Minerva (2025) 63:93–113
https://doi.org/10.1007/s11024-024-09538-y

Environmental Care: How Marine Scientists Relate to Environmental Changes

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Accepted: 13 June 2024 / Published online: 16 July 2024

Abstract

Marine scientists have reported drastic environmental changes in marine and polar regions as a result of climate change. The changes range from species compositions in coastal regions and the deep-sea floor, the degradation of water and ice quality to the ever-growing plastic pollution affecting marine habitats. Marine scientists study these changes in their fieldwork, and communicate their findings in scientific publications. Some also rally in protests for the necessity of political programs to tackle changes. Based on ethnographic visits and interviews with marine scientists, this study examines how marine scientists experience and act on environmental changes as individuals and as collectives. In order to analyze their experiences and actions, I use the notion of care and portray care in different times and spaces, from work to protest. I demonstrate how care needs to be situated in different times and spaces, how care is embedded in a complex relationship of institutional requirements and structural demands that researchers experience, but also how care receives institutionalization and has an impact on research interests and agendas. In doing so, I show the social and epistemic consequences of care, opening up a view of individual and collective care in the marine sciences.

Keywords Care · Environmental care · Activism · Marine science

Introduction

In 2022, I participated online in the UN Ocean Conference which took place in Lisbon. At this event, early career representative of the European Marine Board, Rebecca Zitoun, mentioned that the relationship between scientists and politics is of

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high importance in the field of marine science. In fact, she argued that research institutes should already engage with political dimensions of research and development at the level of education. She suggests that policy training should become part of university curricula and that these changes need to be implemented in a timely manner. Rebecca stated, "we want to see change happen much faster." Another conference participant, director of Scripps Institution of Oceanography, Margaret Leinen, narrated her experience of an attendant who stood up during dinner and said "we need to stop the science and start to act." Leinen recalled how they received a round of applause and agreed with the statement by arguing for a better connection of research and action. These observations at the 2022 UN Ocean Conference are exemplary of broader trends in the marine science community, in which scientists are not only presenting research results but also calling for political change and action. Although other scientific fields likewise observe and research environmental changes, marine scientists are already socialized into a community concerned with environmental changes (see, for example, Oreskes 1996). The ocean and areas adjunct to it — for example, the polar regions — have been studied for decades to document long- and short-term changes. Lately, man-made environmental concerns, such as effects of climate change, biodiversity loss, or environmental pollution, have reached a new dimension based on the expected irreversibility, urgency and rapidity of changes. This also feeds into calls for urgent action as exemplified by observations at the UN Ocean Conference.

In this study, I focus on scientists who work at a renowned German marine science research institute and are concerned with changes measured and depicted through different disciplines, such as ecology, microbiology, and biogeoscience. The scientists of the institute research a range of topics that focus on anthropogenic effects on the environment. For example, they study changes in species compositions in coastal regions and the deep-sea floor, the degradation of water and ice quality, or the ever-growing plastic pollution affecting marine habitats. They not only study and write scientific publications about environmental changes; some also participate in or even organize protest activities. Furthermore, many scientists that I interviewed experience what Albrecht and colleagues (2007) call "Solastalgia": emotional distress caused by environmental changes. The scientists often speak of deep sadness when they talk about their research and their motivations for protest. For example, a marine ecologist told me about colleagues who research the Great Barrier Reef in Australia and how they are deeply touched after every dive, seeing the ruins of the coral reef. She starts sobbing when she talks about her colleagues and says that she too is overwhelmed when she sees how the environments she researches change so drastically. Yet what does the feeling of sadness or even desperation stand for? According to emotion theorists, emotions often indicate the initiation into care practices (see Pulcini 2017). Thus, I take the scientists' emotional distress as an initiating moment for their environmental care. To understand the environmental care of marine scientists, I ask: How do scientists care for environmental changes? What are the social and epistemic impacts of their care? The notion of care allows me to focus on an "affective state, a material vital doing, and an ethico-political obligation" (Puig de la Bellacasa 2010: 90). It also allows me to analyze different times and spaces in which they care, at work and beyond.

Based on interview material and field notes from my observation at the institute, I show that for these marine research scientists, environmental care is part of different practices. To do so, I conceptually lean on care and care-related debates in Science and Technology Studies (STS). According to Murphy (2015: 721), care carries four different meanings (if not more): "first, it refers to the state of being emotionally attached to or fond of something; second, it means to provide for, look after, protect, sustain, and be responsible for something; third, it indicates attention and concern, to be careful, watchful, meticulous, and cautious; while its fourth meaning (…) is to be troubled, worried, sorrowed, uneasy, and unsettled." These four different meanings are opened up in various care-related debates in STS. Scholars in STS have conceptually focussed on care as a sensitivity to unfold what otherwise stays at the margin (see e.g. Puig de la Bellacasa 2011). They have asked what is cared for, how care is put into practice, by whom, and why. Connected to these questions, a focus on care allows me to analyze different times and spaces that are being cared for in affective relationships which sometimes do and sometimes do not translate into consequential action (Schrader 2015; Puig de la Bellacasa 2015). It is important to note that caring also has a "dark side" (Martin et al. 2015), for example, when caring has a selective attention to something and disregards other concerns.

Care-debates in STS are central for my analysis of marine scientists' environmental care. They allow me to show when the scientists care, what their care consists of, and what it results in. STS based care-debates also allow me to illustrate environmental care in its complexity, namely by showing that environmental care needs to be situated in today's research realities, which configures care not as naïve but as embedded in research structures and institutional processes. For example, I demonstrate how the marine scientists' environmental care relates to research programs and competitive parameters, and also how it leads to potential coping possibilities or receives institutionalization. In so doing, I focus on the social and epistemic consequences of individual and collective caring.

In the following sections, I first attend to relevant characteristics of environmental sciences with a focus on marine science through a literature review that contextualizes my study in the historical foundations of marine science. Subsequently, I will elaborate on relevant care debates and how these provide a basis for my understanding of environmental care of marine scientists.

Marine Science: Between Continuity and Change

In the context of this paper, I am interested in how marine scientists' environmental care impacts research and knowledge production as well as lives of marine scientists. Knowledge about environmental changes is never neutral, and is embedded in the beliefs and values of knowledge cultures, meaning that different "knowledges lead to different actions" as "how one acts is already bound up with how one knows" (Mahony and Hulme 2018: 411). Hence, I first situate the marine scientists in the historical development of a research culture with its own beliefs and values.

Environmental sciences have recently gained widespread attention from scholars, as they inhabit a prominent role for demarcating today's relationship between

science and society and executing responsible research in practice (e.g. Dickel et al. 2020; Kaldewey 2018; Weingart 2002). One field which offers insights into the changing relationship of science and society is that of marine sciences. Marine science is specifically interesting as a field characterized by continuity and change in its field-specificities (Lehman 2018; Vermeulen 2013). This interplay of continuity and change is a reason to think of it as a form of new natural history (Vermeulen 2013) or as a representative field which deals with questions critical to the planet and thereby offers a reflexive account of today's research practices. For example, ocean science — an even larger umbrella term that captures the many sub-disciplines studying the ocean — is considered a central community to understand how evaluation practices change and impact knowledge practices[1]. In line with this, I argue that marine science represents an ideal field for a reflection on how scientists care for environmental changes.

Marine scientists have a long history of intimate engagements with the ocean and marine life. This history has had an impact on how and where marine scientists work and what their studies focus on. In the late 19th century, marine science underwent a transition regarding the place of knowledge production. Marine institutes were often transferred closer to the shoreline and away from larger university buildings, which brought scientists closer to their objects of study (Kohler 2002). De Bont (2009) has argued that such a move led to specific ecologies of the respective marine stations, which had social and physical effects on epistemic work and eventually resulted in scientists becoming involved with local communities, such as through collaborations with fishermen. At the same time as place played an important role for the development of the field, the research practices of marine science changed from mainly ship-based to based on remotely-operated sensing instruments and machines (Helmreich 2009; Lehman 2018). This shift did not substitute for ship-based research but rather marked a development in the physical sector of marine science, a development which is claimed to make the ocean more abstract and less situated (McCormack 2012). This methodological shift also allowed the inclusion of a broader range of scientists, as it made the ocean more accessible and changed the relationship with and reliance on non-human technologies in the field (Lehman 2018).

In addition to these broader developments in marine science, field-specific narratives help construct scientific ideals that mirror the environmental care of scientists in this research field. For example, for a long time, marine scientists have been considered deeply passionate about their work, leaving family behind to go to sea (Oreskes 1996). This historical narrative is informed by an emotional relationship with the sea. It also coexists easily with other ideals that foregrounded the scientist as an individual trailblazer and creative inventor (e.g. Daston 2003; Shapin 2008). The interpretation of marine scientists and their scientific ideals continued further in the mid-20th century, developing into an imagination of "science pursued by barefoot youths in ragged shorts and greasy shirts on the wave-swept decks of sailing ships" (Sullivan 1961: 246). Both field-specific ideals similarly configure a scientist deeply passionate about the sea. This inclination to research the environment is in line with the develop-

[1] See, for example, the ERC-funded project "Fluid Knowledge" (PI: Sarah de Rijcke): www.fluid-knowledge.com

ment of marine science alongside predominant problems in the 20th century, such as marine pollution and overfishing (Vanderpool 1983). As a result, research in marine science has recently changed and is now largely about "human encounter with the sea" (Helmreich 2009: 133).

The human encounter with the sea has transformed prominently in the last decades, for example, due to increased levels of pollution and the effects of anthropogenic climate change. Marine scientists not only articulate scientific responses to environmental changes but also relate to environmental problems in their fieldwork, in dissemination activities, in policy counseling or in protests. Protecting the ocean and studying environmental changes are connected to a shift in viewing the ocean as a space of abundance and infinite recovery to understanding it as a space in need of protection connected to the vast changes it has undergone in the last century (Rozwadowski 2018). Marine science institutes that study the ocean and organizations intending to raise awareness for ocean protection formed in the last century and since then have been an important signifier of environmental care in the marine sector. This care continues until today. Working with environmental changes leaves scientists "deeply engaged with harmful matter on a daily basis," a situation which also allows for radical responses and "radical scientists" (Liboiron 2016: 92). The term "radical scientists" refers to research that scientists in the marine area accomplish and also to political involvements that result from it. The concern for the environment that accompanies prominent environmental changes is also evident in the story that this article starts with, or in a plethora of institute homepages that declare potential threats to the well-being of the ocean, or in funding schemes and political campaigns. The UN Decade for Ocean Science campaign, a framework of the United Nations, is an example for the latter. It is promoted as a campaign that aims to bring together stakeholders and projects to create "the science we need for the ocean we want"[2].

While the marine scientists' environmental care has historical roots, it is also very much a care in the present. Environmental care is tangible as a research concern that is oriented towards environmental changes; as funding programs and the creation of research areas; or as political involvement. But although there are traces of environmental care in the history and development of marine science, they have not necessarily been deciphered as such. In the following, I discuss STS-based conceptualizations of care that are important for my analyses.

Analytical Framework: Environmental Care

As the historical development of the field of marine science shows, care is central in a field researching and at times even acting upon potentially dramatic environmental changes. I use care as a way to stay attentive to the relationships between scientists and environmental changes. This attentiveness urges me to capture how the scientists care, in what times and places they care, and what their care entails. Inspired by Murphy's (2015) proposed four meanings of care, I attend to the marine scientists' care as emotional attachment that researchers have with their place of research and

[2] https://oceandecade.org

their research objects; their perceived responsibility and efforts to protect environments and species; the attention and concern for environmental changes they enact in research and protest; and their experiences of being troubled and worried about environmental changes.

In the two main empirical parts, I attend to four aspects of care that are particularly important for this paper.

First, I introduce the marine scientists' care with a focus on what would otherwise stay implicit: emotional attachments, as well as the socio-political orderings that the scientists create when they care. Studies of care emphasize revealing what might be lost otherwise, what transgresses social orders in a way that it might be missed or unseen. Care has been described as practice and as "persistent tinkering" (Mol et al. 2010: 14). Mol and colleagues (2010: 7) argue that care practices have to be "carefully attended to" in order not to disappear or stay at the margins. They further claim that we have to be specific about care in order to maintain its "effectiveness, its tenacity and its strength." Along these lines and building on Latour's (2004) 'matters of concern,' Puig de la Bellacasa (2011: 96) developed the well-known term 'matters of care,' an idea that foregrounds care as a critical device to ask questions such as: who cares, what for and how to care. She thereby draws on a "speculative commitment to neglected things" (2011: 85). Staying attentive to what might otherwise be unseen is a core concern in my work on marine science, such as when paying attention to care as situated in today's competitive research realities or to care in relation to emotions.

Second, another conceptualization that has become part of care-related debates and is relevant for environmental care is the classification of care into *caring for* and *caring about* someone (Schrader 2015). *Caring for*, a goal-oriented form, for example, present in the health care sector (Mol 2008), means to work towards improvement of a specific situation. *Caring about* evokes an affective relationship, but it also means one that does "not have to issue from a specific 'need', nor must it translate into a specific action" (Schrader 2015: 668). This specification is relevant for the different times and spaces this study considers. While some instances point towards the aim to create action, others do not, such as protest organization or fieldwork observation, respectively. Yet while *caring for* is set to create a hands-on modus, *caring about* can at the same time "[nurture] caring ideas, intentions or feelings" (Blazek et al. 2015). It is thus important for me to stay attentive not necessarily to potentialities of action but rather to the effects of care and the relationships that are formed.

Third, I analyze different times and places of environmental care. Care studies often focus on local contexts, such as when analyzing care in the health sector, which is unavoidably anchored locally (see e.g. Moser 2011; Swallow and Hillman 2019; Jerak-Zuiderent 2015; Coopmans and McNamara 2020). At the same time, care has also been related to the distant other, for example, in the case of global transformations. Pulcini (2017) discusses care as a form of attending to the unknown other, an "other" as variable as marginalized people living in suburbs or catastrophic environmental events (e.g. earthquakes, tsunamis). She discusses the probability of compassion and emotional involvement for far-away events and suggests that while the emotional involvement might take place even for geographically-distant events, the commitment might remain vague. Activating a critical commitment in a "global and interdependent world" (2017: 70) and turning it into practice creates a challenge when

caring for distant others. This complexity is tangible in the marine scientists' relationship with environmental changes, for example, when fieldwork is accomplished in far away places. Care has also been researched along different timescales. Puig de la Bellacasa (2015: 692), for example, considers "care time" as the possibility to reflect on and rethink experiences with potentially threatening futures. She argues that "care time" appears "dense, thickened with a multiplicity of entangled and involved timelines, rather than compressed and subordinated to the linear achievement of future output" (2015: 709). The marine scientists' care likewise involves narratives of the past and present while remaining relevant when imagining (potential) futures.

Finally, similar to the scholarly characterization of emotions as not naïve and embedded in power structures (e.g. Hochschild 2003; Ahmed 2010; Illouz 2007), care too has a "dark side" (Martin et al. 2015: 627). Martin and colleagues suggest thinking of care as "critical care" (2015), a reflexive moment in which we as researchers question how we engage with our research in our studies and what we encourage with our engagement and questions. Critical care would, accordingly, allow to frame our own care as a "selective mode of attention" (Martin et al. 2015: 635) in which some debates are cared for while others stay at the margins (see also Lindén and Lydahl 2021 for another summary of care as an analytic). Jerak-Zuiderent (2020: 197) explores the position of the knower in scholarly accounts and attends to neglected things that demand "caring obligations." Yet she states that this attentiveness is necessarily asymmetrical, an asymmetry that echoes the importance of critical care and of understanding care's materialities and ethico-political obligations.

Following the depiction of how care starts, I will analyze the scientists' individual and collective care in different times and spaces and demonstrate what their care entails. Thus, I show environmental care in different times and places as the scientists relate with, think along and potentially also act on environmental changes.

Material and Methods

The core of my empirical material consists of interview data and ethnographic observations with scientists from a renowned German marine research institute. I conducted 25 qualitative interviews that lasted between 40 and 90 minutes. The interviewees range in rank from PhD students, postdocs, and group leaders to tenured senior scientists and full professors. The interviewees are part of or lead different research groups. While the interviewees represent a mix of senior and junior scientists, differences in their relationship with environmental changes were not a main concern in this paper. All of them are employed by the same research institute: a leading research institute in the field of marine science. I also draw on fieldwork in the research institute, including observations of work in the laboratory, participation in team meetings and observations of TV interviews with scientists. While this paper draws mainly on interview material, the observations represent an important contextualization for this study which makes tangible the importance of individual and collective dimensions of scientific work (see e.g. Schönbauer 2017).

In order to gain insights about the scientists' environmental care, I composed an interview guideline with three parts. The first part focused on the scientists' socializa-

tion into their discipline and how they experienced their first academic expedition to a far-away place. The second part focused on their research work and science communication efforts, protest activities and engagement in multi-stakeholder settings. The third and final part encouraged interviewees to reflect on the social, political and epistemic dimensions of their research and other involvements (if applicable), and allowed participants to reflect on future imaginations for the role of environmental scientists. The interviews showed how the scientists narrate their past and present experiences with environmental changes and how they understand and act on their relationship with these changes. To paraphrase Murphy (2015), the narratives allowed me to convey how the scientists characterize their emotional attachment, their efforts to protect and take on responsibility for changes, their attention and concerns, as well as their troubles and worries with regard to environmental changes. I take their narratives as essential elements of social life (Czarniawska 2004), a form of knowing which steers the scientists' stories and their interpretations of these stories. For example, the interviewees reference potential environmental risks; they also explain what it means to care as a marine researcher and in which format; they explain how they define and understand anthropogenic change; and they craft ways to care for environmental harm while also referring to the difficulties of action. These and other references provide insights into narratives that construct a storyline (Czarniawska 2004) connecting past and present experiences into a life story. They also provide stories of a particular community that is predominantly concerned with studying environmental changes.

To analyze the interviews with marine scientists, I used a grounded theory approach (Charmaz 2006; Strauss and Corbin 1998). My analysis began with a first phase of multiple rounds of open coding using the ATLAS.ti software, which allowed for initial codes to emerge. In the second analytical phase, I refined and ordered the codes and conducted extensive memo writing until the analysis reached a point of saturation and no new codes emerged. Based on this analytical scheme, I identified salient themes in the stories of the marine scientists: career pathways, research directions, environmental harm, political action, emotional distress. These salient themes instructed my resulting analysis. I have divided the empirical part into two main parts that describe caring as individuals and caring as collectives, respectively. Below, I first sketch individual care of scientists in the workplace, and then dwell specifically on collective care as part of a protest group and other institutional interest groups. Many scientists that I interviewed sympathize with protest activities while only some routinely participate in them. Thus, the second part includes additional interview partners with scientists from the institute that participate in and organize protest activities. Moreover, I have anonymized all interviewees' names using pseudonyms and removed information related to the research institute which could disclose their identities.

Findings

Caring as Individuals

The marine scientists' environmental care is often embedded in a long-standing environmental interest, an interest inspired by specific events such as fieldwork experiences. Even despite technical changes, expeditions represent a cornerstone of marine science research (see e.g. Helmreich 2009; Lehman 2018). The institute's policy encouraged the marine scientists to participate in an expedition at least once. Expeditions at this research institute were typically undertaken with midsize to large ships, including scientists and ship crews, with longer expeditions lasting for up to eight weeks. During the expeditions, the scientists collected samples in areas that are otherwise inaccessible to humans. These expeditions are often perceived as opportunities to establish a close relationship with one's research and datasets. Grit, a senior postdoc studying jellyfish and freshwater snails, talked about expeditions as a possibility to "see how things are," namely to see the landscapes the samples originate from. Expeditions were also understood as an important opportunity to create a relationship with the place under study. Victoria, a young group leader studying Arctic marine life, described expeditions as an experience of "something that you never saw before and you'll never see again," an experience in which one understands the "magic" of the place under study. For her, and many others, expeditions were an otherworldly experience. These and similar narrations appeared across all professional levels.

But there is more to it than that. Expeditions inform the emotional relationships of scientists and their research objects. This is most relevant when the environments they study start to change. Helena, a senior researcher with long-standing expertise studying the community of organisms in the deep sea, recalled sadness based on the last expedition in which the crew observed "more ice than we had in the last 20 years." She stated that "in 20 years it may no longer exist," a circumstance which "makes you incredibly sad." This emotional relationship is a motivational force for her care. In relation to her emotional experience, Helena was a frequent participant in Climate Marches and events of Scientists for Future, a collective of scientists that supports the Fridays for Future Movement. She also had a profound expertise regarding coast-based wind parks and became an advocate for environmental harm in multistakeholder dialogues. Accordingly, I conceive of care in Helena's case not only as "a disposition, but also (as) a practical and moral action inspired by emotions and feelings" (Pulcini 2017: 2). Hence, environmental care often starts with the marine scientists' emotional relationships that create motivation and commitment for environmental concerns. This emotional relationship has been shown to spur action and manage the eco-anxiety of scientists (Brunet 2022) or install coping mechanisms (Head and Harada 2017). The emotional relationship with changing landscapes also creates entanglements with more than human fragilities, such as Arctic ice landscape or marine life. Thereby, the emerging environmental care expresses more than an emotional relationship. It creates an emotional state in which the scientists can *care about* and *care for* the landscapes they study (see Schrader 2015).

There are other examples of how scientists connect with environmental changes. Michael, a group leader with a long-standing experience and reputation in marine

science, was on numerous expeditions throughout his career. When he recalled his fieldwork experiences, he remembered the changing landscape and thinning ice, and argued that "we see the change," something "no one can argue (…) away."

It does affect you a little bit – doesn't it? 1996 was my first trip to the Arctic and I remember it very well. It was a Swedish icebreaker, it was a big ship, but we only made slow progress because the ice conditions were completely different from what they are today. And to see that the ice is not only receding, but also thinning, and that the ecosystem is changing accordingly (…). I wouldn't have thought that I could experience that with my eyes open. (Michael, group leader)

Michael reported that he always had been concerned with environmental changes, for example, with regard to deep sea mining. But observing changes over time first-hand in a specific place affected him. He referred to awareness and uneasiness with environmental changes. This worry and uneasiness (see Murphy 2015) is a part of care that also resulted in his research in the deep sea based on long-scale time series. Based on his 25 years of tracking changes, he characterized change as also having political effects. Studies that trace changes over a long time can, for example, be used for reports and policy briefs. While many time series cover a project-related period of 3–5 years, Michael's time series already lasted for more than 25 years. His commitment exemplifies what Puig de la Bellacasa (2012/2011) describes as ethico-political, a commitment that stands for a strong urge to understand environmental changes at their core. While Michael's work is not interventionist, his efforts to establish his time series shows continuous engagement to study change and establish knowledge practices that offer different accounts of the deep sea. Starting a time series in the deep sea could even be regarded as vanguard to understand what happens in what Pulcini (2017) calls an unknown other. Michael was successful in contributing to a different understanding of the deep sea: from a slowly changing to a more rapidly changing environment. In this caring for environmental change, he connects different spaces and times and creates an alternative depiction of the deep sea (see e.g. Puig de la Bellacasa 2015; Schrader 2015).

Environmental care is similarly evident in other cases: Two senior scientists whom I met during my time at the research institute narrated how they stood on deck of research vessels and saw plastic objects floating around in the sea or washed up on beaches. Tim, a senior scientist, recalled that he stood next to the ship railing and suddenly saw plastic objects floating around, which he started to count. Ulrike, a senior scientist, similarly remembered that she recognized an increasing amount of plastic objects during her monitoring work on a research vessel in the Arctic. Both scientists have researched plastic objects in and around the sea ever since. The initial attention for objects in the sea turned into a research direction on plastic in the environment. Ulrike became passionate about plastic and plastic pollution, a passion which resulted in numerous publications and research projects. She said that it is important to stay "cheerful" despite research that focuses on environmental changes, but mentions that she failed to create emotional distance between herself and the phenomena. This is based on her realization that litter also has effects on climate change, such as when plastic waste contributes to greenhouse gas emissions. Tim similarly stated that he is "touched" by the potential effects of litter, specifically plastic litter, on marine life, an "empathy" that he does not "want to (…) be taken away" from him. While he needed

distance in his day-to-day work, he lacked this distance when he talked about the development of his interest in plastic and how he began to "see" plastic everywhere.

Tim and Ulrike started their research on plastic in a time when environmental plastic has not been a prominent societal concern or topic in the sciences. Tim recalled that it was difficult to defend one's interest to study marine litter. He received negative responses from other scientists, also based on the fact that funding sources often remain limited. Other scientists at the research institute criticized the focus on marine litter. Similar to other plastic researchers that started their work on plastic (see e.g. Thompson et al. 2004), Tim and Ulrike advocated for a new research concern which only over time got public attention. Research on plastic subsequently received strong media coverage, TV and radio interviews, and an attention which lasts until today. Tim remembered that, based on the attention they received, he was granted more research freedom from his supervisor: "we were quite successful (…) and since then he [note: the supervisor] actually lets me do it." In line with the media coverage, both scientists argued that responsibility is key for them as researchers, tangible, for example, in their public outreach activities and their research projects. Their ethico-political commitment to study ocean plastic also resulted in specific academic questions. Ulrike collected ocean plastic with the help of citizen scientists in the North Atlantic. Back in Germany, she analyzed plastic objects from the Arctic ocean. Together with a master's student, she identified the manufacturers of the collected plastic objects, which was narrated as extremely difficult, and traced their potential origins. She later on created an archive of plastic objects sorted by year and location. In so doing, she cared for an environmental concern and opened up a relational conceptualization of plastic objects in the sea, objects that lose their ownership in the moment of their disposal.

Ulrike and Tim both *stay with the trouble* (Haraway 2016). They work on a research concern which has not always been prominent but rather left at the margins. There are transformative moments in their research: seeing the relation of different environmental changes as well as creating relationships between producers, users and objects from the sea. These instances represent their ethico-political commitment that has a strong impact on their research orientation and research choices. Environmental care combines emotional attachment and responsibility but also attention and concern for research objects (Murphy 2015; Lee 2016). This constellation can also be in tension. Angela, a research group leader who worked on effects and models relevant to climate change, remembered that she has always tried to find a way to continue to study human impacts upon the sea in her career. She stated that "you are really dependent on, of course, the internal institute policy" and that she always checked "if a niche opens up" in the institute. While the institute used to predominantly focus on matters in the Arctic, her research in the Antarctic ocean did not receive institutional attention for a while. Angela initially had trouble receiving funding but stayed with her research interest, an interest she deeply cared about. Later on, the institute shifted its research agenda and Angela received support for her research. Environmental care at work can therefore also be in tension between research interests and career stabilization.

In line with this tension, environmental care in marine science is also related to career trajectories. Grit, a senior postdoc, said that she cares for her research objects,

Arctic snails and jellyfish, and that she demands proper policies for effects related to climate change and biodiversity loss. She also stated her frustration with political (in)action and said that "politicians aren't listening to us and sometimes we are wondering, why are we doing this." Based on her environmental worries, Grit started to retweet statements from Greta Thunberg on the platform X. She appreciated Greta's prominent statement "listen to the scientists." When she discovered a new freshwater snail species in her work, she named it *Greta* in appreciation of Greta Thunberg's work. This resulted in media coverage about her work which she used to "increase (the) impact factor." Grit argued that naming a snail species after Greta Thunberg was "because we are concerned" about climate change, but it was also "for personal interest" in career success. Grit's care allows for a reflexive moment. The attention to an otherwise unseen species like snails or jellyfish represents a careful relationship for often understudied or unseen species, a care that turns to potentially neglected spaces (see Puig de la Bellacasa 2011). A colleague of Grit told me about the need to monitor species such as Arctic jellyfish in order to trace environmental changes in the sea. Her own research is a "matter of care" (Puig de la Bellacasa 2017) in which she honors her political commitment and her scientific interests. But there is also a darker side to her care (see Martin et al. 2015). Choosing to relate environmental worries and career success shows care as environmental worry and uneasiness with the lack of political attention but also as career-related effort. In this case, care is not exclusively a loving act that follows environmental ideals of protection; it also creates attention for the scientists' work and turns to self-care. Grit's decision to both attend to environmental worries and also her career concerns shows the importance of understanding care along its complexity. Related to Coopmans and McNamara (2020), I argue that environmental care needs to be situated in today's research realities and competitive career scripts as it can relate care for research objects, self-care and care in academia.

Grit's story is not the only one which provides insight into care situated in a merit-based academic system. Eva, an expert on sea ice and appointed expert of the institute, similarly cared for environmental changes in her work practices. Eva was an engaged researcher with an Instagram channel where she posted pictures and videos of expeditions. She also wrote a popular science book on her work on melting sea ice. Like Grit, Eva, too, was worried about her impact factor and how well she would perform according to evaluation devices. She tied the lack of a high impact factor to her public engagement, specifically her dissemination and media outreach activities featuring environmental concerns. It is not surprising that Eva's reflection about metrics became bound up with her concerns over whether she is using social media 'effectively': prior scholars have shown that social media has become a common event in the sciences (see e.g. Carrigan and Jordan 2022; Fochler and de Rijcke 2017). These efforts to increase visibility are inevitable when stable positions are not earned easily and metrics for competition and success have become integral to scientific work. Tim, the passionate plastic researcher, provided a similar story. He said that while he has achieved an internal and external reputation that is helpful for his career, he at the same time took on responsibility to communicate about environmental changes that are societally relevant. For Tim, there were two sides to research on environmental changes: research that is publicly funded and creates responsibility for scientists to

contribute to societal progress; and research as a job: "you also have to be very clear that it's not only about science, it's also about jobs."

All these stories represent related components of a science system which connects environmental care, tangible, for example, in the perceived responsibility and long-standing research concerns, with career success and visibility. Environmental care is complex and certainly not linear. It is dependent on career structures and research infrastructures and it is part of emotional resources. Thinking along Murphy's four classification of care (2015), environmental care expresses the scientists' emotional attachment, their worries, their efforts to be protective and create research responsibility for a research object and also to create attention for an environmental concern. In addition, care is not innocent but also expresses the scientists' need to succeed in a merit-based competition.

Caring as a Collective

Next to caring as individuals, the marine scientists' environmental care was part of activities they pursued in groups and as a community. One example is an institute-based Scientists for Future group. The Scientists for Future group (SFFi) was in line with the Fridays for Future movement and part of the wider Scientists for Future alliance. Founded in 2020, it consisted of a small number of core members and a wider network that reads about its work: almost 100 scientists and staff from the institute subscribe to its mailing list. The SFFi group comprised researchers at all career levels, with junior researchers representing the main group. It was also open to engineers, administration and science managers. SFFi members hosted a Youtube channel, participated in climate protests and gave talks, all formats providing an overview on climate-related topics in different forms, for example, as part of a train ride, or for the Youtube channel that was created during the start of the Covid-19 pandemic. The train talks even resulted in a cooperation with a local transport company hosting scientists who gave short talks as part of free tram rides. Some scientists, for example, Michael who accomplished long-lasting time series in the deep sea, were in favor of SFFi but did not necessarily participate in its activities. Others like Helena, Eva or Ulrike, participated in SFFi activities. All participating members I interviewed reported experiencing a similar emotional state when they thought of and talked about environmental changes:

> You have to be careful not to sink into a depression. And you have to pull yourself out of it somehow. Fatalism is also involved. (Ludwig, senior scientist)

The marine scientists' sadness reached a depressive moment and created fatalist mentalities and cynicism in response to the stark environmental changes. Others indicated that helplessness or even fear were part of their emotional response to environmental changes. While the scientists at the institute mostly shared similar environmental concerns, the SFFi members and colleagues in favor of SFFi more clearly reported anxieties arising from the urgency of environmental changes. Their emotional states guided their commitment to *care for* environmental change (Schrader 2015). The collective caring also opened up a coping possibility similar to other extracurricular

activities (see e.g. Schönbauer 2020) as the members were among like-minded peers. Ulrike, for example, framed her SFFi involvement as "a little bit liberating" since she could express her political concerns as a scientist. The SFFi collective thus created a space in which the scientists can release their emotions and can *care for* activities that create awareness. It also symbolizes a care which is dedicated to "maintain, continue and repair 'our world' so that we can live in it as well as possible" (Tronto 1993: 103).

Importantly, however, the SFFi group became part of the institute and its agenda. A main grounds for integration into the institute was SFFi's efforts to communicate science in addition to existing science communication formats. For example, SFFi has been granted the institute's prize for science communication in 2020, a prize which provided the members with a small budget for projects. SFFi activities were also featured on the institute website, including pictures from scientists holding banners during global climate strikes when being in the Arctic during fieldwork. And activities were featured on the SFFi's X account and Youtube channel. This institutionalization is also tangible in the plan to grant PhD students credits for their studies if they present their work in the SFFi Youtube channel. Additionally, a member explained that he was allowed to integrate SFFi activities as part of his work routine. This integration was possible since the group started to allocate small funds for organizational tasks. He spent a calculated period of his work time on SFFi projects. The official allowance to work on SFFi agendas provided the scientist with the possibility to reconcile work and environmental concerns. In so doing, scientists were able to reconcile work activities and interests that exceed traditional interpretations of work. This does not necessarily mean that all SFFi activities were considered part of scientific work. Nevertheless, SFFi meetings could, for example, take place during lunch time, and thereby become part of work schedules, an indication of the daily characteristics of collective caring.

The institutionalization of SFFi's environmental care also mirrored a potential larger transformation in the marine science community. As described in the introduction to this paper, some marine scientists started to talk about protest at conferences. Similarly, the director of the marine institute under study was verbal about the need to not only *care about* but actively *care for* environmental changes (a distinction made by Schrader 2015). The director frequently appeared in TV formats, was interviewed for numerous podcast and radio interviews and more. In all of these interviews, the director spoke about the importance of researching and also acting on environmental changes, thus signifying that an integration of traditional scientific work arenas, such as the laboratory, with other societal arenas, such as protest, were needed. I argue that the institutionalization of environmental care indicates a community that is currently changing. Careful engagements have always existed in the marine community, exemplified historically, for example, by the awareness and worries of marine scientists that have been raised at the end of last century based on pollution and overfishing (e.g. Rozwadowski 2018). However, the current environmental care more explicitly connects local and global domains — care for the unknown other (Pulcini 2017) — and simultaneously a care for local belongings, such as the affiliation with local protest groups. While this might be specific to the marine science community, a community which is intricately connected with its areas of study, this development most likely also happens in other scientific communities, exemplified by the diversity of

scientists speaking out on environmental changes (see e.g. Science Rebellion). The collective caring in protest and its institutionalization indicates a care that is deeply relational and does not discriminate between activities considered outside science and largely emotion-driven, and in contrast scientific ones (see Druglitrø 2018 for a comparison).

The institutionalization of environmental care was also mirrored in another case. Tim and Ulrike's research on plastic had transformative effects in the institute. Their research interests had to be acknowledged by the director and integrated into the 5-year research agenda framing in advance of its execution. They strategized with the institute's director, who became fond of their research and allowed the scientists to make room for their concerns. By getting environmental plastic on the institute's research agenda, the scientists created broad external and internal attention for their research. The internal reception was important for their institutional positioning. Tim stated that colleagues started to appreciate their work and engagement: "it was a stroke of luck, because for the perception in the institute it makes a difference" (Tim, senior scientist). He noticed a change in "how colleagues see you" based on the success with research on plastic. Similarly, Ulrike experienced an increase in requests for bachelor and master theses based on the "hype" (Ulrike, senior scientist) surrounding her project. Students requested to work with her because of her research focus, with some even making decisions about their studies based on environmental concerns. The institutionalization of a research focus on plastic thus highlights the enabling conditions of care, a care which can be considered "concrete work of maintenance with ethical and affective implications" (Puig de la Bellacasa 2017: 5). The maintenance and enabling conditions of environmental care is thus predetermined by institutional structures and predispositions (Hauskeller 2020).

Yet the scientists' care and specifically their involvement in protest activities was not left without critique. Hannes, a senior scientist working on plastic in the environment, recalled a story from a colleague whose funding was cut due to his engagement for the German branch of Scientists for Future. Hannes recalled that the colleague stated how he lost support in the scientific community because of his political involvement. He added that "if you are too political, it can also be detrimental to your career" and that this circumstance is based on a science funding regime that creates dependencies between applicants and reviewers. Similarly, in a *New York Times* opinion piece, Dr. Rose Abramoff, an earth scientist from Oak Ridge National Laboratories, described being fired because of speaking up about climate change[3]. The threat to a career posed by environmental activism does not remain anecdotal but has potential consequences. While the threat to scientific careers and positions is not necessarily new (MacKendrick 2017), the involvement of scientists in environmental activism displays a strong linkage of worries and discomfort with knowledge production in potentially new ways. It also shows that the reception of the scientists' environmental care is not always positive nor neutral. Environmental care is embedded in power structures, institutional dynamics and hierarchies. This becomes evident when environmental care is positively received, such as when SFFi was granted the

[3] Abramoff, Rose. 2023. I'm a Scientist Who Spoke Up About Climate Change. My Employer Fired Me. Opinion. New York Times. Published online January 10 2023.

institute's prize for science communication. This also becomes evident when environmental care leads to tensions, such as when it has potential negative effects for a career in science. Environmental care in this case showcases a care that needs to be understood in its complexity and along its situated interpretation.

Discussion and Conclusion

I started this paper by asking: How do scientists care for environmental changes? And what are the social and epistemic impacts of their care? I have presented examples of the scientists' environmental care mediated in different times and places, from fieldwork and expeditions to research choices and protest activities. Following Murphy's definition of the interpretation of care (2015), the marine scientists in this study are emotionally attached to their research; they look after and hold themselves accountable to study environmental changes; they attend to and are concerned with the changes; and they are troubled by them individually and collectively. The empirical examples above offer insights into the diversity of care and its social and epistemic effects.

First, I have shown how marine scientists care individually. Their care, as initiated by emotional attachment, turns from admiration for the enchantedness of their remote fieldsites into sadness and profound worries about the environmental changes they observe in the places they study. They narrate their emotional relationship as one of the reasons they study changes and choose projects, organize outreach activities and even build novel institutional frameworks for research. This emotional work has been previously documented (see e.g. Brunet 2022; Mitroff 1974; Parker and Hackett 2014) but arrives with a different twist along the prominent and potentially irreversible changes that occur in the marine sector. Marine scientists are not simply concerned with environmental changes; rather, they (re-)orient their work along such changes, and even build careers based on environmental changes. This is also tangible in the uneasiness that scientists often experience and the responsibility they take on when researching environmental changes. The scientists care for exploring otherwise unseen topics, such as plastic pollution or the deep sea, research topics with far-reaching political effects. Their care is, however, not innocent (see e.g. Martin et al. 2015). Some marine scientists not only re-orient their research choices but – with regard to unstable work positions – are concerned with research success and creating attention for their work. As Latour and Woolgar's credibility cycle has taught us (1986), researchers earn credit for their scientific data production that they can invest for new research. Instead of attending to the specificities of this model, which others have done so carefully (see e.g. Hessels et al. 2019), I argue that the marine scientists' care also needs to be contextualized into the inner workings of science, such as needs for self-presentation, creating a nichè and visibility and gaining institutional career security. Their care for environmental problems displays an emotional affectedness, cautious attention and responsibility for research interests as well as self-care for career stability.

Second, I have attended to the marine scientists' collective caring. Similar to the first example, the marine scientists' emotional involvement provides grounding for

their participation in protest activities. The institute-based Scientists for Future group (SFFi) allows the scientists to share environmental concerns and collectively cope with their anxieties. Importantly, SFFi activities are being institutionalized. Other examples exist too, such as research initiatives for topics of initially only marginal interest. This maintenance work highlights not only the preparation of care but also what needs to be done for its stabilization (Puig de la Bellacasa 2017). Through this institutionalization and thereby stabilization of SFFi and specific research agendas, a collective way of caring and thereby commitment for care is established. The scientists' involvement in SFFi is, however, not without doubt and challenge. Some scientists trade stories of harmful consequences for a career in science when participating in protest activities, or stories of criticism on the choice of institutionalized research agendas. Hence, there is critique from within the science community on what is considered suitable engagement and what is not. In line with this negotiation, Liboiron (2016: 6) describes "radical" scientists as scientists that have become part of politics and that are "at the forefront of articulating novel forms of harm" (from plastics). The marine scientists that I portray in this study are not necessarily radical but rather engaged through their environmental care.

Where to go from here and what does Environmental Care allow us to understand? In this paper, I have focused on what the marine scientists' environmental care consists of and results in. I have attended to often unseen careful relationships between scientists, their research and environmental concerns. I have also shown that the scientists *care for* and *about* environmental changes and that they do so in different times and places. I have highlighted that care relates different times and spaces and that care is indeed not naïve. Let me elaborate what this means for a conceptualization of environmental care:

Environmental care offers insights into the complexities of caring in turbulent times with regards to potential catastrophic events lingering in the future and cases of destruction or variable harm that reside in the past and present. The stories I have curated for this paper show that care needs to be situated in different stories and experiences of scientists. Care is also related with what Pulcini (2017) calls an unknown other, for example, a potential environmental harm. In contrast to Pulcini, I find that the marine scientists that I portray are highly committed to studying and acting compassionately on geographically distant events, be it changes in Arctic and Antarctic areas or global events such as effects related to climate change. Thus, environmental care goes beyond local interactions (e.g. de Bont 2009) or innovation-dependent changes in the marine science sector (Helmreich 2009). The marine scientists stay with the trouble (Haraway 2016) in different times (Puig de la Bellacasa 2015) and care for more-than-human ecologies (e.g. Eidenskog 2021; Druglitrø 2018; Schrader 2015) in research and beyond, in protest. In fact, their care also creates institutionalized spaces, when they transform research agendas of the institute or when a protest group becomes an addition to a research institute. Furthermore, junior and experienced senior scientists care in similar ways. While early career scientists are certainly more dependent upon success in their careers, their emotional relationship with the landscapes they experience through fieldwork, and also their perceived responsibility

to respond to environmental change in general, are similar. Based on this, I want to allow thinking about a form of care which is not necessarily always specific, located, or directed towards one place and one singular care time. Instead, environmental care can open up a scientific culture, its norms and values, that might be changing along the current drastic environmental changes.

Meanwhile, the scientists' care is not innocent. A focus on environmental care helps to understand the inner workings of care, such as selective attention to specific topics, an attention that needs to be troubled and unsettled in order to create constructive ways of moving and acting in times of ecological harm (Martin et al. 2015). I find it important to analyze how care for environmental problems works and how this care, too, follows competitive and representational parameters or mirrors normativities in its practice. Normative underpinnings came to the forefront, for example, during the worldwide "Science Marches" taking place in 2017, an initiative to support scientific research and policymaking that is science-informed. "Believe the scientists" or "listen to the scientists" already became catchphrases back then, with normative underpinnings of what scientists ought to fulfill (Penders 2017). In order to demystify the normative interpretation of what environmental scientists ought to serve, and to challenge underlying technocratic visions, I emphasize what many STS scholars have already proposed: to situate scientists and knowledge production and to reflect on the forms and formats of their care. We need to analyze the different times and spaces in which care is enacted as social and professional commitment for environmental changes. But we also need to attentively experiment with futures in science that allow us as STS researchers to collectively "maintain, continue and repair 'our world' so that we can live in it as well as possible" (Tronto 1993: 103). And we need to ask how it might be possible to create spaces in academia that mirror what "all scholars have been promised upon entering the university: the time and space to think, to work together, and to rethink what might be possible" (Lindén and Lydal 2021). Environmental care of marine scientists as addressed in this paper might help to start this conversation and sensitize STS researchers to the different dimensions of care in practice and its different formats. I argue that it is imperative to create further analyses that pay close attention to different times and places in which scientists care, and understand the complexities and practices of this care.

Acknowledgements This research was made possible first of all through the marine scientists who generously agreed to talk to me and allowed me to accompany their work. I would like to thank the editors of Minerva and the reviewers for their generous and constructive comments. I also thank my colleagues for their thoughts and invaluable comments on the manuscript among them Niki Vermeulen, Fiona Kinniburgh and Marc Strotmann. I would also like to thank Mallory James who helped me edit the piece. And I thank the Austrian Science Fund that granted me with an Erwin Schrödinger Fellowship which provided this unique opportunity for research.

Funding The data acquisition and analysis was funded by the Austrian Science Fund with an Erwin Schrödinger-postdoctoral grant "Choreographies of Environmental Engagement".
Open Access funding enabled and organized by Projekt DEAL.

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