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RESEARCH

Working seagrasses: emerging coastal ethics in the Mexican Caribbean

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Abstract
The article explores the emergence of coastal ethics in the Anthropocene, focusing on the Riviera Maya in Mexico. In response to escalating challenges such as coastal degradation and *Sargassum* impact, the study shifts the focus from blame to the practices of marine biologists engaged in repairing ecosystems, particularly seagrasses. The concept of "working seagrasses" is introduced, emphasizing the functional, performative, and manipulative aspects of human-seagrass interactions. Through ethnographic fieldwork, the author observes a departure from blame-based approaches prevalent in the field towards marine biologists, who actively work to repair seagrass beds. Three empirical examples illustrate different dimensions of working seagrasses, shedding light on scientists' curated interactions, ecological restoration practices, and the role of species recognition in coastal ethics. The study explores multi-species entanglements along Mexican coasts, emphasizing collaborative efforts between humans and non-humans. By addressing how marine biologists respond to coastal degradation and involving non-human actors, the study contributes to understanding evolving coastal ethics in the Anthropocene.

Keywords Coastal ethics · Mexico · Climate change · Coastal futures · Nature-based solutions

An introduction to the question of emerging coastal ethics in Mexico

Coasts are contact zones (Pratt 1991). Much like cities (Acosta et al. 2023), coasts are spaces that promote living in close contact with others—be they human or non-human. To think with Tsing (2021) we can perceive of coasts as multi-species landscapes (Tsing 2012), formed by humans and other species, as well as nonliving actors, such as sand and stones, too. In our "Anthropocene world" (Tsing 2021; see also Davis et al. 2019; Tsing et al. 2019; Ejsing 2022; Welz 2022 for critical examinations and methodological implications of the term), coasts face increasing transitions, challenges, and changes: rising water temperatures and ocean levels, increased input of nutrients, eutrophication, and acidification, to name a few. These dynamics provoke questions of how coastal futures could or should look like, foster novel approaches "necessary to imagine desirable futures," as Acosta et al. argue in the introduction to this special issue, and bring the important question for whom coasts will be livable spaces in the future to the fore. Coasts have become—to think with Latour (1995)—a matter of concern, provoking questions of coastal ethics.

Inspired by the research agenda on urban ethics developed and suggested by Acosta et al. (2023), the article does not seek to offer philosophical clarity or normative answers as to what coastal ethics are but is interested in the dynamics of how different coastal actors negotiate between "contrasting ideas and actions […] on what may be better" (p. 2) for the coast they inhabit, in this case, the *Riviera Maya* in Mexico. The article localizes the emergence of coastal ethics against the backdrop of developing practices of working with seagrass in the Mexican Caribbean. Seagrasses play a pivotal role in coastal ecosystems, prevent coastal erosion, slow down storms and hurricanes, feed various species, and offer a habitat to many different creatures (James et al. 2019), helping to mitigate the effects of climate change and preventing coastal damage, as they accumulate sediment on the seafloor (Fusi and Daffonchio 2019; James et al. 2019; Viana et al. 2019; de Almeida et al. 2022; Cullen-Unsworth et al. 2014). Seagrass beds are suffering from climate change and anthropogenic impact on the environment: plastic in the sea, eutrophication, tourists trampling on the seabed, rising temperatures, nitrogen

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pollution, and diseases (Turschwell et al. 2021); the list of challenges for the "green power plants" is long. In Mexico and elsewhere in the Caribbean, the dangers seagrasses face are exacerbated by *Sargassum*[1], a macroalgae, which have begun arriving in Mexico in 2015. These algae do not only put increasing pressure on seagrass beds, but also on the tourism industry; when one thinks of the *Riviera Maya*, white sandy beaches, coral reefs, tequila galore, and endless sunshine usually come to mind (Pi-Sunyer and Daltabuit 2010; Torres and Momsen 2005; Vassallo-Oby 2010; Azcárate 2020; Mowforth and Munt 1998; Manuel-Navarrete and Redclift 2012); in a nutshell, the Mexican Caribbean represents tourist paradise. The ability to create tourist paradise was first and foremost, dependent on intact ecosystems, for which seagrass meadows played a pivotal role, hinting at the entanglements among humans and non-humans in coastal areas. Given the loss of seagrasses, the question of how the future of the *Riviera Maya* could or should look like arises alongside the question of who works towards the coast and its future. The article sheds light on how coastal ethics emerge in the Anthropocene by focusing on changes in thinking and practices among marine biologists the author has been carrying out ethnographic fieldwork with since 2019 in the Mexican Caribbean. My interest in seagrasses stems from my research on *Sargassum*, and it is the arrival of the algae that made me think about emerging coastal ethics in the Mexican Caribbean. But why?

The question of responsibility for the algae in particular and the coast in general repeatedly occurred during fieldwork: Given the multiplicity of recommendations published as how to respond to *Sargassum*, it should hardly be surprising that there is a multiplicity of ways of conferring responsibility for the algae. It is, thus, no surprise that different actors have emphasized diverse culprits in conversation with me: environmentalists blame the travel industry for unsustainable forms of tourism; local residents blame politicians and the Mexican government for its apparent inaction; hoteliers claim that Brazil is to blame for the deforestation in the Amazon and the consequences it produces in the form of higher nutrient levels in the Atlantic Ocean, on which *Sargassum* allegedly feeds (see also McAdam-Otto 2022). Blaming, however, did not lead to action as I observed. An observation that is not surprising: In 1999, Giddens argued that responsibility itself is at crisis considering new human relationships with nature in times of increasing climate change and manifold uncertainties, as people responsible for the damage we observe, and experience can often not be clearly identified. Ribot (2013) contends that climate change has ignited "a new politics of cause and blame," and Rudiak-Gould (2015) demonstrates that blaming usually leads to bypassing of responsibility, which fosters ignorance and inaction. Yet, during fieldwork, I made another observation: The marine biologists I worked with did not participate in blaming others. Instead, I observed how they use their knowledge of local ecosystems to address the damages they witness among seagrass beds and the coast, which, in part, result from *Sargassum*'s impact. Consequently, I am interested in shifting the focus away from questions of blame, paying attention to the practices employed by marine biologists to create a coastal future they interpreted as worthwhile living for humans and non-humans instead. They do so, I argue, by "working seagrasses." Working seagrasses takes the functional aspect of this species seriously, but at the same time refers to working seagrasses' performative effect and to the manipulative aspect humans introduce to working seagrasses. The approach developed by the natural scientists reflects the recent trend towards using "other lifeforms to help ecosystems recuperate after decades if not centuries of human predation" (Acosta and Ley 2023, p. 3).

My perspective is inspired by the heuristic tool of "ecologies of repair," developed by Blanco-Wells (2021), to examine repair work in the Anthropocene beyond a linear, human-centered narrative (Ryan 2012; Myers 2017). Examining repair practices from a multi-species perspective enabled me to observe how humans and non-humans interact along Mexican coasts, to better understand which relations emerge among them, and to shed light on the "entanglements of human and more-than-human actors as they work together, with and against each other" (Gesing 2019, 211). Employing a perspective on multi-species entanglements is especially fruitful in the context of coastal degradation, as it is, at the same time "coproduced and coproductive" among humans and non-humans (Gesing 2019, 222). Understanding practices of repair work resonates with newer strands in conceptualizing responsibility, calling for relational understandings thereof, including human and non-human agencies (Trnka and Trundle 2014; Bennett 2010; Rosellón-Druker et al. 2023). This relational approach towards understanding responsibility resonates with the "ethical turn" (Dürr et al. 2019) in the social and cultural sciences and fosters an analysis of ethics as "a form of reflection and practice concerned with the question of how a society […] should be" (Lakoff and Collier 2004: 421.). Examining 'working seagrasses' in Mexico speaks to these concepts and bodies of literature, expanding them by offering a multi-species perspective. The approach allows to better understand how the thinking about

[1] While floating Sargassum is an important habitat for various fish, spawning ground, and shade provider for ocean creatures, the list of its negative attributes is long: the algae deprive the coastal waters of oxygen which leads to fish mortality; prevent seagrass from photosynthesizing; alter the water's pH level, temperature, and quality; release hydrogen sulfite during decomposition, causing respiratory problems among coastal residents; and jam boats' engines, making fishermen's work more difficult; and with their ability to cover beaches and change the water's color, these algae pose a challenge to the tourism industry, which has to deal with increasingly disaffected travelers (Lopez et al. 2008; Louime et al. 2017).

certain species changes, and which different practices are employed to create the coastal future of the *Riviera Maya.*

"Working seagrasses" highlights the work seagrasses perform under water, ranging from producing oxygen, offering shade and shelter to ocean inhabitants, to stabilizing the sea floor and to maintaining water quality. If seagrasses are not working—i.e., if they do not photosynthesize and, ultimately, perish—the ecosystem is under threat. But "working seagrasses," as argued here, also sheds light on the relational character of human-seagrass relations: It shows, on the one hand, how marine biologists work with seagrasses, i.e., how they spend time in the lab and in the water to study and repair seagrasses, and how they are trying to generate more attention for a species they genuinely love and interpret as worthy of protection. On the other hand, it highlights the agencies of seagrasses, and how they make themselves noticeable in the Anthropocene (Tsing et al. 2019). I offer three examples in the empirical part, each highlighting a different aspect: The first one carves out the *curated interaction* among scientists, turtles, seagrass, and algae. The second example sheds light on *restoration* as a specific ecological practice. The third example demonstrates that *recognition of species* plays a crucial role in coastal ethics. By examining these dimensions of working seagrasses, I address the following questions: How do marine biologists in Mexico deal with increasing coastal degradation? Which practices do they develop to create a coastal future, and how are non-human actors involved? And which coastal ethics emerge?

The algae enthusiast among seagrass lovers: fieldwork in Mexico

During a total of 13 months of fieldwork and participant observation in person and—COVID related—online, divided between 2019, 2020, 2022, and 2023, I conducted 26 face-to-face interviews[2] with different actors such as policy advisors, governmental representatives, biologists, villagers, fishermen, NGO coordinators, environmentalists and volunteers, hoteliers, hotel association representatives, entrepreneurs, and tourists as well as bloggers and local tour guides about the *Riviera Maya* and the multiple challenges the coastal region currently experiences. Congruent with "sensory ethnography" (Pink 2015), I went snorkeling and swimming to observe *Sargassum*'s and seagrass' interaction with species such as fish, birds, and corals, I walked along the beaches to smell and touch algae and seagrass, I followed *Sargassum* to dumping sites, I microscoped seagrass seedlings, and I worked as a beach cleaner. All these practices and activities helped to immerse myself in the multi-species world I study (Haraway 2010, 2016; Kirksey and Helmreich 2010; Kohn 2013; Kirksey 2014). It was especially through joint fieldwork with marine biologists—and alongside them in their lab—that I learned about non-human agencies (Latour 1995, 2018; Whatmore 2002; Bennett 2010; Kirksey and Helmreich 2010; Gesing 2016, 2019; Gesing et al. 2019) and how they generate the coastal multi-species landscape. I was especially able to learn about *Sargassum*-seagrass interactions while I spent several weeks in the lab and on the water with marine biologists in August and September 2022.

As a researcher, I got involved in helping them to collect *Sargassum* samples from the water (see Fig. 1), I helped them grow seagrass seedlings, we went snorkeling together to assess reef health, I learned how to run experiments, and I was trained to determine nitrogen and nitrate levels. *Sargassum* was the "hot topic" in the lab, and I learned that my colleagues had not always been doing research on the algae but started to devote their research to *Sargassum* since the algae had begun landing in the *Riviera Maya.* Loreena[3], who manages the lab, stated laughingly: "We did not choose *Sargassum*, *Sargassum* chose us!" (conversation with Loreena, 2022). The species they chose for their research is seagrass, while the species I chose for my research is *Sargassum*.

While my fascination with *Sargassum* long predates my contact with marine biologists, it was through them and their perspectives that I learned to care about seagrass, and to be affected by its degradation under current conditions. When we examined seagrass samples in the lab, I was told that "every leaf has a history, which most people do not know" (Eva, August 2023), hinting at the little attention that seagrasses usually receive. I was fascinated when I heard Viola's perspective on seagrasses and her relation to these underwater plants in August 2023: "The reef is like New York City. Most people would be attracted, but I find it too hectic. Seagrasses are like rural areas, nice and tranquil. They calm me down when I dive. They make me forget time." The more I learned about seagrasses and the role they play in ecosystem integrity and for my interlocutors, the more fascinated and interested I became. Much like the biologists, I began to worry about the future of the coast and

[2] Both interviews and informal conversations were conducted in either English or Spanish, and, as common for ethnographic studies, translation in the context of this research took place not only between languages, between natural scientists and social scientists, but also in translating spoken words into an ethnographic text. It is important to note here that seagrass in English was referred to as seagrass—and never seaweed; in Spanish, we spoke about *pastos marinos* or used the Latin term for the species we were researching (*Thalassia*). Seagrasses are plants that have roots and can flower. They are sometimes mistakenly referred to in public discourse as seaweed, which is a macroalga.

[3] All interlocutors gave their consent to participate in either verbal or written form. They were given pseudonyms.

Fig. 1 During fieldwork, I collected *Sargassum* samples alongside marine biologists. The photo illustrates how we determined the density and quantity of the algae. The photo was taken in August 2022 in Puerto Morelos. Photo credit: Laura Otto

Fig. 2 Seagrass under the microscope. The green plants contribute to coastal integrity and are essential for ecosystem vitality. The photo was taken in August 2022 in a research lab in Puerto Morelos. Photo credit: Laura Otto

seagrasses, while my perspective on and relation with many species in the field are still framed through my lens as a European, who, for example, tends to view turtles, much like tourists, as a cute species worthy of care and protection, and who had little appreciation for seagrasses prior to fieldwork. That has, indeed, changed, pertaining to the argument that emerging coastal ethics in Mexico entail both, a change in thinking about certain species, and in practices of working with—or against—them.

How seagrasses, red algae, and humans work together

The marine biologists I worked with are seagrass enthusiasts. In their offices, some researchers had placed stickers stating "I love seagrasses" on their office windows and shared their enthusiasm for the plant with everyone in the lab. Often times, I was called to see what they found under the microscope (see Fig. 2). Yet, during fieldwork, I came to realize that my interlocutors are worried about the future of the Mexican Caribbean as a habitat for both human and non-human species. Whereas 20 years ago, they told me, diving was like visiting friends—by which my interlocutors meant that they would see fish, corals, and other marine life and ocean inhabitants—they now feel as if they are going to the cemetery instead, visiting their friends' graves. It is hardly surprising, then, that many of my research partners self-diagnosed with what they called "ecologist depression." It is understandable, even relatable: As an ethnographer, I learned what it means to encounter fish suffocating in the ocean due to a lack of oxygen, I experienced how dystopian and frightening beaches buried under *Sargassum* appear, and I witnessed what it feels like to observe birds disgustedly searching for food in decaying *Sargassum*.

While research on the exact impact of *Sargassum* on seagrass is still under way, my interlocutors were unanimous in their diagnosis that *Sargassum* "makes the life of seagrasses difficult," as Flora (interview 2022) put it. With the arrival of *Sargassum*, new species are becoming part of coastal Mexican waters, with Camila—who, like Flora, is a marine biologist—arguing that "they might bring diseases to the

Fig. 3 The photo depicts a pile of seagrass and *Sargassum*. My research partners are concerned about the negative impact that *Sargassum* has on the seagrass beds. The photo was taken in August 2023 on a beach in Puerto Morelos. Photo credit: Laura Otto

seagrasses. We do not know. It is a very insecure situation, and it is changing all the coastal ecosystems completely."

Another fear Camila articulated concerns increasing coastal erosion.

> "The seagrasses of course, they are going to deteriorate even further, near the shore, most of them are gone there. And we're going to have a newish problem: coastal squeeze. So that basically means that the water level is going to rise a little bit, the mangroves come closer to shore. And then the reef is going to disappear. The seagrasses are going to disappear. In the end, we will be squeezed between mangroves and the ocean. If these dynamics continue and if we face coastal squeeze, it won't be economically viable in the future to pay attention to our coast. Repair, then, will simply be too expensive. So, our coast, our beaches, will basically fade away. That's the scenario" (interview 2022).

Dying seagrasses are a cause of major concern for my interlocutors. They are afraid that they and their non-human "friends" will lose their habitat (see Fig. 3). Their hope to try to save the *Riviera Maya* as a multi-species habitat helped them address their self-diagnosed depression. My interlocutors were unanimous in their belief that they would never be able to restore the ecosystem to what it once was; they viewed approaches aiming at mere restoration as unrealistic. Instead, they were interested in developing nature-based solutions, working with other species, such as red algae or seagrasses, to work towards a coastal future under and with new conditions. These new conditions have created a situation in which new coastal ethics emerge as the following empirical examples illustrate. While my interlocutors from within marine biology have always been attentive to seagrasses throughout their careers, they have now become attentive to species beyond their original research interest and object. They no longer merely conduct research for the sake of science; instead, the marine biologists I have worked with have decided to opt for an ethics of concern including seagrasses but also other species and engage with their practices in being responsible for the future of the *Riviera Maya.*

Delicious seagrasses, inedible algae: convincing sea turtles to feed elsewhere

The fate of seagrass meadows in the Mexican Caribbean is closely entwined with the presence of sea turtles—who themselves face an inhospitable environment. For centuries, sea turtles were hunted for both food and trophy. More recently, pollution, industrial fishing practices, sea-based tourism, and coastal development have significantly impacted sea turtle populations. It is estimated that the populations in the WCR, of which the Gulf of Mexico is part, have declined by 99% since the arrival of Christopher Columbus in the area (Valverde and Holzwart 2017). In 1993, the local ecological center in Akumal—the town's name means "place of the turtles" in Mayan language—developed the Sea Turtle Protection Program, a conservation effort put in place following the designation to list sea turtles under the Endangered Species Act in 1978 (Sea Turtle Conservancy 2013). In Akumal Bay, loggerheads (*Caretta caretta*) and green turtles (*Chelonia mydas*) nest along its beaches every year, and some animals are year-round residents. Akumal Bay and its resorts were advertised as great spots to watch sea turtles and to snorkel with them, a popular tourist activity which depends on "rendering non-human life for sale" (Barua 2016; 2019). The turtles of Akumal are a great example of how a species was transformed from being seen as a resource for food or as a souvenir into something worth protecting, hinting at changing and situated ethics of treating turtles who are often viewed to be "charismatic species" which has a detrimental impact on the ethics evolving in thinking about and dealing with them (Lorimer 2007; Ducarme et al. 2013). Its economic value should, however, not go

unmentioned: Residents of Akumal and the surrounding villages make a living through their work as snorkeling guides, and resorts attract visitors by advertising the green giants. "In the past they were hunted with harpoons, today with cameras," notes Jorge, who works as a tourist guide in Akumal (conversation with Jorge, 2020).

During fieldwork in August and September 2022, I joined a non-governmental organization whose goal is to protect turtles. When the team of volunteers and biologists identifies a nest on the beach, they protect it by placing a sign so that tourists do not step on the eggs. Every night, several volunteers patrol the beaches and help hatchlings reach the ocean, which includes moving away *Sargassum* so that the recently hatched turtles can march into the sea; chasing away racoons who are on the lookout for a small snack; and by constantly reminding hotels and travelers to switch off lights after dark so that the baby turtles do not lose their orientation. These volunteers travel to Akumal from around the world, and no weather prevents them from conducting their activities: We went out every night, including during heavy rain and storms, dedicated to protecting these little creatures. The population, as I learned from Alesia who leads the team of volunteers, is recovering well.

The development Alesia described makes tourists, tour operators and the local NGO very happy. "But the seagrasses are very unhappy," as Eva, a marine biologist concerned with the well-being of Caribbean seagrasses told me in the summer of 2022. "I love turtles, don't get me wrong. But with their pronounced appetite, they really heavily impact the growth and stability of seagrasses." In our conversation, I could tell that she indeed admires turtles—several photos of the species decorate her office—but that she is very concerned about the seagrass because of the turtles' voracious appetite. A conflict ensues between wanting to protect turtles and wanting to protect seagrasses, "because I love seagrasses, too!", Eva remarked (conversation, 2022). This, indeed, marks ethical tensions present in the field and poses the question of what constitutes responsible action directed towards protecting both, seagrasses and turtles, and, thus, the future of the *Riviera Maya.*

The turtles' grazing routine is characterized by cropping old seagrass leaves, eating a few fresh ones, moving forward to a different seagrass patch, and returning to the first one once it has recovered from their feeding. With decreasing seagrass meadows, the turtles have, however, changed their grazing patterns: In addition to the old leaves, they now eat up all the fresh leaves, and consume the seeds and roots, too. Such turtle behavior makes a recovery of these seagrass meadows impossible and contributes to seagrass extinction and coastal erosion. By doing so, the turtles not only endanger their own survival in the long run, they also jeopardize human coastal residents' futures. But how to convince these stubborn turtles to refrain from their eating habits?

While turtles have a pronounced appetite, it is not the case that they eat everything the ocean has to offer. Eva and her team discovered that the turtles avoid eating a specific species of red algae. These algae, marine biologists noted, are considered unpalatable by the turtles, which, most likely, has to do with their consistency. Thus, they serve as a natural defense to protect seagrass beds against hungry turtles. The team of marine biologists has started planting these red algae as underwater fences around certain seagrass beds, so that the turtles do not destroy them completely and, instead, look for food elsewhere. "When the seagrass meadows have recovered," Eva explained (interview 2022), "we remove the red algae so the turtles can return for food." Meanwhile, other seagrass beds are protected from the feasting turtles with the help of the red algae. My interlocutors' hope is that this newly curated interaction between algae, turtles, seagrass, and people protects the nearshore ecosystem and the coast. The biologists successfully assembled species in new webs and made them work with and against one another. The example demonstrates how marine biologists work together with algae to produce working—that is functioning—seagrasses. In trying to protect seagrasses, the biologists also work towards the sustainability of the turtle population and, at the same time, generate ecosystem integrity that will also contribute to making human life along the *Riviera Maya* possible in the future. The newly created multi-species web illustrates that the marine biologists I have worked with not only viewed turtles to be stubborn, but as a species that needs to be corrected, fenced in without using artificial fences, and yet grazed properly. The biologists have developed a new ethics of managing, but also knowing, the turtles in Akumal Bay. These experimental practices developed within the emerging coastal ethics only work, after all, if human expertise and knowledge, as well as non-human actors, successfully interact and work together (Gesing 2019, 217).

Reintroducing seagrasses to coastal waters

The Mexican Caribbean is world-famous for its white beaches, palm-fringed stretches of sand, crystal-clear water, colorful reefs, and its vibrant flora and fauna. The majority of travelers, and many of my interlocutors who live in the area, believe that these factors create "paradise." Most of my interlocutors from within the tourism industry, however, did not have seagrass on their radar as a generator of paradise, and neither did the hotel operators think much about these plants and the hidden work they perform to stabilize coastal ecosystems—and ultimately their product: a commodified version of paradise. My interlocutors from within marine biology—cognizant of the impact seagrasses have on coastal and beach integrity, including blue and turquoise clear and clean waters—have, as they told me, tried to

convince hoteliers to protect the seagrass meadows in front of their beaches for many years. But nobody would listen to the marine biologists and the warnings they issued in terms of seagrass meadows becoming smaller. "Hoteliers would not really listen to me," Eva recalled,

> "because they did not see the damage I saw. When I told them that the ocean has less distinct colors, they said: I do not see it. When I told them, that they are losing seagrasses, they answered: I don't think so. Their businesses were going well, and tourists came. So, it was hard for me to convince them to invest in environmental protection. But now they do!" (interview, 2022).

Why the change? The arrival of *Sargassum* is, compared to marginal change in the color of ocean waters and shrinking underwater seagrass meadows, a very visible form of environmental change. Nobody can ignore the brown algae mountains piling up on beaches, nobody can ignore the strong smell the algae releases when decaying, and nobody can deny the brownish looking water the algae produces. In addition, the beaches of the famous *Riviera Maya* have become smaller and smaller over the years, which also relates to seagrass loss. Tourists have begun complaining, and hoteliers fear that their businesses will suffer tremendously from these costal changes and damages. The situation is a window of opportunity for marine biologists working in the area to convince hoteliers of the importance to protect seagrasses and, thus, to promote new ethics of knowing and valuing seagrasses.

The marine biologists now closely collaborate with a five-star resort located between Puerto Morelos and Cancún in trying to reintroduce seagrasses to a bay in which it was once abundant but is now extinct. Its extinction is closely connected to the arrival of *Sargassum* and to how the hotel managed the arriving algae. Like many other hotels, they initially invested in "technological fixes," installing barriers in the ocean to keep *Sargassum* at bay. Viola, a marine biologist focusing on the environmental transformation *Sargassum* arrival brings about in her work, has developed a pronounced interest in studying seagrass health in near-shore waters. To analyze dynamics and environmental change these 'technological fixes' entail, she—among other methods—makes use of drone photos and satellite data. One photo captured by a drone was especially revealing regarding the effects of these technological fixes in relation to seagrasses.

> "We are sitting in front of Viola's computer, and she browses through her photo album, while explaining to me how to approach *Sargassum* using this data. She stopped at a photo displaying the bottom of the ocean and asked me: 'What do you see?' I noticed two things: seagrass meadows and white sand. Viola drew my attention to white stripes on the ocean floor: 'You can see sand ridges here, in the middle of seagrass beds. The heavy chains used to attach the *Sargassum* barriers to the seabed with hooks moved with the waves and teared these fissures in the seagrass beds. In addition, *Sargassum* got stuck at the barrier and 'stood' above the seagrass, which in turn severely impacted its photosynthesis'" (field diary entrance, 2022).

Viola et al. concluded that these technological fixes—which they did not interpret being helpful within ecologies of repair—might, in the short run, help to keep beaches free from *Sargassum*, but would do additional harm to their valued seagrass meadows. Instead of further investing in these technological fixes, my interlocutors advocated for more nature-based solutions among hoteliers, as they were convinced that these so-called "fixes" were either not fixing the problem sustainably or, even, creating new ones. They were given permission by hotel management to experiment with reintroducing seagrasses to the bay. Working on coastal stability does not only mean that my interlocutors simply employ their knowledge, but above all, they must generate new knowledge to better understand seagrass-*Sargassum* relations. That *Sargassum* had chosen them, to refer to Loreena's quip, also means that my interlocutors moved away from merely doing science for the sake of science, but instead work on practical solutions whose immediate aim is intended to address the issue of coastal degradation along the *Riviera Maya.* Eva, who is very much involved with reintroducing the seagrasses, stopped conducting merely basic research. Instead, she has become very much involved in what she called restoration:

> "I studied basic biology, basic interactions, what is flowering doing, are small bugs pollinating the flowers, what are the turtles doing with seagrass? Basic biology, but very interesting. I really considered these meadows, the way they were, stable. But meanwhile, I started to study more how their system works. I never thought I needed to work on restoration. And that's what I'm working on now." (Eva, informal conversation, 2022).

Engaging themselves in ecosystem restoration helps my interlocutors handle their "ecologist depression," as it helps them "to keep going" (interview with Eva, 2022). At the same time, their decision to assume responsibility for the future of the coast also demonstrates that environmental crisis is, quite literally, an opportunity to experiment (Blanco-Wells 2021, 4). It was in the lab that I learned how my interlocutors experiment with *Sargassum* and seagrasses, making use of their knowledge about seagrasses to better understand the impact *Sargassum* has on the "underwater power plants."

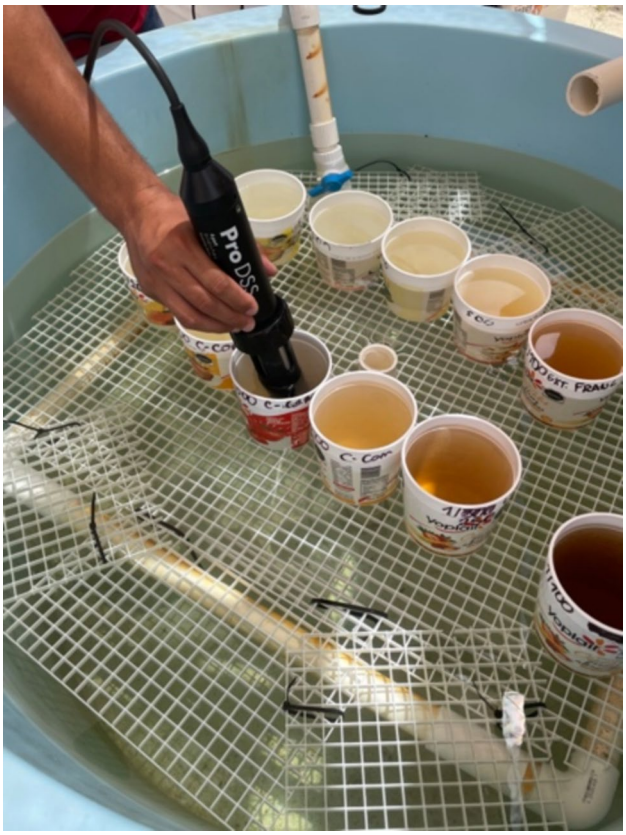

Fig. 4 During fieldwork, I assisted in several experiments directed towards better understanding the conditions for seagrasses in waters which in *Sargassum* is present. The photo was taken in September 2023 in a lab in Puerto Morelos. Photo credit: Laura Otto

In several experiments, they have allowed *Sargassum* to react with recently germinated seagrass seeds, and seagrasses functioned here as a proxy to better understand *Sargassum* (see Fig. 4). How coastal integrity can be produced under the conditions of *Sargassum* o arrival is still a costly experiment: "It's a lot of money, a lot of effort and time to do restoration of ecosystems," Camila explained to me (interview, 2022), and "we don't know if the seagrass transplants are going to be successful. I hope they are. It is difficult for them with the bad water quality. But we chose a seagrass species, *Thalassia*, that is relatively resistant. We have to wait and see, but we have hope." While new ethics of knowing seagrasses and valuing these plants emerge, uncertainty about the future of the coast is still prevalent. However, the dynamics on site led to a situation in which the actors experiencing coastal degradation in their everyday life become more attentive towards various species, they change their thinking about different species, and develop new practices in dealing and interacting with them, which gives room to multi-species repair work in the Anthropocene, and, resulting therefrom, new coastal ethics.

The moment of the seagrass?

My interlocutors not only hoped that replanted seagrass would protect the coast from further degradation, but also hoped that seagrass would receive more attention in Mexico. It was in the summer of 2022, when Eva told me the following story: A few years ago, she was invited for joint research on seagrasses with colleagues from Australia. She did not travel "Down Under" alone: A few *Thalassia* plants accompanied her on the trip, and she carried them in her hand luggage, knowing that the little plants are sensitive. In her excitement about the upcoming joint research with the Australian colleagues, she had forgotten to register the plants for entry and was stopped by border security. After all, one cannot simply bring living beings into Australia. Eva reported that the border guard took the plants and examined them. While she feared a hefty warning, he instead simply asked: "Is that seagrass?" Eva did not trust her ears. In Mexico, she told me, hardly anyone knows what seagrass looks like. She was thrilled that the border guard recognized the plants, and even years later, when she told me the story, a satisfied smile appeared on her face. If only it were the same in Mexico—that everyone could easily identify seagrass!

My interlocutors were somewhat surprised that coastal residents had little interest in seagrasses, given how vital they are for coastal survival of all kinds of species. A recurring theme during fieldwork was, thus, the scarce attention paid to seagrasses, which locally reflects the "lack of appreciation" for this species (Cullen-Unsworth et al. 2014; also Nordlund et al. 2018). I learned in conversation with marine biologists that the Caribbean had been blessed with intact seagrass meadows for decades. These green species carried out their work, which was taken for granted and often went unnoticed by humans. Eva recalled in conversation with me that "seagrasses," at least in comparison to colorful corals and fascinating mangrove forests, "lack charisma" (interview with Eva, 2022). She observed that people in Mexico have never been very interested in the seagrass meadows along their shores, and she, while laughing slightly, told me: "Nobody here cares about seagrass, except me and my team in the lab" (interview with Eva, 2022). She has, throughout her career, focused on seagrasses. The lacking charisma she diagnosed seagrasses with would not only relate to their somewhat unexciting green color, as Eva elaborated: "Here, you find the seagrasses a couple of meters away from the beach, underwater in the ocean. They never show up on the surface, as we have no tides here. They appear to be a dark spot in the water, and you only see how fascinating they are when you snorkel or dive." Tadeo, a marine biologist with a focus on coral reefs, told me in a similar fashion that Mexico "does not have a seagrass tradition," and people do not feel as though they have a relationship with these underwater plants. My interlocutors' accounts suggest that

the value people ascribe to species is closely interwoven with their visibility which becomes all the more evident in light of *Sargassum* landings: While seagrasses are such a hidden species, *Sargassum* is the opposite. With its ability to float, to color the water brown, and with its smell like rotten eggs, *Sargassum* makes itself noticeable to coastal residents and visitors. The attention generated by the algae is remarkably pronounced. It also provides an opportunity for my interlocutors to elevate the status of seagrasses. Eva told me that a maximum of ten people came to the public talks she gave on seagrasses a few years ago, but now with *Sargassum* being so visible on shore, "there are hundreds of people coming to my talks now, sometimes they even wait outside. And I use the opportunity to not only talk about *Sargassum*, but to stress the importance of our seagrasses, and I tell everyone that yes, seagrasses are interesting, too!" *Sargassum* arrival on shore and its consequences has now raised human attention beyond the community of marine biologists to another—at first glance perhaps less exciting—species. Current dynamics of coastal degradation hold the potential for seagrass no longer to be seen as the boring green underwater weed, but to be recognized as a protagonist of coastal futures, with seagrasses increasingly emerging as a matter of concern (Latour 2004): They gather a multitude of actors, connect diverse sites, generate different practices. Hand in hand with growing seagrass concern goes intensified seagrass care, and my interlocutors in Mexico, much like other natural scientists, hope that raised seagrass attention leads to a situation in which they no longer "remain in the shadow of their more illustrious neighbors, coral reefs, in terms of media attention, research and conservation funding" (Unsworth et al. 2018). That shift in thinking about and valuing seagrasses has, at least, worked with me, the anthropologist who started fieldwork without having paid attention to these underwater plants. In a recent zoom conversation with my interlocutors from Mexico, they have pleasantly noted that a portrait of seagrasses now also adorns my office, 9000 km away from the lab in which I was first told that when most people "see seagrasses, they see trash. But we see life" (Eva, August 2023).

Conclusion

Increasing coastal degradation along the famous *Riviera Maya* is exacerbated by seagrass loss, calling into question the future of the Mexican Caribbean. In a situation in which different actors have assigned responsibility to each other for coastal degradation through blaming, marine biologists, in contrast, have begun developing practical solutions beyond blaming or "technological fixes" to work towards a coastal future that is livable for humans and non-humans, being aware of the fact that a livable coastal future can only be maintained if people care for the ecosystem so that the ecosystem can care for its multi-species inhabitants (Puig de la Bellacasa 2017). To reach this state of mutual care, matters of fact must become matters of concern (Latour 1995), as the examples referring to seagrass have demonstrated. The article has paid attention to the questions of how marine biologists in Mexico deal with increasing coastal degradation, which practices they develop to create a coastal future, how non-human actors are involved, and which coastal ethics emerge within these dynamics. Three examples from fieldwork offered empirical insights: The first focused on how my interlocutors try to protect seagrasses from hungry turtles, the second focused on how marine biologists reintroduce seagrasses to a bay where they have become extinct, and the third illustrated how *Sargassum* arrival alters which species are given value and attention. Not only have these examples contributed to specify the concept of "ecologies of repair" (Blanco-Wells 2021), which can be understood as a "collection of relations between heterogenous entities to work together for some time" (Müller and Schurr 2016) by highlighting the situated and temporal character of "working seagrasses," suggesting that "repair work" in the Anthropocene is enacted among and through different species. The examples have, in addition, shown that the coastal ethics which emerged within 'working seagrasses' entailed a shift in ethics of ecosystem engagement on a very practical level, and a shift in ethics of knowing and valuing coastal ecosystems and species. Coastal ethics must be understood as relational, embedded and situated, and are, indeed, characterized by tensions: Marine biologists do not share the same understanding of coasts and whom they are for as tourism industry stakeholders, and yet these actors and their perspectives are intertwined when it comes to working towards coastal futures in Mexico. It was not marine biologists' goal to protect the coast as a product for tourism, but the travel industry and its needs were nevertheless entangled with their practices. The tourism stakeholders in Akumal, for example, allowed for the dissemination of red algae, as they had an interest in a stable turtle population. Hoteliers agreed to experimentation with the costly renaturation of seagrasses, as they had an interest in wide, sandy beaches. While actors from the tourism industry were primarily concerned with the coastal future from a human point of view, the practices I observed among marine biologists were directed at coastal integrity in and of itself. The approach offered here not only highlights how practices developed by marine biologists, such as planting red algae or reintroducing seagrasses, "reopen our imagination to what is possible within the ruins we created" (Tsing 2015), but it helps us to understand the potential for "climate futures that do not simply repeat the mistakes of the past" (Spencer et al. 2019). By and large, the article demonstrated that coasts become zones where advances in natural sciences increasingly reflect complex

multi-species constellations. Considering these dynamics, coastal regions become areas of creative thinking and action, where novel approaches to ecosystems are put to the test, resulting in new coastal ethics and visions of the future. When reflecting on ecological developments along the *Riviera Maya* and the attendant practices by marine biologists outlined in this article, it is worth inquiring if "working seagrasses"—quite literally—contain within them the seeds of coasts' own protection.

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