al. (2017: 403) call for Civic Science that "empowers people to question the state of things rather than simply serving the state."

The definition of citizen science commonly adopted in natural field sciences is in line with the above dictionary definition. Silvertown (2009: 467) describes a citizen scientist as "a volunteer who collects and/or processes data as part of a scientific inquiry." He attributes the burgeoning of citizen science projects to three factors. First, the existence of suitable technologies for disseminating information about projects and gathering data from the public, such as open biodiversity databases, have made public participation in science available for a broader public. Acorn (2017: 775) goes as far as to say that the term citizen science "was coined to accommodate the emergence of large online databases in recent decades." Second, this was linked with the realization among professional scientists that the public represents a free source of labor and skills (Silvertown, 2009). Citizen science has also emerged as an important public policy issue as governments aim to capitalize on it (Kimura and Kinchy, 2019). Third, research funders have started to increasingly expect public outreach from grant holders, so citizen science emerged as a two-for-one opportunity.

Science and technology studies scholars have cautioned about the neoliberal turn in science, illustrated by the perception of citizen science as the provision of free labor, skills, and even funding for professional science. Vohland et al. (2019) define neoliberalism as a political ideology that prefers market solutions to government solutions on efficiency grounds and stands for the economization of everyday life and a move away from common good to individual concern. According to them, environmental sciences are particularly susceptible to neoliberal knowledge appropriation. As the state outsources, for instance, biodiversity monitoring to volunteer citizens, it can be argued that citizen scientists are expected to play the role that has previously belonged to public agencies (Kimura and Kinchy, 2019). Some citizen science programs have been criticized as extractivist, treating the citizens as 'data drones' and not considering the different knowledges, ethics, and ways of relating with nature people have (Lorimer, 2007; Ellis and Waterton, 2004). Turnhout et al. (2014) discuss how biodiversity governance has been permeated by 'measurementality,' a linear understanding of the relationship between science and policy: the accumulation of data is expected to lead to its effective implementation in policymaking. Knowledge production becomes increasingly geared towards those aspects of biodiversity that are considered scientifically, politically, or economically relevant. With its technocratic, economic, and managerial discourses, measurementality shifts the focus from political action to knowledge and loses sight of the diversity of ways of knowing biodiversity (also Irwin, 1995).

Dickel et al. (2019) write how civic technoscience, such as collecting biodiversity data via large online platforms, involves the public in the technological world making and constitutes technosocial publics. Here, the role of the public is limited to either embracing the technoscientific imaginaries or engaging in critical discourses (Dickel et al., 2019). Still, Vohland et al. (2019) see the impact of citizen science as ambivalent: it can either strengthen the neoliberalization of science by providing free data, and public goods like education, or citizen science can challenge neoliberalization by promoting new forms of cooperation and learning, that may safeguard non-economized sphere and lead to sustainability.

The hybrid nature of citizen science has resulted in doubts and criticism towards the different ends of the spectrum. Citizen science is suspected of being a 'stamp collecting' kind of exercise rather than 'proper' hypothesis-driven science (Elliott and Rosenberg, 2019). The quality of the data collected by citizens is often questioned (Oberhauser and Prysby, 2008), and citizen scientists are feared to hold an advocacy position rather than a 'properly' disinterested scientific approach (Elliott

and Rosenberg, 2019). The authors state, however, that citizens' engagement in political advocacy does not threaten the quality of their scientific work, but, on the contrary, the value-laden perspective of citizen scientists may even increase scientific objectivity by uncovering values or assumptions in traditional scientific work and illustrating the need for different kinds of data for different purposes (Elliott and Rosenberg, 2019; Mazel-Cabasse, 2019). To fulfill the promises of citizen science, Eleta et al. (2019) call for designing citizen science projects with ethics at their core.

Decline of taxonomy, decline of amateur entomology?

Research on nature has become dominated by experimental sciences, shifting the epistemic practices in a way that sciences, where amateurs have played the most important role, have become marginalized (Strasser et al., 2019). While the decline of professional taxonomists has been widely publicized, Hopkins and Freckleton (2002) claim that the decline of amateur researchers may represent an underappreciated threat to conservation. Amateurs are particularly important in generating occurrence records of species (Elliott and Rosenberg, 2019; Hopkins and Freckleton, 2002; Pearson and Shetterly, 2006; Vohland et al., 2019), and therefore their decline may have a disproportionate impact upon the information available for conservation planning (Hopkins and Freckleton, 2002). To highlight the importance of amateurs, the latest Finnish Red List of endangered species (Hyvärinen et al., 2019) acknowledges the amateur contributions on various taxa on 42 occasions. Regarding several groups, the authors had to write that few, if any, amateurs are focusing on them. New identification literature is expected to inspire amateurs focusing on, e.g., little-known fungi or insect groups.

Amateurs have many advantages to professional scientists in providing knowledge on insects and other fauna. First, amateurs are more widely distributed than professionals, and thus their activity provides better geographic coverage (Hopkins and Freckleton, 2002). Second, amateurs are free to pursue their interests and can devote their time to recording species occurrences that may provide valuable background information for conservation, whereas professionals may have limited time and interest for general surveys. Furthermore, Hopkins and Freckleton point out that amateurs frequently attend entomological society meetings, providing them an opportunity to share the unique body of knowledge they possess, which raises the study's standards and encourages fellow amateurs to expand their interests. Without this taxonomic expertise, there is no one capable of assessing the conservation status of taxa that are difficult to identify, and focusing conservation efforts only on easily identified taxa may lead to skewed conservation priorities (Hopkins and Freckleton, 2002). Committed, specialized volunteer naturalists may be top experts regarding the species or taxa of their interest locally, nationally, and even internationally. In some fields, they may even dominate the progress and agenda of the discipline (Pearson and Shetterly, 2006).

Citizen science is often presented as new and revolutionary by its proponents. However, two precedents are sometimes acknowledged: the amateur naturalist tradition of the 18th and 19th centuries, and the 'science for the people' movement, and the critique of science of the 1960s and 1970s (Strasser et al., 2019). However, it does not seem clear what the relationship of citizen science and amateur naturalism is, as amateur naturalism is not only a historical but a continuing contemporary tradition, taking many forms that cannot be reduced to the narrowest definitions of citizen science. The label of citizen science should not obscure or determine the meaning of practices such as amateur entomology that are significant in and of themselves (Strasser et al., 2019). Acorn (2017) perceives citizen science as an extension of traditional amateur entomology. Many amateurs possess statistical and theoretical training from a related field useful for relevant analyses (Kaplan, 2009).

In reflections on the history of citizen science, it is often pointed out that all science has civic or amateur roots (Pearson and Shetterly, 2006). Mid-19th century, all entomologists were still amateurs. Through the professionalization of science from the early to late 20th century, amateurs were marginalized (Kaplan, 2009). Still,

amateur entomologists continue contributing to the field, and Kaplan (2009: 328) writes that "entomology advances through the efforts of its many amateur practitioners." The first entomological societies came about in England in the mid-18th century to share knowledge on *Lepidoptera* (butterflies and moths) (Kaplan, 2009). In 1999, the Directory of Entomological Societies listed 514 entomological associations worldwide (Pearson and Shetterly, 2006). 194 of them were interested in general entomology; the rest had more focused missions. 107 general entomological associations were primarily for professionals, 85 for both professionals and amateurs, and 2 expressly for amateurs. A more recent listing arrived at 285 entomological societies worldwide (Ameixa et al., 2017). The lists are likely to be non-comprehensive, as it is challenging to find information on all the local and regional societies in different language areas. The numbers point to a decline, but locally the amateur entomologist societies may even be growing.

Insect imaginaries and ethical citizen science

Insects have intrigued people as they have played a prominent role in our perception of life (Hogue, 2009). Insects are the most numerous group of animals, making up over half of all known species (Foottit and Adler, 2009). The field of entomology is diverse, and pest control has been one key driver of entomological research. Smith and Kennedy (2009) distinguish between basic and applied entomology, the applied fields including economic, agricultural, medical, and veterinary entomology. Cultural entomology is a field that studies the role of insects in language, literature, music, folklore, religion, art, and recreation (Hogue, 2009; Raffles, 2010). Insects have even modeled for the development of architecture and artificial intelligence (Parikka, 2010).

However, especially in the West, the typical attitude towards insects has been that of aversion. From an anthropocentric perspective, insects are perceived to be on the bottom of a species hierarchy as the 'ultimate other' (Knight and Barnett, 2008; Sleigh, 2006). The multiplicity, 'monstrosity,' i.e., the physical difference from humans, autonomy, and parasitism are insect characters that are perceived as being outside the normal boundaries of aesthetics and satisfactions (Lemelin and Fine, 2013) and a threat to the idea of bounded, personal subjectivity (Hillman, 1997), associated with illness and death. Therefore, amateur entomology has remained in the recreational fringe (Lemelin and Fine, 2013), outside the leisure commonplace, unlike, for example, bird-watching.

Entomologists have mostly stayed out of the environmental debates of the last decades (Smith and Kennedy, 2009). Concern over pollinator decline rose in the wake of the IPBES report in 2016, stating that over three-quarters of main global food crops rely on insect pollination (IPBES, 2016). In 2017, the 'insect apocalypse' became headlines after a German study discovered a 75 percent decline in insect biomass in protected areas (Hallmann et al., 2017). The extinction of insects has become an emblem of the current ecological crisis. It poses new challenges to the field of entomology, and according to Smith and Kennedy (2009), calls for a modification of entomologists' self-image towards 'entomological statesmanship.

The 'insect apocalypse' has captured the public's imagination and may provide opportunities for engaging the public in entomological citizen science. The citizen science initiatives should, however, consider the diverse motivations of amateur entomologists, and technoscientific projects should also be made useful for the naturalists' purposes (Acorn, 2017; Vohland et al., 2019). Citizen science projects may conflict with the amateurs' existing data gathering habits (Acorn, 2017). There may be intrinsic conflicts, as while some amateurs are motivated by the possibility of participating in science, the primary motivation for many citizens and amateur naturalists is "to care for nature, to be outdoors, and to do something they perceive as enjoyable and meaningful" (Vohland et al., 2019: 4). For those interested in ecology and conservation, the measure of success in citizen science projects is the degree to which the data is used for positive environmental changes (Acorn, 2017; Dosemagen and Parker, 2019). Ellis and Waterton (2005) have called this a reciprocal 'first contract' between amateurs and nature: nature provides the amateurs wonder and

knowledge, and the amateurs, for their part, make sure that data extracted from nature is appropriately used toward preservation.

Nevertheless, the data does not speak for itself; it is put to various uses. The biodiversity knowledge-gathering efforts, including citizen science programs, do not self-evidently aim at conservation. Furthermore, there is no way of knowing to what uses data might be put, once it is stored in databases, now emphasizing open access. Conservation-oriented citizens may not be motivated to participate in science for the sake of science.

Amateurs contributing to research provide not only their cognitive capabilities but also a unique set of perceptive and affective qualities (Strasser et al., 2019). Amateurs deeply familiar with local entomological fauna add a layer of lived experience to their scientific knowledge, enriching it and making it more relevant for many purposes. Mazel-Cabasse (2019) points out how our capacity to use emotions in response to disasters such as ecological crises is a too often disregarded competence. Studying the affective aspects of epistemic cultures may allow crafting more nuanced responses to environmental disasters and advocating for a more grounded science. For Wylie et al. (2017: 414), STS may offer a form of grounded research "to robustly ask the question of how we wish to construct our collective futures."

(N)ethnography and affect

The empirical material for this study has been collected by ethnographic observation of Finnish amateur entomologists, both offline and online. Ethnographic observation aims to understand a particular culture or society in its terms (e.g., Madden, 2010). To discover the practices of an epistemic culture, Knorr-Cetina (2007: 364) calls for "a working familiarity with the frames of meaning within which people enact their lives." My interest in amateur entomology has continued since 2002. I joined the Tampere Entomological Society, started receiving the society's annual journal, *Diamina*, and its email list. The publications and emails form part of the research material. I have participated in the society's monthly meetings as an observer, and notes from seven meetings are included in the research material. I am not an entomologist of any kind myself; my interest is in the amateur culture and environmental agency. The study materials contain six semi-structured interviews with amateur entomologists, further six interviews with professionals from environmental administration and natural history museums, and informal personal communications with the entomologists. The interviews were recorded and transcribed verbatim. Excerpts from the data have been translated from Finnish by the author.

Netnographic research considers the virtual world as 'the field' and applies ethnographic observation on the internet (Kosinski et al., 2015; Kozinets, 2010; Reid and Duffy, 2018). I followed the virtual presence of the amateur entomologists, tracing the actors, activities, histories of the societies, and memberships. I mapped the Finnish entomological scene via the web pages and social media groups of the societies and other electronic media content. The emergence of social media has also affected amateur naturalism. Through popular social media groups, people who do not participate in the traditional, specialized naturalist societies have found ways to share their enthusiasm for nature and ask for peer support with species identification. For the study, I followed one such group in particular, the 'Suomen ötökät – Bugs of Finland' group on Facebook. The group was established in 2013 and now has over 19,500 members. The broader netnographic observation allowed to set the findings from the local society into a broader context.

While ethnographic analysis aims at describing the study subject on its terms, I will address the affective aspects of amateur entomology. This is not something the amateurs themselves emphasize, and therefore the choice requires consideration of research ethics. My aim is not to present amateur entomology as 'irrational' or anything of the like but, on the contrary, to discuss how affects and emotions are fundamental in naturalist epistemologies. There are still deep epistemological divides, as in the natural sciences it is often not considered appropriate or relevant to discuss topics such as emotions in research. As citizen scientists, the amateurs balance between the natural scientific epistemologies and those of pleasure, leisure, and care, as I will discuss below.

This balancing act is crucial to take into account in designing citizen science.

Geographer Jamie Lorimer (2007, 2008) has studied the significance of affect in UK biodiversity conservation and conceptualized nonhuman charisma to draw attention to the importance of affects. Focusing on charisma allows us to see differences and potentials for agency in nonhuman nature. The concept of affect has been employed differently in various research traditions, some emphasizing the corporeality and intensity of affects, others holding affects and emotions as synonymous (Taira, 2007). Following Deleuze and Guattari (1987), research on affects often distinguishes between affect, feeling, and emotion. For Anderson (2006), affectivity is corporeal, pre-conscious, immediate flow between a human body and another body. Physical feelings are momentary expressions of affects in the body—immediate assessments of the affect. Finally, Anderson (2006) takes emotions as qualitative classifications of affects, bringing affects to the world of meanings for conscious interpretation.

In studying flying squirrel surveyors, Nygren and Jokinen (2013) emphasize the diversity and personal strengths of the surveyors, which makes it impossible to standardize the affective knowledge practices fully. Similarly, entomologists tune into the characteristics of the observed species and become trained in observing them. Affects are not independent of the subject - they are influenced by the person's knowledge, skills, emotions, interests, and motivations. However, affects are not purely subjective either: cultural norms and conventions influence what sort of things each of us invests in and what gives meaning to life. Grossberg (1997) views affects as building capacity for action and tuning in to what matters.

Conceptualizing affects as bodily intensities sets limits to how they can be studied. A shortcoming of this study is that I have not observed the entomologists' affects firsthand on the field, but instead ex-post accounts and expressions of them in the society meetings. Similar to Peltola and Tuomisaari (2015), I have analyzed expressions of affects in observation and interview data. More precisely, I looked for expressions of different types of nonhuman charisma (Lorimer, 2007). Studying affects requires attentiveness from the researcher – I had to let myself be affected by the amateur entomologists. In addition to the choice of words, I paid attention to the amateur entomologists' interpersonal exchanges, tone of voice, and facial and body language, as expressions of emotions resulting from affects, drawing primarily on Anderson's (2006) conceptualization of affect. The study contributes an empirical case of how to employ the concepts of nonhuman charisma in studying affects in field sciences, and emphasizing affects I argue for diversified epistemologies.

The Finnish amateur entomology scene

Tampere Entomological Society, which is in focus here, was established in 1967. Before, it functioned as a specialized club under a local naturalist society (Santaoja, 2021). The Society currently has over 160 members, comprising mainly local amateur entomologists but including also some professional 'corresponding' members nationally. The society is run by a board, elected yearly. The board's tasks are divided between a chairperson, secretary, treasurer, museum coordinator, journal editor, and scientific coordinator. The society aims to circulate the chairs not to burden the same persons and to get new people involved. However, the chairperson has remained unchanged for 15 years. A milestone was reached in the society's monthly meeting in April 2021, as the first woman ever was appointed as a member of the board. One (male) attendee in the online meeting noted: "Things are changing as 4 of the 18 attendees here are women, so perhaps it is time to end the era of all-male panels".

Amateur naturalism has a long history in Finland and elsewhere, going back to the 18th century. In Finland, there are seven active entomological societies. Considering the size of the country, with a population of ca. 5,5 million, it is safe to say there is a lively entomological tradition.

The oldest Finnish entomological society is the Helsinki Entomological Society, founded in 1919. At the time, the language of science in Finland was mainly Swedish. In the bilingual society, communications were held both in Swedish and in Finnish. A Finnish-speaking society, the Ento-

mological Society of Finland was established in 1935. The society aims to provide a platform for amateur as well as professional entomologists. The Helsinki-based societies collaborate closely and organize, for instance, their monthly meetings partly together. The membership practice of the Helsinki Entomological Society remains somewhat exclusive, as a new member is required to have a recommendation from two previous members before acceptance. The election to membership is a common practice among entomological societies with professional members (Kaplan, 2009), but as an amateur society, the Tampere Entomological Society, for one, accepts anyone willing to join. The new members are formally accepted in the society's meeting.

The third oldest entomological society in Finland is the Entomological Club of the Turku Zoological and Botanical Society, established in 1948. The society is closely connected to biology students and researchers at the University of Turku, but it aims to bring together both amateur and professional naturalists.

The above-mentioned societies are generalist entomological societies. The largest entomological society is the Finnish Lepidopterological Society, with its ca. 1100 members, established in 1955. The society brings together butterfly and moth enthusiasts from beginners to professional researchers and has a couple of local clubs in different parts of the country. In 2010, the Lepidopterological Society, with the Helsinki Entomological Society and the Entomological Society of Finland, established Hyönteistarvike Tibiale Ltd, a company selling entomological equipment and literature.

The sixth society, the Insect Club Cupido, was established in 1989. Organizationally, it is placed under the local Hämeenlinna nature conservation association, which is part of The Finnish Association for Nature Conservation (Suomen Luonnonsuojeluliitto). Finally, the seventh Finnish entomological society is the Oulu Entomological Club that functions in close collaboration with the Finnish Lepidopterological Society and the Zoological Museum of the University of Oulu. The club is not a formally registered association but an informal collective of amateur and professional entomologists, biology students, and photographers. The roots of the club go back decades to the former Friends of Nature Oulu. The club became reactivated in 2014 by some active entomologists based in Northern Finland.

Lepidoptera (butterflies and moths) and Coleoptera (beetles) have traditionally been popular subjects of entomological observation, but more recently also Odonata (dragonflies) have interested larger numbers of people (Kaplan, 2009). The latest newcomer to the Finnish entomological scene was the Finnish Dragonfly Society, established in 2006. The interest in dragonflies was rising in the wake of the book *Finnish dragonflies* (Karjalainen, 2002), and the dragonfly enthusiasts organized themselves into a society. However, it was soon realized that the administrative duties in running a registered association took time from the actual study of the dragonflies, and in 2016 the association was disbanded. Interest in dragonflies seems to be still on the rise, and activities are continued without the association.

The activities of Tampere Entomological Society, like the other societies, follow a seasonal cycle also described by Kaplan (2009). From autumn until spring, the emphasis of activities is indoors. The Tampere society holds monthly meetings at the local natural history museum, typically attended by 15-20 people. At the museum, the amateurs have access to the entomological collections for referencing their observations. In the meetings, the members or invited experts give presentations on certain taxa or entomological fauna of a specific geographic area. Photos and specimens are identified together, and the members inform their fellow entomologists of their findings (also Hopkins and Freckleton, 2002). The Tampere society has also organized identification meetings, where the members learn to identify species with the help of a microscope aided by more experienced peers. The individual entomologists commonly travel abroad, combining leisure and entomological observation, and images from these trips are shared in the societies' monthly meetings. The entomologists describe the meetings as 'colloquial'; afterward, the younger entomologists may go for a beer together.

Summer, then, is a time of intensive fieldwork, and meetings are on hold. Some entomologists

prefer to venture alone, whereas others go with a friend or a group of peers. Some of the entomological societies organize field trips aimed at beginner entomologists and the public at large. For entomologists, there are several criteria for choosing the destination for a field trip. It may be individual interest to see a particular species, or there may be external demand for knowledge on insects in a given area. The experienced amateurs of the Tampere Entomological Society collaborate closely with conservation professionals and environmental administration and carry out commissioned studies. I will get back to this collaboration more closely below.

In addition to monthly meetings and fieldwork, the entomologists keep written records of their findings. These are often published in the societies' journals and possibly nowhere else. For this reason, the societies' publications are a valuable information source, for instance, for compiling the red list of endangered species (Hyvärinen et al., 2019). The Helsinki Entomological Society published a series, *Notulae Entomologicae*, from 1921 until 1989. From 1990, the Society, together with the Entomological Society of Finland, the Finnish Lepidopterological Society, and the Entomological Club of the Turku Zoological and Botanical Society published the peer-reviewed scientific series *Entomologica Fennica*, with four issues annually. In 2019, *Entomologica Fennica* was terminated, and papers falling within the journal's scope are submitted to *Annales Zoologici Fennici*, an international peer-reviewed journal published by the Finnish Zoological and Botanical Publishing Board.

Additionally, the societies publish their journals for the members. The Finnish Lepidopterological Society has published *Baptria* journal quarterly since 1976. The journal covers all aspects of entomology focused on butterflies and moths, from the dispersion, behavior, identification, and conservation to issues related to amateur lepidopterology in general. The Tampere Entomological Society has published its *Diamina* journal annually since 1992. The journal publishes articles in various formats, from field reports to shorter notifications, annual reviews of larger butterflies in the region, and essays on aspects of amateur entomology. In addition to entomological articles, the journal publishes texts that can be characterized as cultural entomology. For instance, a member of the society wrote on butterfly-themed stamps worldwide (Koivikko, 2019). Finally, the Entomological Club of the Turku Zoological and Botanical Society has published a web-based journal called *w-album* since 2004. The journal reports studies on local entomological fauna and is published irregularly, depending on the availability of articles from the society members.

The entomological societies are networked nationally and internationally. The Helsinki Entomological Society used to organize national entomological days to bring together amateur and professional entomologists, but recently the collaboration has taken other forms. The Finnish Lepidopterological Society organizes Entomological Weekends annually. The entomologists had a volunteer-run internet discussion forum and a database for entomological observations. However, these have recently been integrated into the Finnish Biodiversity Information Facility (FinBIF, laji.fi), coordinated by the Finnish Natural History Museum in Helsinki.

The Helsinki Entomological Society has organized meetings of Nordic entomologists. The Nordic societies take turns in organizing the meetings, and now also the Baltic countries belong to the network. Furthermore, the entomological societies exchange their publications internationally: for instance, in the meetings of the Tampere Entomological Society, Swedish, Danish, and Spanish entomological journals were circulated. While many amateur entomologists are not multilingual, the use of scientific names for the species works as a lingua franca. I will return to the issue of Latin names shortly.

The interest in dragonflies discussed above exemplifies the significance of new identification literature available in one's language (Lemelin and Fine, 2013). Pearson and Shetterly (2006) write how popular field guides, with quality photography, encourage more professionals and amateurs to go to the field and study organisms in greater depth. The publication of field guides accelerates the development of skills. Pearson and Shetterly describe how, with a field guide in hand, an enthusiastic amateur may gather reliable information, expanding the data set to the point

that the field guide may become obsolete. Lack of reliable literature and identification guides useful for the amateurs have been identified as one of the major barriers to amateur entomology (Lester et al., 2014), but the situation has recently improved. Many of the recent Finnish entomological books have been authored by experienced amateur entomologists, highlighting the fuzzy boundary between amateurs and professionals (Meyer, 2005). For instance, two active members of the Tampere society authored the book *Suomen vesiperhoset - Trichoptera of Finland* on caddisfly (Salokannel and Mattila, 2018).

Another development making amateur entomology more accessible than before is the internet and social media. Naturalists' social media groups are also used for recruiting participants to citizen science projects, such as the Bumblebee Watch or the Finnish mushroom atlas. While social media and the internet may create new citizen scientists, it takes time before the new enthusiasts grow into expert amateurs. Interestingly, while there are only a few women in the entomological societies as active members, in the social media groups such as "The Bugs of Finland," women are actively posting images of insects and asking for help in identification. Taking photographs and sharing them on the internet seems to motivate many beginner entomologists. Social media may provide equal space for participation, independent of time and place, and perhaps in being somewhat 'faceless' also a space with less emphasis on gender or expert hierarchies. The gender balance in the entomological societies seems to be also changing, as the Tampere example attests. Many female society members are trained biologists, working, for instance, in conservation, and have joined the society both for professional development and personal interest.

An amateur entomologist career

Köhler (1989) has presented 'the typical career path' of an amateur entomologist based on a study of German amateur entomologists. According to him, the path begins with collecting specimens, as the amateur naturalist mimics imagined professional scientists. As the amateur becomes more knowledgeable, they want to develop their identification skills, so they find their way to the entomological societies. As the skills and knowledge increase and the amateurs can mentor younger naturalists, they are further motivated to continue on the career path. Amateur entomology may be 'omnivorous' initially, but a more experienced entomologist usually chooses an area of specialization. Finally, they may end up in a leading role in the society and receive esteem by giving lectures, publishing, and participating in scientific and/or conservation work. According to Köhler (1989), entomologists are also motivated by finding a new species and having it named after them. Factors further maintaining the naturalist career include enchantment by natural diversity, the practices and openness of the entomological society, and friendships formed in conjunction with entomological activities. While Köhler's (1989) career path is structured along with the production of scientific knowledge, it points to the importance of affects in maintaining the career.

The typical career path applies to Finnish amateur entomologists, at least to the more experienced ones and the key persons in entomological societies. For example, the chairperson of the Tampere society, Tero Piirainen, disclosed how his entomological career started as a young boy. Like many entomologists, Piirainen started with butterflies but expanded his activities to cover other insect groups. Piirainen has a professional career in the IT sector. As an amateur entomologist, he works as an expert, for instance, in the national expert group for Diptera, alongside professional entomologists. The group aims to support the conservation, amateur observation, and research on Finnish Diptera species and maintains the checklist of the Diptera of Finland. Piirainen has visited schools to talk about bugs to children, and having unparalleled taxonomic expertise, he has taught identification skills for university biology students. The distinction between amateurs and professionals seems somewhat redundant for the entomologists; the distinguishing factor is expertise, regardless of professional or institutional status. Professionals may 'moonlight' as amateurs or become one as they retire, and it is not unheard of that an amateur would move into a professional entomologist career. Ellis and

Waterton (2005: 677) have described this as an implicit 'ladder of esteem,' which is "an incentive to learn, to gain more advanced knowledge of species and their attributes. It appears to be an important ordering device within naturalist communities, dictating patterns of interaction and learning."

While some entomological societies have youth programs (Kaplan, 2009), the Tampere society has chosen a different approach. Although there are concerns about the continuity of the society with the aging of active members and new aspiring entomologists are warmly welcomed, becoming integrated into the semi-scientific society might not be straightforward. "We cannot run a children's program; it would not serve our purposes then," explained an interviewed entomologist. One practice beginning entomologists may find intimidating is the use of Latin species names, as one interviewed entomologists remembered:

> I remember when I started to attend, it was totally astounding when there are a thousand larger butterflies and more than a thousand smaller moths and three thousand beetles, and people talk using scientific names just like that, and everybody knows right away, oh yes, that butterfly lives in that and that village. [I28]

I thought the use of Latin names for species could be interpreted as a sign of scientism (Haack, 2009), a worldview emphasizing science as the best source for human knowledge and willingness to affiliate with it, "mimicking imagined professional scientists" (Köhler, 1989). But the scientific coordinator of Tampere Entomological Society, Juha Salokannel, demonstrated with a series of three questions in the Society's meeting that the amateur entomologists are not using Latin names out of snobbery:

> (i) "How many of you are familiar with the species *Phigalia pilosaria*?" Everybody in the meeting raised their hand (except me); (ii) "How many of you know the name of the species in Finnish?" No hands; (iii) "And how many of you would be able to translate what the name of the species means?" Still no hands; the entomologists looked at one another, puzzled. The species in question has a Finnish name, 'sulkamittari,' but the Latin 'pilosaria' was more familiar to the entomologists.

Most of the amateur entomologists do not know Latin beyond the species names. The use of Latin names has been unavoidable, as, at the time when the more experienced entomologists started, even the domestic species did not have common names. In the 1980s, Finnish names were used for some of the most common butterfly species. Learning the Latin names is instead a sign of the amateurs' devotion. The Finnish species names have recently started to take over due to new photography-oriented amateur entomologists and new identification literature. The chair of Tampere Entomological Society, Tero Piirainen has participated in a working group developing the Finnish nomenclature for Diptera species. According to him, the Finnish naming proceeds in bursts, often in connection to book projects.

The Latin names may give the species – and thus the amateurs - a certain scientific charisma. Common species have Finnish names, and therefore, a species that is now called by its Latin name may be recently discovered and, as such, of particular interest to the entomologists. This kind of scientific charisma does not, however, attract all naturalists:

> When you for example ask someone, "What is this spider?" and you hear the scientific name, the interest just vanishes. So it's just some random thing; it doesn't even have a Finnish name. [I6]

For some, the Finnish species names and the aesthetics and cultural history inscribed in them are an essential part of the amateur naturalist endeavor. The interviewee described how they could not get the same kind of feel for a species if they could not talk about it in their language. Creativity and innovation have an important motivating role for some amateur entomologists. Creativity may be related to the names or the aesthetics of the insects. The chair of Tampere society also draws insects, and his scientifically accurate, detailed drawings are visible in the society's Diamina journal and illustrations at the local natural history museum.

Proceeding on the 'career path' offers the amateurs opportunities for creativity related to capturing and identifying insects. I was told of an instance where an amateur wrote to the ento-

mologists' discussion forum that they had identified over a hundred beetle species from an area in half an hour using only a plastic bucket. They then left the fellow entomologists guessing how this was possible before revealing the method: some ant species have a "waste management site" where they take the inedible parts of their prey; the entomologist had taken such a waste pile with the bucket and identified the beetle species from the discarded backplates. As citizen scientists, the amateurs are not only following the scientific methods but developing new ones, rewarded by acknowledgment among peers.

While Köhler's (1989) amateur career path seems to apply to modern amateur entomology, it is also limited and dated. The amateur entomologists' motivations are not captured by a desire to climb a ladder of esteem. The career path may take many shapes, and the entomologists are increasingly motivated by environmental concern, often featuring 'entomological statemanship' called for by Smith and Kennedy (2009). The amateurs are pushed to maneuver and "to take on enough of capital-S Science to gain legitimacy among credentialed scientists" (Wylie et al., 2017: 411) and environmental authorities. In the society meetings, the affective side of entomology and the role of species' charisma can be expressed.

Affects in amateur entomology

Lorimer's (2007) concept of nonhuman charisma points to the importance of affects in research and conservation. Lorimer distinguished three kinds of nonhuman charisma: ecological, aesthetic, and corporeal. Ecological charisma is based on ethology, the study of animal behavior. The physiology of the human body sets limits to our perception of nature and the detectability of species. We most easily detect those species whose spatial and temporal rhythms are compatible with ours. As visual animals, we easily detect large colorful butterflies during daylight, but to study moths means tuning the daily rhythms to match those of the nocturnal insects. Species requiring extra effort may be charismatic to some entomologists if there is a potential for discoveries.

Insects attain ecological charisma also from their status as a species, for instance, being endangered or previously undetected in a given area. Ecological charisma is relational and depends on the identification skills and interests of an amateur. An amateur reported on the results of a local study in the entomologists' email list:

> In addition to finding interesting species in the area, one wouldn't believe we would find SUCH interesting species and even so many different species. No endangered larger butterflies were found, but "locally fun species."

'Locally fun species,' less frequently seen in the region, may have ecological charisma regardless of not being endangered. Also common species may be ecologically charismatic. One amateur entomologist, who had been studying beetles in an area, described the catching efforts in an entomologist meeting: "We didn't get anything really good—just ordinary earth stompers," referring to beetles commonly known to live in the area. Talk of 'earth stompers' indicates an affinity towards the insects, an ethical notion of sharing the Earth with other "stompers." A 'really good' species would have been a species previously unknown in the area and with a possible endangered status that could have served as ammunition for conservation.

For the amateur naturalists, the ecological charisma of insects seems to be primarily charisma of the species—not of insect individuals. Insects may gain individual ecological charisma as entomologists sometimes take larvae home to grow into adult insects to determine the species and half-jokingly name them. Occasionally for some entomologists, the insects may become momentarily personified through the use of personal prepositions: "S/he perhaps takes cover that way by imitating a hymenopteran." Even though the insect's behavior is understood to be instinctive, the amateur emphatizes with its lifeworld, indicating a profoundly ethical perspective.

The second type of nonhuman charisma defined by Lorimer (2007) is aesthetic, which can be further specified into 'cute' and 'feral' charisma. We often find species with recognizable faces, especially large mammals such as the panda bear, charismatic. 'Monstrous' insects radically differing from an anthropocentric aesthetic norm have feral charisma. Entomologists studied by Lorimer

(2007) were critical towards cuddly charisma and admired instead organisms that appear wild and chaotic. Feral charisma entails the complexity, autonomy, and specific kind of beauty of the other. Different kinds of aesthetic charisma may play a role at different stages of an amateur entomologist's career, as highlighted in an interview:

> I suppose in principle people are interested in butterflies for the same reason as the rest of nature: they are aesthetically pleasing . . . look nice. But when one starts to get interested in other insects, I suppose it's more like an interest in biological diversity in general and so insects basically just because they are so big a part of this diversity . . . and quite an exciting part of it. [I1]

The different types of nonhuman charisma order the amateur and professional naturalists and place them on different stages of the career path. Interest in pretty butterflies is typically considered an activity for beginning entomologists. The Tampere Entomological Society has consciously employed the aesthetic charisma of insects in recruiting new aficionados: the society regularly exhibits its activities at a gardening fair, and for this, they have put together showy collections of tropical butterflies to attract visitors. In an expert context, the amateurs avoid referring to cuddly-type aesthetic charisma, but amongst themselves, they may easily call species "pretty." Appreciation of feral charisma is connected to understanding the ecological value of the species. In a society meeting, the entomologists jokingly referred to a rare species as "small and ugly, so we shouldn't show a picture of it to the environmental authorities," indicating that the authorities might not understand the feral charisma and thus the conservation value of the species.

The third form of nonhuman charisma is corporeal charisma, which Lorimer (2007) again divides into epiphanies and jouissance. By epiphanies or moments of enlightenment, Lorimer (2007) depicts encounters that in the narratives of amateurs have taken place in childhood and have had an emotional effect on them. The encounter may be unique or may occur periodically, such as bird migration. Many of the interviewed entomologists described some kind of epiphanies—moments when the miraculous world of insects revealed itself to them, and the spark for amateur entomology was lit. These epiphanies often seem to be social: another person, such as a more experienced entomologist, initiated the new entomologist's career. An interviewee told how he tried to inspire his children into naturalist activities by taking them to natural history museums. However, as it happened, he was himself blown away by the insect world.

> Others have to travel to the other side of the world to experience something marvelous. But one only has to look into the grass or turn a leaf, and there's a marvelous world. [I28]

The other kind of corporeal nonhuman charisma, jouissance, means emotional and intellectual satisfaction and a feeling of manageability that comes from, for example, identifying a species. There were likely moments of jouissance, as the amateur entomologists in Tampere found an aquatic butterfly species previously unknown to science in 1998. The species was named *Oxyethira tamperensis*, and 20 years later, the place where it was found was protected. The insect is just a couple of millimeters long, with hairy wings, so its charisma is rather ecological, related to its scientific and conservation status, than aesthetic. Similarly, in the entomologists' meeting, one of the entomologists said modestly: "I have one small species here." A red cardboard box with a tiny copper-winged insect pinned in it was passed around. As it soon turned out, the species was a previously unknown species to Finland. The understatement of "one small species" highlighted its ecological charisma and the jouissance of the find.

The amateur entomologists themselves possess a kind of feral charisma that they cultivate with jouissance. The entomologists may describe themselves as researcher types and independent thinkers with an excellent memory, placing themselves proudly in the recreational fringe (Lemelin and Fine, 2013). As an interviewee mentioned half-jokingly, some of them may have neurological diagnoses, "but you don't have to be more odd than that" [I28]. The entomologist society provides a refuge for the members, many of whom may be alienated from modern society and its disregard of the environment. At the same time, the expert

roles taken by the society members may legitimate their choice of fringe recreation.

According to Lorimer (2007), the charisma of species provides an acceptable forum for expressing the human-nonhuman attachment behind amateur naturalism and nature conservation. Charisma acts as a counterbalance to reductionist discourses and practices of conservation biology that emphasize, for example, molecular biology methods in identifying species. Yet, the expert amateurs also adopt technoscientific methods of identification when necessary. There is a full spectrum of different types of nonhuman charisma at play in amateur entomology, employed and expressed differently in diverse contexts. Feral charisma builds on respecting the complexity, autonomy, and specific kind of beauty of the other, and Lorimer holds it a fundamentally ethical relationship.

Between neoliberal technoscience and ethical nature contract

The members of Tampere Entomological Society collaborate with professional researchers and environmental administration nationally, regionally, and locally. Nationally, the amateurs collaborate with The Finnish Natural History Museum and its efforts in collecting data on biodiversity in the Finnish Biodiversity Information facility. Some of them have participated in the 18 working groups set by the Ministry of the Environment to compile the Finnish Red List of Endangered Species, the latest issued in 2019 (Hyvärinen et al., 2019). The working groups consisted of 170 species experts, including researchers in nature conservation and administration, conservators and researchers in natural history museums, staff in research institutes, and experienced amateurs.

Regionally, the Entomological Society holds annual meetings with environmental authorities to determine their knowledge needs and how the society members can respond to them. The local entomologists have participated in compiling the regional biodiversity program and in setting species conservation priorities. The entomologists monitor endangered species in the region, report to the authorities, and organize restoration and maintenance of habitats of endangered species, such as the rattle grasshopper (*Psophus stridulus*). As the regional environmental authority does not have resources for this (personnel or specialized expertise), the amateur entomologists are commissioned to do the work. The volunteers are compensated for costs, but besides that, the work is done on a voluntary basis.

At least two different, opposite readings of the situation are possible. We could take the tasks performed by the amateurs to be indicative of neoliberalism, where citizens are expected to voluntarily take up tasks that previously belonged to public agencies (Vohland et al., 2019; Kimura and Kinchy, 2019). However, the amateurs do not perceive themselves as exploited neoliberal subjects in top-down citizen science. They are actively involved in determining the forms and content of collaboration, conscious of their expertise and experience. The amateur entomologists see the environmental administration and professional conservationists as necessary allies, with whom they have a functional division of labor. The expert amateurs are emphatic of the situation of environmental administrators, with budget cuts limiting the scope of their work, but at the same time aware of the institutional power the environmental officials wield. In a mutual alliance, the amateur entomologists provide the professionals with 'ammunition for conservation' with their data. Simultaneously, they express their puzzlement in "how little the environmental officials seem to know" [I29], pointing to the limits of academic training compared with practical experience (Cornwell and Campbell, 2011). Also the ethical commitment of the amateurs may set the bar high for professional science that is also concerned with careers and organizational regulations.

Locally, the entomologists collaborate with municipalities, especially with the city of Tampere. As the city grows, so does the demand for surveys on flora and fauna in areas planned for construction. One such area of interest is Lake Iidesjärvi, located near the city center of Tampere. The lake and its surroundings are an important nature and recreation area, but it has been targeted for different types of development over the years due to its location. In 2001 the entomological society surveyed the insect fauna in the area. The study

yielded over 1200 insect species (Piirainen and Salokannel, 2019). In 2003, together with other local conservationist and naturalist societies, the entomological society made an initiative to the city to establish the lake as a nature conservation area. The city council did not respond to the initiative but instead continued to plan the area's development into a recreational park for families. For this, the entomological society was commissioned again during summer 2018 to study the insects in the area. This time the emphasis was on butterflies. Overall, 650 species have been found in the area, including five endangered species and two species possibly previously unknown to science. In its report to the city, the society made detailed recommendations for trees and areas to be left untouched to provide habitat for insect diversity also in the future. It seems the message of the naturalist societies is finally being heard among the local decision-makers, as the newly elected mayor of the city has proposed the lake to be conserved.

In the local case, the amateur entomologists participate as scientific experts on entomological fauna. But their role is dual, as they also participate as active citizens, carrying out community-driven citizen science together with residents and other local naturalist societies, such as the botanical and bird associations. For them, the use of data becomes a form of civic empowerment (Kasperowski and Hillman, 2018). The dual role requires some maneuvering (Wylie et al., 2017), as the preferred self-image of the entomologists is "an expert-type amateur society that affects decision making by providing knowledge", as an interviewee put it. The entomologists aim to steer clear from roles that could be considered openly 'political'; they would prefer the data to speak for itself and lead to desired outcomes for nature. Highlighting the scientific character of the entomological society is, however, a double-edged sword. The expert image may exclude some aspiring entomologists and make amateur entomology less accessible for a broader public. The chair of the society did not consider it problematic, though:

> The general opinion is not that there is too much emphasis on science. It is a conscious choice, and we are not planning to give up on it. It is not considered a problem, either, if we simultaneously close some doors in practice. There are other forums for easier, more popular, or more entertaining amateur entomology, such as groups on social media, and I think we live currently nicely side by side with them.

The members of the entomological society do not contribute equally to the knowledge requests (Strasser et al., 2019). People responsible for various studies ask the other society members to provide data on the species and locations of interest. For example, in the Lake Iidesjärvi entomological study, 12 members of the society took part. According to the yearly report of the society, in 2018, altogether 20 members of the society participated in the commissioned research activities – most of them in one study out of the four carried out by the Society that year. The entomologists cannot respond to all the knowledge needs and calls for participation to leave time for fieldwork driven by personal interests. While some amateur entomologists are motivated by the production of scientific knowledge and participation in conservation, their interests are more diverse. An account by Rasimus (2019) on the finding of a rare species *Tipula (Pterelachisus) crassicornis* exemplifies how amateur interests may not be bound by pre-defined knowledge needs or scientific disciplines. The account begins:

> May 22nd was a hot day in Pirkanmaa region. In the early evening, I had taken two Malaise traps to Orivesi and decided to drop by Siikakangas in Ruovesi to see whether there would be insects' evening swarming in the air. I chose a familiar observation spot in an old-growth pine forest by the shore of Kilpilampi pond at the Siikaneva bog. As the evening sun was still shining low at around 22:15, I managed to net two rather large, dark-colored crane flies, one male, and one female, which I freshly deposited in 70% ethanol.

The account provides the reader with information on where and how the mentioned insects may be found, but the writing style distinguishes it from scientific disciplinary accounts. The observer is not faded out but is an active agent in the story. The text explains how the species was con-

firmed under a microscope the next day and was revealed to be a species previously observed only in Eastern Finland. Moreover, for 120 years, the species was not encountered at all, which made the discovery in Ruovesi, Western Finland, particularly interesting. The text continues as a detective story, taking the protagonist to the Natural History Museum in Helsinki, where old samples of the species are kept. The samples turn out to contain little information but are accompanied by a number that takes the entomologist to the collector's notebooks kept in the museum collections. The detailed fieldnotes take the amateur to entomological field excursions "on the summery roads and blossoming meadows of the 19th century Northern Karelia" and the text recounts the finding of *Tipula (Pterelachisus) crassicornis* by Emil Ivar Grönvik in 1865. The text opens up one among the myriad scientific processes at work (Cornwell and Campbell, 2011). The example shows how experts develop intimate relationships with objects of expertise and learn to observe, imagine and understand them (Knorr-Cetina, 2007). This kind of transdisciplinary accounts may make science more relatable, accessible, and lively.

In addition to pragmatic time use, there may be other reasons amateurs might be reluctant to carry out commissioned surveys or donate their data. Historically, there has been a long-standing 'vital contract' between professionals and amateur naturalists based on reciprocity (Ellis and Waterton, 2005). The amateurs have donated their observations, data, and knowledge to the professionals freely and willingly, with the expectation that the records will contribute to the advancement of a wider good and the accumulation of scientific knowledge. The vital contract has become complicated by other actors entering the field of ecological knowledge production. Consultants may approach amateurs for their specific knowledge, and through them, the question of monetary compensation enters the equation. The amateurs may be pushed to consider why they would give their data for free to someone who benefits from it financially. Another issue is that the surveys made for land use planning do not primarily aim at conservation. The data is used for enabling rather than constraining urban development, which always results in some loss of biodiversity. The amateurs might not want to participate in "rubber-stamping" land use in an area with their data.

In addition to the 'vital contract' between amateurs and professionals, the 'first contract' between amateurs and nature binds the amateur entomologists ethically (Ellis and Waterton, 2005). The first contract obliges the amateurs to not only act as scientific experts but to take on more political and activist roles and function as 'entomological statesmen' defending biodiversity. In an interview, after emphasizing the expert roles of amateur entomologists, one of the amateurs evaluated the importance of amateur naturalism, highlighting the dualism of the activity:

> It is essential that things are good at home and that work is not of the silliest kind, but amateur naturalism is maybe, after all, the most important thing in the world, and one cannot use time better than that. [I3]

A widely discussed and somewhat controversial aspect of amateur entomology, which I take to illustrate ethical entomological conduct, is killing and collecting insects (Lemelin and Fine, 2013). Amateur entomologists perceive catching insects as part of regular scientific practice. Only the largest and visually distinctive insects can be identified accurately in the field or afterward from photos without capturing them. Most of the insects are so small that a researcher has to capture some individuals to identify the species using microscope or DNA identification methods. Entomology guidebooks have had relatively straightforward instructions on killing methods as an essential part of entomology, but recently field guides take an apologetic tone towards collecting (Pearson and Shetterly, 2006). According to an interviewed entomologist, these sections are for "more sensitive people." Especially among the younger entomologist generation, the thinking seems to be that insects should not be killed without reason, even though the amateurs may struggle to put these ethics into words as the practice of collecting is so established:

> I don't know how you can explain it, but most amateur entomologists also think that we won't kill anything without grounds. [. . .] We use a lot

> of traps that don't have poison, so the butterflies are kept alive and . . . Even if it doesn't matter that much, but it's just like . . . [I3]

I take the quote to indicate the first contract between amateur and nature, a reflective empathy towards insects (Aaltola, 2018) – a combination of affective other-directedness and rational deliberation. There seems to be an expanding group of entomologists interested in certain insect groups and who do not collect specimens but rather document their observations by taking photos. There is a difference between collecting insects like stamps, and collecting them for scientific purposes, to provide 'ammunition' for conservation (Hopkins and Freckleton, 2002). This difference is not evident to beginner entomologists, and killing insects is frequently problematized, for instance, in the popular social media group "Bugs of Finland." The amateurs accept the killing of insects pragmatically, but a stamp-collecting type of undiscriminating collecting is no longer looked upon favorably. The difference has to be communicated to aspiring entomologists, and it also invites citizen science projects to consider how to account for the first contract and ethics in their methodology.

Discussion: Catering for diversity

Amateur entomologists participate in citizen science in various ways, but amateur entomology cannot be reduced to any narrow or single understanding of citizen science. Amateurs provide data for national databases, research projects, and regional conservation, but they are not limited to data providers even in that role. They participate in analyzing and reporting the data alongside professional researchers. The amateur entomologists go beyond participation – they decide and design themselves the studies they carry out and the various public outreach activities they participate in. The experienced amateurs train the future professionals on university taxonomy courses, turning the recent roles of amateurs and experts upside down. In these activities, the amateur entomologists' use of data is a form of civic empowerment (Kasperowski and Hillman, 2018). At least the amateur elites can move between scales and contextualize their expertise for effective citizen science (Kimura and Kinchy, 2019).

The adoption of scientific standards has a boundary-bridging role (Ottinger, 2010). The amateur entomologists are part of the epistemic culture of natural sciences; they have interiorized the processes of scientific knowledge creation (Knorr-Cetina, 2007). Nevertheless, they are only partly scientists – they are also much more. In this paper, I have aimed to shed light on the rich culture of amateur entomology. Amateur naturalists develop intimate relationships with the insects they study, and they are linked to them "through libidinal sequences of wantings" (Knorr-Cetina, 2007: 371). These libidinal wantings may be connected to the diversity, beauty, and autonomy of insects, but also to the colloquial amateur-expert entomological society and the possibility to proceed on one's amateur entomologist career and become an acknowledged expert, able to help others on their path. These libidinal wantings portray amateur entomology both as citizen science, leisure, and civic action. However, for many amateur entomologists, I have argued, the primary libidinal wanting is connected to the so-called first contract between amateurs and nature. The intimate relationship of having access to nature and being obliged to care for it is fragile. The ethical first contract is constantly in danger of being dismissed or ridiculed by capital-S Science with its epistemic practices. The scientific standards themselves require democratizing and diversifying (e.g., Ottinger, 2010), as the perception of scientific worldview being superior in every context is flawed (Irwin, 1995).

As epistemic subjects, amateur entomologists encompass several kinds (Kasperowski and Hillman, 2018). They participate in epistemic cultures on par with professional scientists, but they may hold multiple agencies, as illustrated by the example of knowledge production and conservation concerning Lake Iidesjärvi in Tampere, Finland. The agency of amateur entomologists may rotate between different agencies, depending on what is at stake in a given situation (Knorr-Cetina, 2007). The 'entomological statemanship' enacted by amateur entomologists is not only scientific knowledge production. At best, amateur entomology has an opportunity

to democratize science and help imagine more sustainable science, bringing the first contract to bear on epistemic practices. Here, however, I fear the amateurs are somewhat in danger also from themselves in reinforcing the norm that only those with data have a voice (Wylie et al., 2017). It may then fall on STS analyses to show the diverse values of amateur entomology for science and the amateurs themselves.

Strasser et al. (2019) have called for a better understanding of the epistemologies of participatory research in order to better assess the politics of citizen science. Contemporary discourses on participatory research are challenging the current regime of knowledge production, based on the separation of institutionalized professional expertise and the lay public as the consumer of scientific knowledge. Citizen science programs should be organized in a way that does not bring additional burden to the amateurs. While they bring their specialized expertise to bear, citizen science projects should make visible the affective side of amateur entomology. If the fundamentally ethical first contract between amateurs and nature is not respected by initiatives aiming to tap into the amateur knowledges, the amateurs are faced with choices that might result in withdrawal from participation.

Citizen science seems to be somewhat uncomfortably positioned between a neoliberal need for innovation and measurementality and a need to find new sustainable ways of living. Environmental field sciences have adopted a relatively narrow definition of citizen science, treating citizens as data sources. The urgency to find novel ways of responding to environmental crises points to community-driven science being able to question the current state of affairs. There are signs of growing interest in amateur entomology. However, one should not be too quick to channel these emerging amateurs into citizen science programs with limited scope. As Turnhout et al. (2013: 592) have written, "the diversity of life needs to be fostered by a diversity of relations with and ways of knowing biodiversity." Amateur entomology is a holistic and diverse engagement with nature, and it should be cultivated as such.

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Knox Hannah (2020) Thinking Like a Climate: Governing a City in Times of Environmental Change. Durham: Duke University Press. 328 pages. ISBN: 978-1-4780-1086-9.

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"How are we to think like a climate?" This may be the first question that arises when reading the title of Hannah Knox' timely ethnography on climate change governance in the city of Manchester. Is it a mere conceptualisation of climate as a "form of thought" (p.8)? An acknowledgement of "stabilized effects of interactions" (p.8) between interacting entities? Most of all, the prompt to think like a climate invites people to "inhabit global ecological relations and their projection into the future" (p.264). This mode of thinking understands climate in a multifaceted manner, paying special attention to its material dynamics. It brings into view how climate can be understood as a rainstorm disturbing a meeting, and how it is seen in data, spreadsheets, models and documents as well as in activist spaces. *Thinking Like a Climate* explores myriad ways in which planners, politicians, activists and anthropologists can, should and already do try to grasp climate change. The book successfully describes entanglements of city administration and politics, policy-making, activism, climate science and data representations. It starts with theoretical and methodological aspirations that are taken up in two empirical sections and make up the largest part of Knox' ethnography. Though the kaleidoscopic presentation of empirical findings and theoretical approaches is at times difficult to follow, it offers various forms of inspiration and promising tools for future ethnographies of climate change: Knox introduces a lively array of concepts that have the potential to steer new questions and answers about current and future climate governance.

Consequently, *Thinking Like a Climate* is of interest to readers from urban studies, climate anthropology, ecologies of infrastructures, political anthropology and anthropology of knowledge alike. What is more, it paves the way for further climate ethnographies in cities by empirically and conceptually bridging urban studies and climate studies.

Knox builds on relational theories of human-environment entanglements, stressing that climate is beyond the "natural". Rather, it is presented as an ecology of signs brought to our knowledge by mathematical operations. Knox offers a plethora of empirical examples to illustrate the importance of understanding and critically examining these numerical representations in models and their material effects in politics.

In her 2015 article of the same name, Knox outlines how climate's ontology brings together social and scientific topics and renders them equally interesting in political terms. In the article as well as in the book, she is interested in how

it is possible to take political action to deal with climate's material and representational facticity. Her main point is that climate change makes people more politically aware – the scientist, the homeowner, the local administrator – and, consequently, shifts delineations between science and society that must be viewed as politically entangled in questions of ontology and action (Knox, 2015: 99). In her view, it makes sense to look at mundane practices, too, and find new ways of governance to accommodate this shifting "relationship between the objectivity of science and the subjectivity of politics" (Knox, 2015: 105). While she foregrounds the political ontology of climate change in the article, her book focuses on epistemological entanglements. This paves the way for concepts like the *vernacular engineer* and *responsive personhood* (see below) that follow her take on reflexivity as a mode of experimental governance. Simultaneously, Knox' empirical examples hint at a productive tension between theoretically framing climate change as an infrastructure of thought and empirically showcasing the materiality of climate change through knowledge practices.

This tension runs through both empirical sections of Knox' monograph, *Contact Zones* and *Rematerializing Politics*. Knox begins with interrogating the knowledge practices behind numerical operations, representations and percentages in climate science to unveil its entanglements with governmental action at the city scale. Exemplified by Manchester's commitment to reduce 41% of its carbon emissions, Knox addresses how climate change becomes social through people's (political) capacity to participate in achieving such climate goals. Bringing together climate sciences and accounting techniques, she introduces another dimension of thinking like a climate: asking how established ways of knowing climate are unsettled by different footprinting techniques and their implications. In a next step, Knox turns to the (in)ability of climate models to facilitate change, especially in terms of preparedness, with respect to possibly catastrophic climate futures. Here, climate science is but one of many future-making practices at the city scale. She describes how mayors and planners are *stuck in strategies*, struggling to get a hold on climate change as an interdisciplinary, inter-organisational problem. Knox sees remedy in employing an experimental mode of governance that is open to scrutiny from the outside and within, paying attention to the "ecosystemic relationality of climate change" (p.176).

In the second part, Knox shifts her attention to practical forms of action. Among others, she discusses entanglements of climate change in Ecohomes (ecologically friendly, technologically savvy showhomes) as places where someone can become politically effective by engaging in learning processes as an "expert-amateur" (p.204) or a *vernacular engineer*. Vernacular engineers and their Ecohomes constitute a prime example for approaches foregrounding experimental modes of governance: They ground what is understood as trial and experiment in political processes, locate spaces where different knowledge practices constitute what Knox introduces as an ecology of signs, and they connect climate and sociological reality by means of politically charged engagement with their environments. This also serves as an example of *responsive personhood*, which Knox suggests as alternative to *neoliberal personhood* in order to probe how people relate and respond to their (living) environments by caring for or being attuned to them, rather than choosing between functional options that are offered by their surroundings. Knox suggests that the main contribution of *Thinking Like a Climate* is to move away from a choice-making subject. Responsiveness then is a vital capacity of the entangled human subject. She argues that a turn to the responsive rather than the choice-making version of the subject might open up new directions for an anthropology of climate change. Criticizing a reading of climate change activism as post-political, Knox proposes the term *propositional politics* to denote an in-between position of activist action, inherently open to broader public participation and challenging notions of expertise in policy development.

Knox closes by framing the book as a redescription that aims to make knowledge practices available for discussion, pointing out that such practices do have the potential to be changed. Those who are looking for hands-on proposals on what this change could look like or how to bring it about will be left wanting though. Instead of further discussing possible paths or ideas, in the last chapter of the book she surprisingly turns to

questions of anthropological practices in climate change. Her suggestion is that anthropologists do not stop at descriptions of social worlds but actively engage in political interactions. Her view confirms Susan Crate's conclusion (2011): An anthropology of climate change should be an engaged anthropology. But almost ten years after this claim, we are left astonished by a profoundly engaged climate ethnography that refrains from making a specific proposal towards anthropologically informed climate governance – a claim we feel Knox' deep immersion in Manchester could meet. In a sense, this reflects where we stand in establishing an anthropological approach to the complex global human-environment relations that we frame as climate change. It also hints at future tasks for our research: to take up (trans-) disciplinary threads and weave them together into a comprehensive anthropological theory of climate change that informs also non-academics.

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Csiszar Alex (2018) The Scientific Journal: Authorship and the Politics of Knowledge in the Nineteenth Century. Chicago: University of Chicago Press. 368 pages. ISBN: 9780226752501

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Social sciences, humanities and STS scholars have for some time been attending to the circulation of popular science and vulgarisation periodicals in the nineteenth century. *The Scientific Journal* argues that, paradoxically, we still know relatively little about how a certain format, periodicity, discourse of propriety and standard of publication congealed as such a thing as a scientific journal to oppose to popular science periodicals in the first place. The book's purpose is to examine how across the century the genre emerged as a canon and token of scientific knowledge, as a locus of expert exchange and as a public endeavour, producing in the process different kinds of authorial, scientific and public legitimacy.

The first chapter examines how the proliferation of increasingly frequent publications opened up routes of circulation of odd findings, miscellanea and renditions of learned societies' minutes. The moral legitimacy of the latter's annals - infrequent, expensive and aimed at the conservation and monopolization of canonized knowledge created by elites unpreoccupied by funding and employment concerns - was now besieged by briefer, faster and sleeker knowledge claims, perhaps apocryphal but embodying the democratic, progressive and radical élan of cheap diffusion and popular debate. Initially recalcitrant, learned societies eventually launched their own journals. Chapter two shows how scientific knowledge became enrolled in remarkably literal battlegrounds concerning the politics of knowledge: publics emerged across Europe as the site of a sovereign, enlightened reason whose political *right* to the public science it *needed* fused with the demands for a free press, the whole incarnated exceptionally well in these periodicals. The third chapter examines how the referee's emergence as a reader charged with examining the soundness of increasingly specific claims consolidated a sense of expertise, scientific credibility and learned authority that would only much later take on the character of gatekeeping. Through the fantastic controversies regarding the originality of Galileo's claims and the discovery of Neptune, chapter four examines how particular publishing practices and venues became viable and legitimate sites of adjudication, verification and authority over such a thing as an established and scientific fact. The fifth chapter analyzes how the efforts to catalogue the cacophony of publications, genres and formats in existence in order to hierarchize and standardize claims, nomenclatures and scientific knowledge had to ask the question of what was to be included and how: considerations spanning availability, originality, provinciality and periodicity informed what effectively counted as a valid scientific outlet where knowledge claims would count. The last chapter returns in a way to the public politics of knowledge, examining national and international efforts to streamline, tame and index a science growing so far beyond anyone's curatorial capacities that it was quickly becoming inaccessible to scientists themselves.

The Scientific Journal is a resounding success and timely, too: it was released as the anthropology journal *HAU*, pioneer in a much hyped, self-conscious experiment in open access, succumbed to a scandal concerning exploitative and abusive managerial practices, recasting the question of the place of journals in the politics of scientific knowledge today. Csiszar's sobering point to all sides of this debate is that such spirited, self-reflexive and highly politicized experimentation with alternative technologies of publication, accountability, diffusion and access, grand and lowly, is not only as old as the concept of the journal, but arguably precedes *and catalyzed* the stabilization of such a thing as a scientific journal to begin with (p.287). Certainly, this particular historiography might be enhanced by the authorial decision to focus on the UK and France, two societies where revolutionary politics were lived in an exceptionally experimental, radical and volatile way. Yet, Csiszar's argument that the triangulation between democratic freedoms, socialist utopianism and a will to public knowledge (p.87-100, p.207) is precisely why scientific societies around the world turned to British cataloguing efforts and the ground breaking Comptes Rendus in France is rendered expertly and convincing.

Beyond the strict subject matter in itself, of particular interest to STS scholars will be the author's examination of how parallels between property in inventive ideas and priority in scientific ideas provided a technical, stable grammar to the scientific question of discovery sequencing and adjudication (p.168-169). Similarly, the analysis through competing historiographies of Galileo's work of the opposition between a legalistic approach to claim adjudication prioritizing evidence, broad diffusion and a kind of openness – who said it, signed it, wrote it, proved it first – and a historical approach prioritizing interpretivism, quiet meticulousness and a kind of introspection – where and when was the essence of this claim first formulated and passed on – is particularly sophisticated (p.170-184).

The whole book also intervenes diagonally in questions certain quarters of the STS and performative branches of social sciences are now asking: who are the publics of scientific, not popular, knowledge and how should "non-experts" and their concerns be included in the production of canonical scientific knowledge. Csiszar retrieves these publics from the somewhat exalted interpretations of reformist and revolutionaries. Publics (occasionally merged narratively with "public opinion") have moved from an unruly mob to the site of representative consensus (p.39), the site of a nec-plus-ultra sort of reason (p.87) who by virtue of belonging to a certain commune, a certain terroir, is best placed to adjudicate and make reasoned judgements (p.103) and safeguard science (p.106). One could argue that except for a passing description of the public sphere as an eminently middle class reading audience commercially oriented to the press (p.121), *The Scientific Journal* tells us less about whether these democratic, republican, utopian publics actually materialized, or how, and how they could have concretely faced the increasingly specialized languages and sites of growing scientific knowledge. Csiszar's point, if slightly implicit, is that those revolutionaries and radicals were precisely those writing and doing what came to be canonised as science; it was less their, or any, *actual* publics than revolutionaries and reformists' imaginations thereof that consolidated the shift away from "oracular" decisions to a more standardised and accountable mechanism of refereeing (p.152). The imagination of those publics catalyzed the shift from an academia with a collective singular research agenda writing for itself to an aggregation of individual research interests scattered in a market place of circulating, continually tested ideas across cheaper and more frequent publications (p.210) and who, via that marketplace, freed the cultural capital of the scientific persona from elite savants who did not need their books to be read or engaged, let alone challenged (p.47). We return in this sense to this book's main argument: from the crucible of political, technological and economic stakes in the production of knowledge the scientific journal emerged as a profoundly self-conscious project, both contingent and utopian.

Encyclopaedic in intensity yet accessible across disciplines, *The Scientific Journal* will be of interest to most social sciences with any STS components. Pitched perhaps slightly above the reach of general audiences, it would work well as course reading either as a whole or broken down in chapters.

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Articles

Book reviews