THE UNIVERSITY OF CHICAGO

WHITHER THE REEF? AN ANTHROPOLOGICAL ANALYSIS OF TECHNOPLANETARY SALVAGE ASTRIDE THE 21ST CENTURY GREAT BARRIER REEF

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ABSTRACT

This dissertation traces how and why technoscientific actors orient to planetary crisis as a field of practical, epistemic, and psychopolitical tension to develop and popularize a controversial array of technical interventions into human/ocean relationality. It asks: What is "climate action" when it takes the form of a competition to open reef-building corals to permanent technoscientific settlement? So-called "life support systems for coral reefs" aim at permanently altering marine life and its dynamic milieu the better to accompany reef-building corals—and, by extension, planetary nature—beyond a predicted horizon of mass extinction. By promising to make an engineering virtue of a geohistorical necessity, globalized coral science has become a major force in the push to turn planetary finitude into the foundations for a new kind of know-how I call technoplanetary salvage. In such light, what the social sciences once diagnosed as technoscience's misrecognized grammar of knowing as mastering nature appears, now, to become its avowed calling. And yet, while technoplanetary salvage remains forward-looking, its vision of "life support" does not point towards managed enclosure or endless bounty but mutual exposure and perpetual maintenance.

In what follows, I argue that a narrowly rational understanding of the problem typically referred to as "climate change" encourages a technofuturist competition over forms of knowledge/power worthy of the description of "climate action." Rather than a break from or reckoning with the historical drivers of our diminished present, this competition fashions "climate change" as a practical and psychopolitical tool with which to redesign and reorient human/ocean relationality—however temporarily or tenuously. "Buying time" for planetary nature in this way suggests that a shift in the terms of human/more-than-human relationality might delay a coming catastrophe. However, because this shift imposes a grammar of simultaneous historical necessity and radical novelty, its price is a growing confusion over the limits, legitimating authority, and ultimate end of human intervention into planetary nature.

Twenty months fieldwork among coral biologists, reef ecologists, government officials, marine park rangers, coral husbandry technicians, lab interns, environmental activists, and media representatives astride the Great Barrier Reef along Australia's northeast coast ground the present inquiry. It proceeds in two parts: first, I contextualize the privileged position of corals within the North Atlantic tradition of natural history and modernist technoscience; second, I ethnographically redescribe technoplanetary experiments that scale from the lab to the oceans, coral biology to robotic surveillance, cyclonic activity to political apathy. By combining critical natural history with critical multispecies ethnography, this dissertation situates corals and the Great Barrier Reef as bound up with—and not mere victims of—the large-scale forces bearing down upon human and more-than-human natures today. I posit "earth distress" as an alternative analytic to "climate change" and draw out a series of nonrational aspects of technoscientific knowing: relating, absorbing, synthesizing, luring, and bewildering. In so doing, I offer some ways in which anthropological inquiry might catch and interrupt various expressions of technoplanetary reasoning that seek to use present day crises and the so-called "geological agency of humankind" as justifications for new experiments in capitalist accumulation and liberal governmentality, which undermine broader horizons of justice and radical empathy in the historical present.

LIST OF FIGURES

PREFACE

Settling behind the wheel in the Chicago suburbs at the height of a Midwest winter, my mind is awash with images of coral crisis. I ease out of the Prairie State College parking lot and replay one of my fieldwork commutes through the imposing automated gates of the Australian federal science agency responsible for knowing what to do with the Great Barrier Reef. What connection between these two places did I summon (or fail to summon?) in the talk I just gave such that it pursues me upon leaving? I glance down at my phone. From the Archimedean point of Google's satellite networks, it tracks my homeward journey up Halsted Street and onto the westbound I-94 so that I don't have to. The map sends me drifting skyward to aerial surveys of Australia's coral reefs devastated by the 2015-16 global mass bleaching event. These flyover photographs testified to dramatic, perceptible changes to the structural integrity of the Great Barrier Reef and by extension all coral reefs, with as yet unknown effects on the broader web of marine life. Their continued circulation on social and conventional media still marks that troubling indeterminacy today (Figure 1).

An Arby's flashes by on my right, a Dunkin' Donuts on my left, up ahead is a Home Depot. I hear the oft-repeated analogy between reefscapes and cityscapes, which figures corals as underwater architects and reef-going organisms as tenants and commuters. "At any scale, corals are live buildings," write marine biologists Covadonga Orejas and Carlos Jiménez (2017). Surely this way of depicting an orderly and flourishing reef community appeals, at least in part, because it sustains a fantasy of the social division of labor as natural, life-sustaining harmony. Then does the urban landscape of strip malls and ad hoc busyness before me reveal the absurdity of this analogy, because the mode of production and exchange that such development services is fragile, predatory and, ultimately and among other things, harmful to coral reefs? Or, as corals and cities find themselves mutually exposed to a future of permanent strain, does a pitched battle between growth and neglect bring them into closer intimacy?

I make for the highway turnoff and find myself admitting, not for the first time, that so much of my research depends on cars. What underwrites the present inquiry are thousands of miles driven, pages printed, gigabytes sent, rooms and screens and appliances illuminated; in short, to use that metric of aspirational responsibility popularized by British Petroleum, a carbon footprint that no words can offset. I flick my turning signal and merge. It flashes on and off, on and off, and I am transported back to a conference room whose atmosphere alternated between

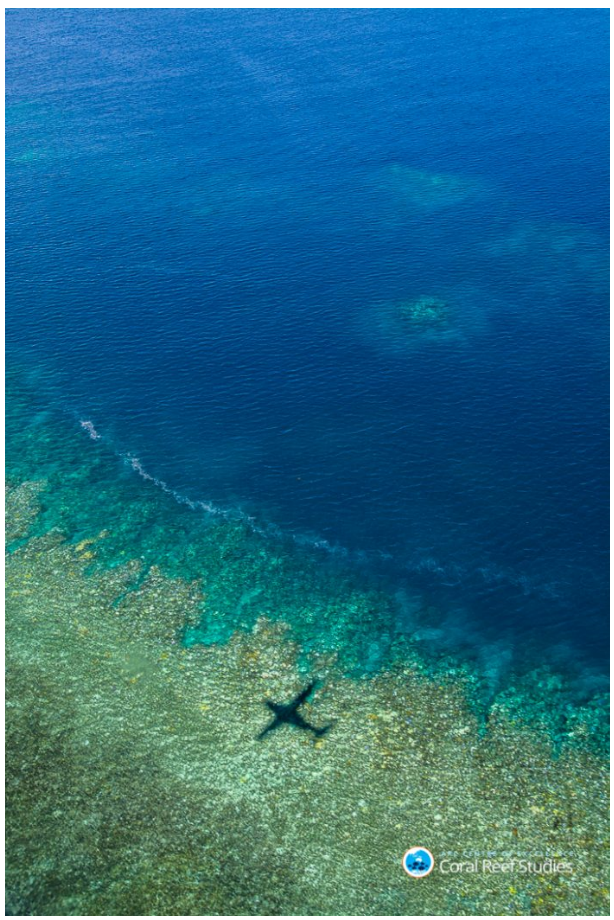

Figure 1. One of a packet of widely-circulated images of the mass coral bleaching across Australia's Great Barrier Reef in 2016/17. The image was taken during an aerial survey later which became published climate research but was also a form of climate action as mass consciousness-raising (Source: Ed Roberts, ARC Centre of Excellence for Coral Reef Studies)

hubbub and hush, hubbub and hush, as presenters filed on and offstage to detail the emergency that befalls coral reefs today and into the foreseeable future—unless, that is, something gives.

*

This moment, daydreaming behind the wheel, is one among many where I have felt myself shadowed, if not to say surrounded, by my own research. This experience is, I am told, an utterly typical one. I share this story, here, as a token of exposure to the planetary through the medium of coral reefs. In this moment, my sense of the local geography of Chicago became strained by an awareness of the global circuits of petrocapitalist production, consumer logistics, and the force of physical and digital infrastructures, which, in their momentum and durability, bear down upon a living earth otherwise understood as a condensation of deep time within the deep space of the universe. The planetary scale is defined by processes, to borrow a phrase from writer Ursula Le Guin, vaster than empires and more slow.

Coral reefs—visible from space, integral to the carbon cycle, and the product of the cumulative concrete labor of innumerable generations of creaturely cooperation—appear to live at such a scale. And as corals are now dying at this same scale, they have come to mediate a widening array of efforts to study, anticipate, and act on the problem typically known as "climate change," which I will be calling "earth distress." To see coral reefs as a medium is not to abstract from or diminish their physical existence. It is rather to suggest that just as coral reefs are one feature of the world as it exists, so too the human capacity to perceive and relay this particular form of life allows people to draw connections and conclusions as to the state of the world, what makes it go round, and how to find a place within it.

Like many other humanistic and social scientific scholars of earth distress, I have continually confronted the profound resistance to thought that the planetary perspective provokes. It is incredibly difficult to maintain awareness of the radical dependence of earthly life upon connectivity, all the more so when such connectivity waxes toxic. It is this seeming excess to historical consciousness that my flashes of encountering "coral crisis" amount to: planetary processes provide the grounds for yet transcend the human condition. Why do groups of scientists, government officials, corporate sponsors, and media actors, along with the publics they recruit extol the planetary qualities of coral reefs in their desire for "climate action"? Corals, it seems, get the planetary in a way we can't. They seem to integrate within their very being abstract concepts of time, space, identity, causation, and change and offer ready access not only to an encounter with the sublime but also, perhaps, a way of harnessing it. At stake in the predicted demise of coral reefs, then, is not only the practical "functions" or "services" that they provide but also an imaginative projection of the power and purpose of radical connectivity. Coral crisis mediates the longing for a kind of human action that would be capable of nothing less than overcoming a profound sense of metaphysical inadequacy in the historical present.

What prompted my slipping in and out of the Chicago commute and the social worlds of coral was the Q&A I had just led at Prairie State College. A sculptor acquaintance had some work in a group show on the plight of coral reefs in warming oceans. For the exhibition opening, she had arranged for a screening of Emmy-award winning documentary *Chasing Coral* (2017). Remembering I had been there during filming, she invited me to speak after the film. Despite the organizers' best efforts, turnout was all but limited to the campus gallery and its friends. One student attended, a reporter for the student newspaper whose careful write-up of the afternoon's proceedings held open the possibility of greater student engagement. Her reporting on our responses to reports of coral crisis was its own call for something like repeat viewing, and so added another ply to the skein of mediations that turn diminishing nature into the stuff of public discourse. That afternoon, however, it seemed like the rest of the students had other things going on, which provoked a palpable frustration in the room as the line between mere absence and motivated avoidance became difficult to assess. Because as the screening wore on, it was as if the intended yet absent college audience proved the film's point, namely, that what ails coral reefs and the planet more generally is a baseline of generalized human indifference for lack of a transformative encounter with coral imagery. Indeed, the film had successfully evangelized the sculptor who sought to repeat its alarm call by crafting ersatz bleached corals, memorialized in sinuous beeswax, resin, and an organic compound known as fosshape. Yet my talk, which glossed the politics of fear immanent to climate science and so the scope for moral reductionism within climate action, seemed only to stoke this frustration further. "Okay, so the situation is dire. But what are we to do?"

Time and again, I have felt the force of this question or a variation on it. After lunch one day at the Australian Institute of Marine Science, I was discussing evolutionary futures with a senior coral biologist. Mid-sentence, she turned to me and did not so much ask as declare of a malevolent public: "you're the anthropologist, how should we change *them*?" A few months later during a break at a workshop on alternative approaches to environmental law, I was speaking with a Catholic nun about the day's proceedings when she summoned the name of Australia's prime minister and pressed me: "but what about *him*, how can we change his mind?" I have also received countless, quieter appeals to a presumed authority to speak if not for coral reefs then for the would-be transformative action required in their name. Supportive colleagues have asked after the evolving prognosis of the Great Barrier Reef, for instance, and, just the other day, the organizer of a psychoanalytic reading group welcomed my request to participate by thanking me for my "attention to the Coral Reef."

How to make sense of appeals like these? On the one hand, they suggest a shared understanding of anthropology as a positivist social science, which may or may not be the same thing as a magical technique of mass influence. In this sense, the point of my studying how people make sense of earth distress and lay claim to climate action would be to discern law-like patterns of negligent behavior that might admit revision. From one aspect, such an association is passing sinister, especially in the Australian settler colonial setting, for it names new frontiers upon which anthropological methods might advance special interests. From another, more hopefully and less suspiciously, it suggests an outsider appreciation for the dialogical method of anthropology and its aspiration to reparative critique. On the other hand, rather than my standing as an anthropologist, perhaps it is the epistemic and moral situatedness of my questioners to which these appeals point: the artist appealing to the power of aesthetic representation, the scientist to the applications of research findings, the religious to the voice of authority, the psychoanalyst to the minded residues of catastrophe. And yet, rather than speculate about status and standing, is it possible to suspend the questions themselves for what they might say about why coral finitude becomes a social question today?

"What are we to do?" "How do we change the public?" "How do we change the prime minister?" "Thank you for your attention to the Coral Reef." These three questions and a statement are not identical. In fact, were it not for the statement, the connection to coral reefs in the historical present could go unremarked. Yet this connection matters. Otherwise, the questions appear to aim at some general and timeless truth about the nature of: (in the first instance) crisis action; (in the second) public indifference; and (in the third) feckless leadership. When viewed in this way, the questions coral crisis throws off come across as what philosopher R.G. Collingwood calls “eternal problems.” An eternal problem is not a problem you can resolve with an appeal to personal preference, as with the question of how many lumps of sugar you take in your tea. Neither is it something you can resolve with an appeal to the historical record, as with the question of what were the changes to the global circulation of goods, people, and power that made “how do you take your tea?” a way of relaying, today, the idea of personal preference. Instead, says Collingwood, an eternal problem is a way of construing a philosophical question that appears to arise across the archive of social thought *as if* it retained the same form yet gave rise to different responses, responses which might then be compared one to another and thus, at long last, yield the right answer. The eternal problem invites a longing for the timeless truth, as the unopened lock does a perfectly matching key.

Collingwood dismisses the eternal problem construction as unanswerable. He deems it an academic stalking horse that occludes considered inquiry into the circumstances under which a question arises—whether for the first or nth time—and assumptions about human nature, natural history, scientific truth, and so on and so forth that prompt its asking. So considered, a question cannot be resolved by preferring one school of thought to another. Rather, it is brought down to earth the better to understand, at a given time and place, what sense of human nature, natural history, scientific truth, worldly authority, and so forth, prompt its asking and thereby warrant it being answered thus and so (Collingwood 2002, 52–76). The point, then, of showing how the above questions borrow of the “eternal problem” construction is not to dismiss them as wrongheaded. It is rather to wonder why it is that, in the historical present, they take up the Great Barrier Reef to reach for eternity? Here is my hunch: that knowing coral qua planetary crisis gives rise to a sense of moral panic that grounds a desire for as yet unannounced modes of human action. To know “climate change” is to desire climactic social change. Yet would such a climax of the human condition lift a sense of worldly disarray or only further affirm it? It is as if something terrible would happen if I looked away from dying corals. I might not see them leave, taking the answer to my questions with them.

Dying corals can mediate an affirming encounter with worldly disarray and, at the same time, a longing for a reparative but as yet unthinkable kind of action. As a mirror of the climate crisis, the terminal state of coral reefs appears to invite ever more refined measurements of the physical world today. As go coral reefs, so go the oceans, so goes the planet; the only possible response to this causal chain, surely, the only *reasonable* emotional response, is to institute a new planetary agreement between global nature and global society? It is possible, however, that the manifest lack of such a response in the historical present only fuels a longing for it, for the return of a just measure with which to sort redemptive from regressive relations between human and more-than-human beings. What’s more, giving force to this longing is an idea of the past not as a resource or refuge but a reminder of lost time and a litany of bad human actions to which coral reefs, in their diminished present state, bear constant and repeated witness. In turning away from the past, we not only clear the way for viewing the coral/climate crisis as an eternal problem but risk denying our own status as historical subjects, as if we, too, live as reefs.

In the late 1960s, one of the central arguments behind the successful pressure campaign to prevent drilling and prospecting for oil on Australia’s Great Barrier Reef was that coral reefs were living things, all the way down. Today, a growing realization that coral reefs might also be dying things seems to be motivating a desire for human beings to lead different lives, all the way down. This sense of inadequacy, this felt lack of change, only stokes a further expectation of some *other* kind of human action, desirable if only as a departure from the seeming monotony of planetary crisis. Lauren Berlant writes “to ask the question of what makes something a case, and not a merely gestural instance, illustration, or example, is to query the adequacy of an object to bear the weight of an explanation worthy of attending to and taking a lesson from; the case is actuarial” (2007, 666). In addition to explaining how coral reefs are dying, coral scientists, reef managers and ocean advocates appear compelled to make the case that such dying matters. Why? Why is the manifest diminishment of coral reefs not enough to go on? Why do coral scientists, reef managers, ocean advocates, and the ordinary people with whom they connect appear compelled to make the case that such dying matters—And what happens when they do?

INTRODUCTION

> Most of us are monsters to whom self-interest is the main motif of life. Only beauty and power of a remarkable order can charm us into forgetting our interests and doing battle on its behalf. The Great Barrier Reef is one place which has that power.
>
> Judith Wright
>
> Whatever we do for coral reefs is good for humanity.
>
> Bob Richmond
>
> Whatever the Anthropocene may be, it is not now being defined by the observation of data but by interpretation, the traditional task of the humanist. Perhaps what have been called the "posthumanities" ought also to involve the "postsciences."
>
> Nicholas Mirzoeff

The project of modern science has long looked to the marine environment as the ultimate proving ground in its efforts to describe how life began and where it might lead (Helmreich 2009; Sloterdijk 2016; Sponsel 2018). Coral reefs have been central to this task, offering spectacular evidence for a cornucopian account of global nature as red in tooth and claw at times yet fundamentally creative. In his debut monograph, *The Structure and Distribution of Coral Reefs* (1842), Charles Darwin gave early impetus to this vision. He depicted ocean and reef in a David and Goliath struggle, where fragile corals triumph over the forces of wind and wave thanks to "another power," the creativity of organic forces. In this distinctively modern natural history, if corals function as a metonym for organic life then Australia's Great Barrier Reef serves as monument. Yet "The Reef," to use the presumptuous shorthand used throughout Australia, has recently set to crumbling, and as it does the marine sciences have come to question the use of their descriptions for responding to a distressed and distressing earth, a planetary power quite indifferent to creative life (McCalman 2014; Veron 2008).

This dissertation is an investigation into the gradual and ongoing diminishment of the web of earthly life as a simultaneous problem and promise for technoplanetary reasoning. It considers the designs with which researchers, technicians, government officials, conservationists, media actors, and mass mediated publics vest the Reef as its historical status undergoes a dramatic reversal. The Reef has long been pointed to as "the world's largest living structure" and the only organism visible from outer space. It is a would-be icon of our living planet. Today, however, it is increasingly pointed to as the "canary in the coalmine of climate change," singing out in distress and warning about the end of life on earth as we know it. I ask: *What is "climate action" when it takes the form of a competition underway to open the Reef up to permanent technoscientific settlement? Why, how and on what authority is this competition drawing political attention, economic interest, and psychosocial enthusiasm to a picture of the planet as a looming problem to solve for rather than an existing home to dwell in?* To answer, I redescribe the crisis-laden world of planetary coral science, management, conservation and engineering. I offer an anthropological gradient of the ongoing and evolving pressures that technoplanetary conceptions of human-coral relationality and historicity place upon the present. I demonstrate the following: that a narrowly rational understanding of the problem known as "climate change" encourages a technofuturist competition over knowledge and power that exacerbates epistemic, political, and moral confusion over how to reckon with increasingly distressed and distressing conditions of present-day earthbound existence. This confusion—regarding how to act, on whose authority, and to what ends—befalls would-be representatives of reef-building corals such as geneticists or filmmakers or marine park rangers and, at the same time, extends to lay publics recruited to such representation and whose interestedness in coral crisis today is, accordingly, deemed decisive to its resolution tomorrow. Put directly: the more tenuous the planetary existence of reef-building corals, the more tenacious the claim of technoscience to represent them, the more tendentious the aims of climate action in their name. In contending that a particular way of reasoning about earth distress begets confusion, my point is not to clear the way for its evacuation or overcoming. Instead, I combine the resources of ethnographic description and immanent critique with psychoanalytic redescription in order to track the way that confusion—as a perhaps foundational dimension of the human condition—accompanies efforts to pin down, if not outwit, "climate change" as a problem. This can be practically and conceptually productive (i.e., in making previously unthinkable or impermissible forms of action seem normal) and destructive at the same time (i.e., in exposing these same forms of action to doubts about their future illegitimacy). I track confusion, therefore, as a way of nourishing and withholding a craving for certainty under conditions of radical doubt, which I submit is a symptom of the difficulty of ever directly pointing to and confronting our distressed and distressing historical present. And, finally, I can only wager that any confusion this very paragraph has occasioned will, by manuscript's end, be something other than a source of frustration.

I bring this dissertation's overarching argument out in two main parts. 1) Even within the dominant tradition of North Atlantic technoscience, what gives force to corals is not their mere existence in the world but their ongoing interest to the ordering of social life under conditions of uncertainty. Corals are time-traveling devices whose meaning in use discloses major shifts in the relationship between science and society, global nature and geopolitics. To be clear: the turn-of-the-20th century consensus according to which coral reefs are not immortal entities and global society is driving their collapse has been a hard-won achievement. It vindicates technoscience as a transnational undertaking. Yet, at the same time, it all too readily singles out conventional political authorities as weak-willed, powerless to act on the scale of space and time that "really matters." The result is a peculiar one: the more that corals reveal the urgency of the climate crisis, the more powerless existing authorities seem to urge on global change. This churn is symptomatic of what I call "earth distress." As I will detail shortly, I offer this language as a phenomenologically grounded alternative to "climate change" as some external reality upon which people are called to act. 2) Technoplanetary salvage does not so much break from the churn of earth distress as it does create new practical openings onto and imaginative projections into it. I explain the scientific theory, ordinary actions, and broader public messaging by which unprecedented and previously unthinkable human interventions into the Reef and by extension planetary nature "take off." Technoplanetary reasoning and salvage orient to "climate change" as something to harness, however obliquely—to anticipate, accelerate, inhabit, polarize, occupy, and redirect. The price of "buying time" for planetary nature in this way is a narrowly rational understanding of earth distress as "climate change" that, although it expands the domain of human agency in the name of climate action, stokes confusion over the political, moral, and ethical implications thereof.

This manuscript offers ways of turning towards technoplanetary reasoning and salvage as forces rapidly and durably altering the dynamics of human/more-than-human relationality and offers some ways and reasons to view the historical present as something other than a problem to solve. Much important scholarship treats planetary engineering as a proposal whose unintended consequences and ethical implications are to be evaluated in abstraction from historical reality. I submit that—when viewed historically and ethnographically—something like disorderly action and ethico-moral tension are immanent to "earth distress" and that technopolitics stabilizes its authority by trying to operationalize and make a virtue of these in context. I write of knowing as relating, absorbing, synthesizing, luring, and bewildering. This is because, if we begin from the assumption that knowing is a way of tensioning some kind of object-relation, then we can move to describe the psychopolitics of more-than-human encounters otherwise than in terms of guilt or innocence, pragmatism or romanticism.

In what follows, I work through the conceptual scaffolding with which I open up this manuscript's key questions. First, I explain why I eschew the language of geoengineering and instead propose to study the making of climate action as a matter of technoplanetary salvage for an earth in distress (Section 1). Second, I explain why knowing and acting upon the whole earth scale necessarily involves interpreting history, even as technoplanetary salvage calls for a radical break with past modes of human/more-than-human relationality. This motivates the need for an anthropological interpretation *of* technoplantary salvage as an emergent formation of human being and doing (Section 2). Third, I present a view of planetary as a perspective simultaneously shot through with a profound sense of power and crisis, an internal tension that devolves from a tremor in historical consciousness and temporality (Section 3). Finally, I close with a short discussion of my fieldwork methods and key writing choices, along with a preview of the dissertation's chapters (Section 4).

1. Earth Distress and Technoplanetary Reasoning

When I began my research, I imagined that open-ended experiments in conservation-driven engineering at the whole earth scale would need to pass some kind of litmus test before gaining sufficient momentum to transform global society. I don't think that anymore. As best I can recall, I did not assume that global political consensus would be a prerequisite for the systematic opening up of nature to technics. However, I did, I believe, assume that some arguable claim as to what the environment is as a concept would need arise and seek mass public sanction, a claim around which not only to rally support and resources but also obtain authorization by admitting contestation. So long as this claim as to the nature of global nature remained emergent and could be argued, I thought, geoengineering would not "take off." How liberal of me (MacIntyre 1988). These assumptions are fuzzy to me now. My research and fieldwork have tutored my sensibility towards more gradual shifts in regimes of natural history. For instance, I understand the dream of technoplanetary reasoning as tethered to and drawing upon far deeper historical traditions of thinking about nature and, at the same time, future-tensed in a way that presumes a need to downplay substantive discussion of how to understand nature. A shift in research object matters too: the time for and tempo of deliberation works differently in coral reef studies than it does in carbon emissions accounting (Bright 2016). My initial assumption (i.e., that technoplanetary reasoning takes its authority from an arguable theory of environment) might, however, explain why one sensitive reader of the politics of nature remains committed to contesting the very idea: "[because the earth] cannot be compared to a machine, it cannot be subjected to any sort of re-engineering" (Latour 2017, 96–97) What I am calling technoplanetary reasoning does not seem to truck with such an earth-machine comparison, does not so much stumble as jump over it in order to subject (the verb is well-chosen) earthbound existence to total salvage in the historical present. What it requires to do so—to act as if the earth might turn out to be like a machine and so available to reengineering, even though we cannot yet recognize it as such—is a sense of collective catastrophe and measurable exposure, which give the operations of technoplanetary salvage an aura of necessity, which necessity is no trifling matter for those who find themselves beset by a patently distressing reality. To recast this within the terms of an enduring anthropological debate, whether technoplanetary salvage is or is not bewitched by the nature/culture binary is moot when a seeming equivalence of technical and natural catastrophe appears to authorize open-ended modes of experimentation into countercatastrophic intervention (Nancy 2015). It is not necessary for the earth *or its real existing historical subjects, including humankind*, to actually be a machine in order to be subjected to reengineering.

What follows is therefore an anthropological inquiry into coral reef studies as a decisive staging post for technoplanetary salvage as an idea, a desire, a movement, a practice, a politics, an ethics. I will demonstrate that this amounts to an inconsistent (i.e., human) but resolutely historical process. By technoplanetary reasoning and/or salvage, I refer to a set of vectors—styles of reasoning about human-nature relations, affective dispositions and recruitments, orientations to political authority, fantasies of technical overcoming, and conceptions of historical action and necessity—that question the proper relationship between human and more-than-human forces and, therefore, the nature and domain of power. I acknowledge that there is something unwieldy and overly general to the expression "technoplanetary reasoning and/or salvage." I intend it as something of a conceptual umbrella. Hence, in the following chapters, I invoke various alternatives that draw out its more specific empirical and historical dimensions, which include "coral science thought collective," "interpretive technoscience," "holobiont engineering," "settler natural history," "interventionism," and "gaslighting."

The implications of this emergent formation of knowledge/power extend beyond the lives of reef-building corals and even the global oceans. As we will see, the status of reef-building corals as a beloved "canary in the coalmine of climate change" makes them the ideal vehicle for initiating so-called "last resort" efforts to prevent a total collapse of the web of earthly life and, in the process, stabilize a would-be "new paradigm" of what human beings are to global nature and vice versa. As technoplanetary reasoning gains traction and momentum, it is beginning to alter not only what the Great Barrier Reef is to the members of an Australian federal research agency but what kinds of points of intervention, modes of encounter, regimes of funding and political authorization are thinkable, desirable and available in different locales, contexts, and milieus all across the world. In late 2018, for instance, the International Panel on Climate Change released its *Special Report on Global Warming of 1.5º* in which it called for nothing less than the "widespread adoption of new and possibly disruptive technologies" to be led by industry but subsidized by government. The relevant paragraph has since become the standard opening citation to motivate all manner of experimental interventions into fundamental geophysical processes. But we are not there yet; technoplanetary salvage is as much a present-day movement as it is a future destination. And so, put differently, just as the proponents of technoplanetary reasoning presume that there is no time left to wait to reengineer the earth neither do social scientists need to wait to ask: why, how, with what effects, and for whose benefit?

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Ten years ago, the push for whole earth re-engineering seemed more an idea than a reality and it was in this context that Latour and a number of other humanistic and social scientific critics articulated a range of counterarguments (e.g., Crist 2013; Latour 2015; Hamilton 2016; Heise 2016; Szerszynski 2016; Wuerthner, Crist, and Butler 2015). Time has not diminished their salience. At the time, technoplanetary reasoning had different names and centers of power: ecomodernism, the new conservation science, and ecological intervention are the three most readily identifiable; the last still dominates reef studies. In a few lines, and adopting their language, here is their position: because climate change either already has or soon will push many ecosystems beyond known tipping points at the whole earth scale thereby compromising their capacity to recover and restore functional pathways (aka "resilience"), and because humanity is historically responsible for this state of affairs, there is urgent need to engage in climate adaptation experiments at the whole of ecosystem scale with all available epistemic, economic, and political means (aka “building resilience”). In short, there is no more cause for restraint when it comes to how best to care for environments hitherto deemed “wild” or “pristine.” As I say, and in what amounted to something of a redux of the Anthropocene debates, many critics disputed this line of reasoning: the presumption of human mastery over nature, the wholesale dismissal of human difference, the fantasy of historical rupture, and so on and so forth. Nevertheless, technoplanetary salvage is underway.

Let me mark one line of counterargument, namely, the fantasy of historical rupture. Central to the case for technopolitical salvage is the notion that history now gives humanity no choice but to embrace a radical new future of experimentality. This argument is based on the scientific consensus regarding the ongoing and accelerating diminishment of planetary life (here again, the IPCC reports and projections are the authorizing point of reference). Yet it also installs a profound antagonism towards historicity as, at base, a compelling record of human failure when viewed at the whole earth scale rather than, for instance, grounds for forgiveness, reckoning, inspiration, accountability, or, broadly put, practical and moral reasoning about how to know what to do to go on in difficult times. That such an attitude towards history is presentist in the extreme is one thing. But it also verges on delusion: earthbound subjects exist in historical not geological time and, as such, we act by virtue of our relationship with other historically coexisting forces. If the fantasy of technoplanetary mastery that this movement chases is not so much amnesiac nor utopian but “uchronic,” to borrow Latour’s (2015) helpful phrase, then what this manuscript examines is why, how, and with what effects does this conception of historicity make its way into the world. One way I do so is with a simple substitution in terms.

Throughout this manuscript, I avoid embracing “climate change” as a diagnostic and instead avow a description of the communal life of “earth distress.” I understand earth distress as the historical condition of shared existence in the shadow of the ongoing, accelerating, and chronic diminishment of the conditions of possibility for human and more-than-human flourishing. Earth distress owes its momentum, in no small part, to the cumulative and cascading effects of technoplanetary reasoning. And yet, precisely because earth distress describes a historical condition and not an epistemic object à la “climate change,” the fact that a would-be reparative version of technoplanetary reasoning may only gain further dominance in years to come does not make it (i.e., technoplanetary reasoning/salvage) somehow distinct from earth distress but simply more intimate with and responsible to it. I see the avoidance of “climate change” and avowal of “earth distress” as one and the same move. The aim is “therapeutic” in that it invites a renewal of practical, ethical, and affective dialogue in dark times, a notion I borrow from philosopher Stanley Cavell and his reading of the work of Ludwig Wittgenstein.

Why “earth distress”? It marks a phenomenon that is: 1) earthbound, *i.e.*, ultimately bearing upon local and global history even if its scientific description derives from the planetary scale; 2) affecting, *i.e.*, unamenable to impassive or externalist description; 3) disruptive, *i.e.*, a pressure that strains the physical, cognitive, and affective relations between forms of life; and 4) chronic, *i.e.,* a historical condition that earthbound beings endure to varying degrees of banality and difficulty and do not simply experience in the eventful temporality of disaster and recovery. Of course, earth distress has many names: the greenhouse effect, global warming, global heating, global weirding, climate change, climate crisis, ecocide, the sixth extinction, and so on. Each of these expressions has a history and a use. I avoid “climate change” for three of its narrowing effects. The first is epistemic, namely, the term is embedded within an idea of nature as a system given to homeostasis and/or state change. The second is historical, the term was the creation of Republican strategist Frank Luntz who, working for the administration of George W. Bush, suggested it as "less frightening" than global warming. As a psychopolitical tool of liberalism, the term has sown confusion and created the impression that if earth distress is anything it is available to orderly political deliberation. Mark, for instance, the long-held hope that "climate action" would follow from a structured and resolved debate between so-called climate alarmists/realists and climate skeptics/deniers. I have come to understand that waiting for, longing for, or craving such a confrontation does not point to the resolution of earth distress but is a psychosocial expression of it, not a way out of but rather into it. The third is conceptual, namely, that climate change is best understood and therefore responded to at the maximal scale of deep time and the whole earth, which is both a challenge to and a repudiation of the phenomenology of ordinary human existence. Throughout this manuscript, sometimes with direct commentary, I use earth distress to resist these narrowing maneuvers. "Climate crisis," an increasingly prevalent idiom, suggests another route of resistance and yet its second term deserves closer commentary.

2. Interpreting Coral Crisis

To say that we live in times of crisis is to say that our lives, as a flow of experience, are as if surrounded by and saturated with thoughts, images, talk, and feelings of a world going awry. One difficulty this presents is learning how to distinguish between the urgency of what is happening "out there" and the urge to describe, relay, and adjudicate "for ourselves" what is happening as if to put things aright. One is the presentation of crisis, a sense of collective threat, and the other the representation of crisis, a proposal—and this it can only be, so long as crisis looms large—for an adequate collective threat response. Consider the long-predicted collapse of the world's coral reefs.[1] Beyond reporting that reef-building corals are dying in rapidly warming oceans, marine scientists, government officials, and lay advocates motivate these reports by interpreting why such dying matters. What is the case to be made from dying corals? Why is crisis conveyed as something you interpret?

Close to a century ago and in a very different context, psychoanalyst and neurologist Sigmund Freud confronted what, from a certain aspect, appears to be a similar difficulty in the sleeping mind. Observing that the world of dreams tends to come across as strange and disorderly to the dreamer, he prescribed a method of interpretation. It involved redescribing the characters and objects and scenes and stories within dreams, their "manifest content," in terms of the waking concerns that they enigmatically convey, their "latent thoughts." The right interpretation would yield insight into the wants, frustrations, tastes and worries that form the backcloth of the dreamer's workaday life yet which, for some reason, they choose to express within a resolutely confusing dreamscape. Crucially for Freud, the analyst's task was not to offer this interpretation but solicit it, in conversation, from the dreamer themselves for they alone were capable of sensing the proper fit between the manifest content of their dreams and the latent thoughts they held onto (Freud 1917; 1977). Neither dreams nor crises can be understood as strictly personal or collective phenomena—what Freud calls the unconscious is, by definition, transindividual. This ambiguity of subjective reference marks their potential to occasion ethical

[1] For an authoritative scientific description, see: "The Coral Reef Crisis: The Critical Importance of <350 ppm CO2" (Veron et al. 2009). Mark the doubling of crisis: first as a noun ("the crisis") pointing to a present-day threat and then as an adjective ("the critical importance") pointing to a threshold beyond which lies chaos. There is the crisis *of living in a world with* dying corals today and the horizon of a graver crisis *of living in a world without* corals tomorrow.

as well as moral uplift.[2] Indeed, to describe the loss of the world's coral reefs as a planetary crisis is to submit, in so many words, that it is a waking nightmare for all. Let me rephrase the questions that open this section: what point—epistemic, political, moral—does an emerging technoplanetary coral reef thought collective make by arguing that the slow death of corals in the historical present *should* be seen as a crisis?

One way of understanding technoplanetary reasoning is by way of the distinctly interpretive attitude it takes towards global nature. The fact that (coral) crisis brings urgency while (coral) interpretation takes time suggests a conceptual slippage and so an opening for anthropological inquiry into the internal tensions (epistemological and sociological, yes, but also metaphysical) proper to this version of "climate action." This manuscript demonstrates how a loosely coordinated thought collective understands and represents coral reefs as auguries of decisive planetary change. [3] Representation, here, carries the twofold meaning of faithfully depicting coral reefs to some interested public and of standing in for coral reefs to advance good faith moral or political claims in their name. Yet insofar as the coral reef crisis is the premise for concluding that the human condition is bound up with the planet's fate, the (indirect)

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[2] Freud's method of dream interpretation was avowedly dialogical and refused generalization, yet that is not to say it is individualistic in the conventional sense. Moreover, Freud hardly shied away from collective analysis (e.g., Freud 1975). In the anthropological tradition, how and why dreams become shared are important questions (both for so-called moderns or not) (Levi-Strauss 1963; Graham 1999; Miyazaki 2006; Mittermaier 2015; Taussig 2004). A personal dream can lay the groundwork for crisis resolution (Lear 2006) just as a shared dream can generate personal crises (Samuel 2012).

[3] "Thought collective" is intellectual historian Philip Mirowski's expression, which he borrows from Ludwig Fleck's social history of scientific facticity. Mirowski uses the term to refer to the "intricately structured long-term philosophical and political project" that developed and disseminated neoliberal ideology (Mirowski and Plehwe 2009, 426). I do not make the same claim to historical continuity or containment. The web of social relations behind the technoplanetary salvage is sometimes defined, sometimes loose, and sometimes incidental. My use of "thought collective" is intended to underscore that this way of knowing coral reefs: 1) is not representative of all coral science; 2) is not authored or authorized exclusively by scientists; 3) is potentially antagonistic towards other ways of knowing coral reefs, to which some of its members may remain attached; 4) makes claims about what coral reefs are and are good for in the service of broader social, cultural, and political aims; 5) and so, in a word, portends a new settlement between people and corals, science and society.

representation of reefs is not only self-interested but also self-invested and therefore something like (direct) participation. This is another slippage and opening for inquiry; let me highlight it by reworking a phrase of Raymond Williams': the coral representative *is* the coral image.[4] By freighting would-be dying coral reefs with such questions as "What is earthly life? What does it want? What can we do for it?" the thought collective I examine recruits publics to a way of knowing planetary nature as fragile and, at the same time, to a way of desiring technoplanetary salvage. In so doing, interpretive technoplanetary reasoning voids the conventional terms of so-called modernist scientific authority—namely, knowing observation of nature as a reality external to human affairs—the better to gain traction within ongoing disputes over the politics and ethics of "climate action."[5]

I describe this tense situation in which the future of planetary reef studies and global nature come together into question as *knowing in prognosis*, an expression I borrow from Jain's (2013) study of cancer as a total social fact. Because interpretive technoplanetary science is motivated towards salvage, it presumes non-indifference to its object. What results is a way of knowing coral reefs that exceeds descriptions of discrete forms of damage and loss and, instead, aspires to lay the groundwork for "climate action" at a total scale. What this betokens is not just the possibility of redressing the diminishment of coral life but also addressing the human condition—its political institutions, affective dispositions, and ethical compunctions—to urge a technoplanetary agreement in the name of a less distressing future natural history. In order to draw these postpositivist dimensions into relief, each of the chapters of this dissertation shades in

[4] "The political representative is the political image," wrote Williams (2015, 206).
[5] The question of whether the avowedly dispassionate modern scientific project is achievable or self-coherent has been widely discussed and, what's more, largely resolved in the negative (Daston and Galison 2007; Haraway 1988; Feyerabend 2010; Latour 1993). Nevertheless, it remains the case that this description of what modern science aims at—a positivist, objective and culturally unmediated description of the non-human world—retains considerable force both for what scientific actors expect of themselves and others expect of science.

an aspect of knowing that exceeds a narrowly rational description of coral reefs as observable entities. These are: knowing as relating (Chapter 1), knowing as absorbing (Chapter 2), knowing as synthesizing (Chapter 3), knowing as luring (Chapter 4), knowing as bewildering (Chapter 5). If this gerund stacking is disorienting, I might say that the present introduction has been centering knowing as mediating to begin to establish why and how coral reefs became exemplars of planetary crisis in the early 21st century and thus the ideal fuel for a burning desire for new forms of planetary agency. Before discussing this more fully, some final words on interpretation.

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Interpretation, in the most general terms, refers to an act of explanation, clarification, or translation. It is often associated with humanistic inquiry, wherein literary studies, art criticism, or the social sciences take up some seemingly circumscribed entity (e.g., a text, an image, an event, an interaction) as an opening onto some broader horizon of existence (e.g., a literary style, a perspective on nature, a cultural inheritance, a power dynamic). It is also, as suggested earlier, a centerpiece of the psychoanalytic tradition. To interpret is to propose a way of seeing and of telling something "as it (really) is" and therefore to run the risk of "getting it (really) wrong." The parentheses are (really) important as they mark the way in which interpretation aims less at truth as certainty than truth as clarity, which is to say an encounter with reality whose stability involves a degree of projective imagination on the part of those involved in interpretation. Indeed, not for nothing is divination another vital and transcultural domain of interpretation. Similarly, in the example of Freudian dream analysis, the interpretive success depends upon a felicitously tense dialogue between analyst and analysand. Interpretations, in other words, are open to interpretation.

Interpretations take a position, and in so doing motivate a discussion of what is just, good, beautiful, and true (Mitchell 1983). This makes for a contentious undertaking. Because what is at stake in an interpretation is not only our understanding of some object but also of our/selves and how the two relate.[6] For a case in point, consider this chapter's epigraphs. The late Australian poet and conservationist, Judith Wright, elevates coral reefs as figures of wonder and authority whose mighty beauty reveal the monstrosity in human nature. The US scientist Bob Richmond, conversely, lauds the union of human and coral needs and deeds. Because both imply that observing coral reefs can yield insight into human potential, moral virtue, and the grounds for action, they illustrate visual activist and media scholar Nicholas Mirzoeff's claim that, today, humanistic *and* scientific inquiry meet earthly life in the spirit of interpretation.

Before turning to the mediations that connect fragile coral reefs to the planetary scale, some elaboration of Mirzoeff's remarks is in order as it will help gain traction on how and why to track the historicity of technoplanetary salvage. His headline claim is that recent disagreements over the proper periodization of the so-called Anthropocene[7] have empowered geologists and Earth systems scientists to embrace interpretation at the expense of the would-be apolitical practice of empirical description. Debates about whether to periodize the Anthropocene from, for instance, the Columbian exchange in 1492 or the advent of the steam engine in 1784 or

[6] First, the slash here marks the fact that this subject may be individual and/or collective. Second, if interpretation is fraught with the possibility of misinterpretation, what is threatened is not simply my knowledge of an object but my knowledge of knowing, my ability to know anything at all. Stanley Cavell makes this point forcefully in his contribution to the abovementioned volume (Mitchell 1983, 181–202). It follows from the possibility, after psychoanalysis, of splitting the subject of interpretation: the usual picture holds that it is we who interpret a text (or an image or a crisis), an equally plausible picture is that we can use a text (or an image or a crisis) to interpret our/selves. At the risk of making things too pat, this dissertation uses the crisis interpretation of coral reefs in order to redescribe (i.e., offer an interpretation of) the historical necessity of technoplanetary reasoning today and so unsettle its hold.

[7] In broad terms, the Anthropocene refers to the era of earth history during which human beings became capable of large-scale terraformation. For a thorough conceptual history of the Anthropocene, see (Bonneuil and Fressoz 2016), and for a review of its uptake and contestation within anthropology, see (Mathews 2020).

the United States' Trinity nuclear test in 1945, he argues, only appear to address a value-neutral question of historical timing: "When did human beings achieve the power to remake the planet?" In reality, however, these different periodizations are differing interpretations that aim at deciding value-laden questions about the telling of history, such as: "How deliberate must some set of actions have been to amount to 'geological agency'? How universal must the responsibility for carrying them out have been to indict humankind as a geohistorical species? How distinctively human must their reverberating effects have been to signal a shift in planetary power relations?" In taking up these questions, albeit indirectly, scientific knowledge serves to *not only point out but give reasons for historical change at the planetary scale.* The result is a metanarrative wherein the desire to document and explain the whole earth's history as an abstract human struggle to acquire planetary agency overwhelms existing inquiries into the contexts, causes, effects and inherent unpredictability of concrete historical episodes. Paradoxically, and perhaps all the more so in submitting the placement of the so-called "golden spike" to debate, if the Anthropocene concept enshrines the "geological agency of humankind" it does so in the form not of a "mastery of nature" but a masterfully ahistorical "non-mastery of nature." This all but invites the possibility of a redemptive rejoinder in the form of a remastering of what time remains. Hence the warrant frequently proffered for technoplanetary salvage to the effect of "because humanity has caused this, now we have to fix this." *Put directly, a particular interpretation of historical time is the basis for the uchronic problem-solution approach to earth distress.*

Thus, while the Anthropocene appears to be a heuristic for periodizing a shift in geophysical dynamics, what subtends it is a desire, forged in the crucible of furious scientific agreement over the present-day reality of an earth in distress, to interpret world history once and for all. Although initiated by a minority of specialists in formal stratigraphic deliberations, academics from all disciplines, environmental advocates, writers, artists, and media actors have relayed the Anthropocene concept and its twinning of scientific diagnosis with historical reckoning—an indication of the allure, variety, and ambivalences of this "new cultural formation" (Mirzoeff 2018, 140). My purpose is not to evaluate the adequacy or absurdity of the Anthropocene concept. Because if the so-called "Age of the Anthropocene" is less a name for the historical present than a historical metanarrative, then it is ready-made for disagreement.[8]

As I will shortly demonstrate, coral reefs mediate global nature *as* the earth has become distressed (i.e., in continuity with geohistory and not abstracted from it retrospectively as a recently acquired diagnostic). Nevertheless, the continued and widely circulated documentation of the sensitivity of coral reefs to variations in geophysical conditions has cemented their cultural (and not just empirical) status as an early warning system for planetary change. To wit: as go the world's coral reefs, so go the oceans, so goes the planet; the climate crisis can be redescribed as a coral reef crisis. Yet just as there are sound scientific reasons for interpreting large-scale shifts in coral life, so too there are sound humanistic reasons for interpreting large-scale contests over what to do with coral science in a distressed and distressing world. What do I gain from "knowing" that everything is on the line? Towards or against what and whom do I direct my last breath? In the last half century, one of the signal contributions of the history, philosophy, and anthropology of science has been to track and decode the constitutive entanglement of science and society. I have been suggesting that technoplanetary salvage appears to avow this entanglement while nonetheless downplaying the politics implied as so much prevarication

[8] The "original" reference point for the concept is a paper from atmospheric chemist Paul Crutzen and freshwater biologist Eugene Stoermer (2000). For some a sense of how social sciences scholars have reworked the concept towards different epistemic ends, see Hamilton (2016), McBrien (2016), or Parikka (2014)..

before the shared historical fate of humans and the planet. It is precisely because there is nothing self-explanatory about what to do with a terminal diagnosis, planetary or otherwise (Farman 2017; Jain 2013; Solhdju and Rivières 2021), that interpretation arises as a political, moral, and cultural problem. The questions and methods of the social scientific study of the sciences therefore stand renewed not diminished before technoplanetary reasoning. This requires, however, a continued commitment to brushing science and technology against the grain even as these fields consolidate their empirical authority as a matter of existential, planetary import. In this sense, by following the science of coral crisis and its social uptake, I examine the inherent instability within technoplanetary reasoning and action of which, it might be said, the Anthropocene debate is but one, now familiar and high profile, expression.

With the force of interpretation in mind, I can now pose the coral crisis as a conjuncture of geophysical *and* geopolitical uncertainty. At issue is, on the one hand, the gradual degradation of the world's coral reefs because of ongoing and accelerating ocean heating and acidification. On the other, there is the imaginative projection of this same degradation, the question of its broader meaning, and thus the material for an emerging thought collective to promote global social change.

3. The Planetary as Politics of Lack

Scholars of the social life of science and technology have demonstrated that empirical knowledge of the natural world arises through and depends upon mediation. This means that irrespective of the truth status of the claims that scientific communities make about why the physical world is as it is and does what it does, social forces drive the process of learned inquiry itself (Fleck 2008). Scientists develop ways of inquiring into the properties and abilities of living entities, physical forces, chemical reactions, or sensory apparatuses strategically (Feyerabend 2010). They appeal to shifting theoretical and practical standards of truth in the process (Kuhn 2012), and thereby embrace the agonism of collective deliberation in the pursuit of epistemic authority (Latour and Woolgar 2013; Latour 1986). In the process, the prevailing criteria of what makes for "good science" trope on shifting public mores and ideals of ethical conduct (Daston and Galison 2007). As such, natural history and human nature are moving targets that coevolve according to assumptions whose basis can be described as historical (Hacking 1983), ideological (Haraway 1989) or as metaphysical (Collingwood 1960).

Alongside and often in conversation with such work, anthropologists and political theorists of modernity have established the central role that knowledge plays in giving shape to the nature and domain of power. A number of scholars have paid special attention to the expanding domain of the so-called "life sciences," whose modes of taxonomic, medical, statistical, and legal reasoning generate concepts, classifications, norms and exceptions that simultaneously describe and prescribe the conditions under which people come together and come apart.[9] By tracking the explanatory reach of the biosciences from the 18th century onwards, they show how a distinctive conception of life developed alongside and helped to propel modernity from a distinctively North Atlantic mode of social organization to a globalized and globalizing meshwork of science, law, economics, and historiography (e.g., Hacking 1998; Foucault 1990; Franklin 2007; Jasanoff 2010; Sunder Rajan 2006). At the same time, modernity was always already the byproduct of repeated encounters and interactions with its alleged others, historical subjects whose status as full participants in the North Atlantic tradition was always and

[9] This periphrase is an alternative to the shorthand of "social life," an expression that shows how conventional it has become, even (or perhaps especially) in the social sciences, to reach for "life" in order to describe dynamic, ordinary, and worldly experience.

often violently in question, which questioning was itself a historical precondition for the consolidation of the North Atlantic tradition's self-understanding as timeless, universalizing, and authoritative (Trouillot 2002; 2003).[10]

In this view, life is not the force or principle through which human and other than human entities manifest their existence.[11] Instead, it is a dynamic capacity whose "fundamental" properties (such as complexity, speciation, vigor, finitude, regeneration) the biosciences can, restlessly and relentlessly, sound and measure without ever, once and for all, surrounding as a metaphysical force. Biology, then, might not coincide with either life "itself" or the study thereof. Rather, it is the web of connections between these two domains, which achieves dimension and resolution through successive stages of description, explanation, and revision (Canguilhem 2001; Matlin 2018; Hans-Jorg Rheinberger 1997). As a biological subject, life is given to simplicity or complexity, normalcy or deviation, growth or decay. And, as a dynamic capacity and biological given, life became the often-unquestioned basis for social, economic, and political processes that govern self-fashioning and group formation (Foucault 2003).[12]

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[10] The questions of when modernity begins or ends, what it eclipses or doesn't, whom it includes or excludes are inextricably connected. As Trouillot (2002) explains, the hegemony of modernity as a North Atlantic universal depends upon the erasure of the historical particularity of its own emergence. Not only does this direct attention away from the concrete and often violence history of othering within modernization. It obscures, in the process, the fact that, as a relational practice, othering not only pitted "moderns" against "nonmoderns" according to the terms of a subjugating fantasy of historical superiority, but also "nonmoderns" against themselves according to a subjugating reality of historical rupture. The result, Trouillot writes, is that: "Modernity creates its others—multiple, multi-faced, multilayered. It has done so from day one: we have always been modern, differently modern, contradictorily modern, otherwise modern—yet undoubtedly modern." (233) For another foundational elaboration on splitting of the colonized subject and the historical misreading that well-meaning moderns give of it, see Fanon (2008).

[11] Such a conception of life does not disappear from the world entirely. It is retained as an historical archetype of "premodern" notions of life, yet also grounds the Romantic tradition whose "(post)modern" offshoots include Marxian theory (e.g., Moore 2015) and psychoanalysis (e.g., Irigaray and Marder 2016). The question of how these two conceptions of life relate in the aftermath of modernization is therefore a complicated one; see Anidjar (2011) for an important discussion.

[12] For a powerful example of the biologization of politics and the politicization of biology, see (Nguyen 2010).

The desire for governance of earthly life is, I have been suggesting, one of the hallmarks of the planetary. The planetary denotes a way of seeing the world—teeming with organisms, weather systems, topographies, machines, institutions, ideologies, interdependencies—as a dynamic yet unified totality whose temporal and spatial coordinates cannot be plotted on established axes of human historical and geographical development in time.[13] The planetary is not planet earth. It is an attitude towards or an awareness of the planet as a totality available, *perhaps only aspirationally*, to reorientation.[14] The planetary is a scale at which to depict, study, explain, interpret, exploit, destroy, or repair large-scale forces that precede, exceed, yet continue to seed the conditions of possibility for human history-making. Such a way of seeing and its associated ways of acting commingle with, indeed depend upon, other than human entities and energies that outmaneuver embodied human experience.[15] Here are some examples: petroleum reserves and the drilling technologies that produce them; weather systems and the meteorological reports that track them; migratory corridors and the creatures that fashion them; financial crashes and the housing stock that underwrite them; distressed coral reefs and the cascade of geophysical

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[13] "A planetary imaginary includes globalities of every kind (finance, technology, international relations) but also the earth system (geology, atmosphere, glaciers, oceans, and biosphere) *as one totality*. What is increasingly powerful about this point of view is that it both relies on the national security state for the technologies, finances, and interests that create the possibility of seeing in this fashion, but also, *in a single gesture*, exceeds the nation state as the political form that matters" (Masco 2020, 17–18)

[14] Lachlann Jain's mesmerizing picture book, *Things That Ar*t, might help clarify the correspondence I am seeking to avoid. They write: "a science drawing ... purports to have two components: the thing and the label, each illustrating the other. *Spleen* labels spleen and vice versa: once you recognize it, you can remove it. The authority of science lies in part on the dual reference of saying and seeing for yourself" (Jain 2019, 103). In saying that the planetary is not the planet, I mean that the planetary is not something one draws, points to, or apprehends as a representation. In this sense, it is more akin to a style of drawing and hence a style of reasoning.

[15] I borrow the verb "outmaneuver" from biologist Stephen Jay Gould's aphoristic take on evolution in "nonmoral" terms, cited by Hugh Raffles: "Caterpillars are not suffering to teach us something; they have simply been outmaneuvred" (Raffles 2011, 69). By "energies," I refer to the sense in which the other than human entities through which humans access the planetary appear to be, to some degree, autotelic. Energy, in this sense, is not a dynamic potential awaiting harnessing but a form or aspect that already implies a "finished" project. Put differently, energy is as energy does, not only in use but also at rest (Marder 2017). To wit, before being processed into crude, shale oil exists as deposited matter, which achievement results from and indexes a set of bounded interactions with its surrounding stratum.

processes and seafaring kin that depend on them. Coral reefs mediate such a planetary perspective: impossibly complex, incredibly powerful, partially unknowable, and aesthetically alluring. The Great Barrier Reef, moreover, appears to offer a further condensation thereof: historically identifiable and geographically circumscribable. Precisely because the planetary presumes something like the ability to gain access to the magic of scaling, what makes coral reefs available to planetary thinking is, as we shall see, a constant oscillation between the diminutive and the monumental.

Figure 2. The first photo of Earth from space by a human camera operator is often pointed to as a catalyst for planetary consciousness-raising. This owes, in part, to the runaway success of a 1966 button campaign by Stewart Brand, a deep ecology evangelist, editor of the Whole Earth Catalog, and present-day booster of technoplanetary salvage. The buttons were inspired by an LSD trip and simply read: “why haven’t we seen a photograph of the whole earth yet?” (Source: NASA/JSC)

Here is another angle of approach. The deep oceans and deep space are two practically distant places and yet, curiously, they are often drawn together by technoscience as similarly remote and inhospitable "extremes." This holds rhetorically, in descriptions of sea creatures as "alien" life or underwater diving as a journey into "inner space," and practically, in the technical development of non-terrestrial habitats or of the mental and bodily techniques required to labor off world (Bright and Kimmey 2021; Helmreich 2009; Lykke and Bryld 2000; Olson 2018; Valentine, Olson, and Battaglia 2012). The possibility of triangulating, however temporarily, the human condition into such places therefore often gives rise to generalizations that manage, however tendentiously, to displace the friction inherent in social organization. A case in point is the infamous "Blue Marble," a photograph taken on December 7, 1972, by two crew members of NASA's Apollo 17 and often referred to as one of the most massively reproduced images of all time (Figure 2). The planetary appears as a cliché, an image-surrogate for a potentially transformative encounter with a place we might *all* call home. But it is also as an image-thought that expresses the United States' aspirations to geopolitical hegemony and, simultaneously, the futility thereof. Because no matter how totalizing the American gaze of the would-be whole earth cataloguers, their perspectival mastery lives the unstable existence of a latent image seized in a fraction of a second on a moon a quarter of a million miles from Kansas. In circulation, the photograph exposes the manifest unamericanness of its object, and, simultaneously, the assertion of distinctly American conventions of how to envision the cosmos.[16] Indeed, the fact that the planetary shimmers with parody makes it no less powerful.[17] Because regardless of whether the

[16] Indeed, it might be said that *Blue Marble* illustrates the fickleness of empire, whose claim to supremacy forever depends upon the persistence of a form of difference to annihilate (Luxemburg 2015).

[17] Consider that the dynamic I am describing recalls the rules of the game of marbles, alluded to in the photograph's title. No matter the pride a player takes in the individual marbles that make up their collection, each one becomes a generic weapon in the struggle to displace and thereby gain possession of their opponents' marbles in the circle of

planetary delivers on a promise of common origins or total mastery—who "we" are and where we "are going"—it remains a mode of awareness that inspires projects of extraordinary ambition, commits as yet undeveloped resources, produces novel institutions, challenges sovereignty, refashions publics, and so forth.

Consider, for example, the twenty-first century corporatized U.S. space race, the ongoing "clean-up" of the fallout from the Fukushima meltdown in the Pacific, the geopolitical implications of China's Roads & Belt initiative, the coordinated yet unevenly distributed development of COVID-19 vaccines, or the claims of petrochemical companies on decayed Permian-era reef-building organisms whose ongoing combustion is literally fueling the annihilation of reefs today. Facing the planetary, whether with enchantment (Connolly 2017), dread (Grove 2019) or renewed humanism (Chakrabarty 2019) means reckoning with powers that, on the one hand, eclipse the competencies and decisions of human beings as historical subjects and, on the other, define the conditions of possibility for what life on earth will become.[18]

The planetary abounds in the historical present as the putative grounds from which to visualize, analyze, and respond to large-scale problems that have hitherto foundered due to the difficulties of negotiating historical, political, and cultural disagreement. Earth distress is a case in point. It involves a transformation of geophysical processes legible at the scale of deep time

play. For a similar claim about the gravity of parody albeit in a different context, see Butler (1990)'s discussion of the reality effects of gender identification.

[18] Another way into this configuration is through Donna Haraway's "Cyborg Manifesto" (1988). It is no coincidence that Haraway centers irony as the rhetorical mode in which to understand oneself as cyborg, which she presents as a figure who wilfully transgresses the boundaries of earthbound living in order to make a home in exile from hitherto stable categories of being. If Haraway's implied slogan of "we are all cyborgs now" rings cryptic if not unduly optimistic (indeed, the author herself has since qualified its utopian upshot), it might nevertheless serve as a reminder of the way that seeing the human from a planetary perspective seems often to unmoor thought and action from its more everyday coordinates.

and whose description, from the nineteenth century onwards, invariably implicates human communities and their capacity for coordinated action. Yet, as Joseph Masco observes, precisely what the planetary lacks is a governance structure or a politics adequate to its gaze: "there are not yet political systems operating on the right scale to address truly planetary problems" (2020, 18). Hence, even for scholars who argue that the planetary cannot be understood as a unified whole and must instead be examined as a meshwork of connections between parts, what aggravates a problem like earth distress is an observable and felt lack of "diplomats" (Latour 2017). The planetary, in other words, is marked by a blind spot of collective coordination, which is as the same time constitutive of its historical urgency. *The question arises whether knowing at the planetary scale suffers from a lack of politics or whether a politics of lack is what defines the planetary scale.*

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This lack is discernible in the serial failure of existing supranational processes to render certain problems available to meaningful action at the planetary scale. The effects of earth distress continue to register in unevenly distributed regimes of toxicity, resource spoliation, and habitat destruction. The material forces driving this phenomenon are as persistent and robust as ever, whether fossil fuel production and consumption, land clearing, industrialized agriculture, global aviation, and large-scale infrastructure developments. Meanwhile, rather than challenging the necessity of such forces to communal existence, the majority of supranational programs aimed at local or global "climate action" has tended to vindicate the epistemic and moral authority of these same forces by hitching them to the virtue of measuring global warming as a planetary problem. Consider carbon accounting, footprints, and capture and storage or emissions reduction targets, trading, and offsets or fuel efficiency standards. Many of these techniques, often metaphorized as policy levers or market ratchets, were initially designed and then shepherded into existence by corporate polluters. Yet more significantly, they consolidate the planetary as the necessary scale for doing good deeds in the name of earth distress while directing communities, corporations, and governments away from any mutually transformative political project at infraplanetary scales (e.g., Bonneuil and Fressoz 2016; Bright 2016; James 2020; Lohmann 2016; Owen 2012). More recent efforts to augment planetary measurement with intervention, of which this dissertation is one study, tend also to direct collective energies towards consolidating present-day distributions of power and knowledge rather than, for instance, reckoning with their ravages, confronting the fear of their loss, let alone embracing a social otherwise.[19] Such developments all make the planetary seem crisis prone.

At the beginning of her essential anthropological precis on crisis, Roitman (2014) pauses on the term's present ubiquity and seeming obviousness. As a noun, crisis readily claims adjectives such as environmental, humanitarian, financial, energy, or debt in a way that gives distinct and complex historical events (*e.g.*, the deployment of Soviet missiles to Cuba in 1962 or the Greek government's inability to service its public debt in 2009) a "generic logic" (2014, 3). When used in this way, crisis suggests a way of talking about matters historical and historical mattering *as if* from a position outside of history, wherein a given set of events and the reasoning that led to them betoken profound epistemic and moral disorder. As Roitman writes: "Both prognosis and the very apprehension of history are defined by the negative occupation of an immanent world: *what went wrong*?" (2014, 9, emphasis in original). Crisis thus appears to be a moment when history itself manifests as judgment. This sense of history as judgment invites critique, a cognate of crisis, which is to say a second order judgment on the part of historical

[19] For a powerful discussion of this dynamic, see Jobson (2020).

actors assumed to be alert to yet not captured by crisis, whose interpretive skills might discern sound epistemic and moral bearings for history "after" crisis.[20]

Roitman's text is indebted to the writings of Reinhart Koselleck. He contrasts premodern understandings of crisis as a (divine) test of human virtue in the face of (mortal) worldly unknowability with a modern understanding of crisis as the judgment of history. In such light, crisis invites critique, as an epistemico-moral activity whereby historical subjects describe and recast their predicament in order to move themselves, others, and thus world history beyond crisis. Koselleck argues that such an understanding configures history and historical knowledge in mutual disarray, which presumes "a specific historical consciousness—*a consciousness that posits history as a temporality upon which one can act*" (7, emphasis in original). From a planetary perspective, it is no longer obvious that such a possibility exists. But what possibility is that, historical consciousness or actionable history? This seems to be the conundrum that the planetary offers up, or, should that be, renews. The totality of earth distress and the indeterminacy of interpretation introduce a potent sense of uncertainty to the idea that historical temporality is available to human design—recall the measure of the "geological agency of mankind" is planetary catastrophe, and so the human mastery of geohistory is accident-prone. And yet, at the very same time, earth distress offers a potent sense of clarity regarding the need for something like a heightened consciousness of historical time. The planetary presents a metaphysical puzzle, a "crisis in crisis" (Masco 2020).

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[20] "After," here, refers both to the manner in which crisis appears to demarcate the past from the present, because its onset discloses, to the clear-sighted subject of the historical present, the possibility of retrospectively constituting its conditions of possibility. "After" also refers to the status of crisis as an epistemic resource, a knowledge object, to which the critic turns their gaze in order to fashion a proposed departure (i.e., a break, a temporal future). For a distinction of this doubling and its pertinence to the conceptualization of time in an uncertain present, see (Grusin 2018).

The large-scale problems that define the planetary, shot through with the reality effects of other-than-human forces, defy human understanding and decision-making as an enterprise seeking to cleave history past from future possibility. They suggest an estrangement, if not outright divorce, of knowledge of the world from action in the world. The emerging diminishment of life at a planetary scale as a result of earth distress and the felt desire for climate action are thus two sides of the same coin.

In the early years of the Apollo missions, Hannah Arendt (1963) anticipated the pressure that technoplanetary places upon self-understanding in a bracing essay on the space race and its abiding technics. She notes that the theoretical and experimental advances of cutting-edge physics and biology have assuredly expanded the conceptual and technical reach of humankind, yet they do so by reaching "behind" and "beyond" the common sense and everyday experience of reality as it resonates with embodied and minded human beings. This form of knowledge does not just drive a wedge between scientists and non-scientists, experts and lay persons, such that the former have the terms and tools to explain reality where the latter do not. Instead, Arendt argues, the scientist is, also, wedged out of reality. For while these new explanations may come to life in the lab or on the page, the scientist cannot give themselves over to them fully without abandoning "the same world of sense perception, of common sense, and of everyday language as [their] fellow citizens" (530). They embrace a "power of understanding" befitting the needs of their research subject at the expense of their own faculty of "human understanding." What results is the paradoxical achievement of a form of knowledge of reality as action at a distance from human reasoning and communication.

This is knowledge of our world as driven by forces and processes that can be sounded scientifically with precision not despite but because of the fact that our experience of them can only ever be indirect. To illustrate: however "advanced" in scientific terms, the world according to Schrödinger's cat is inaccessible to the stuff of everyday experience in a way that the world according to Newton's apple, however apocryphal the tale, is not. In devising ways of extending technical and descriptive purchase upon this world, scientific practice devises ways of acting that do not resolve but simply consolidate this deficit. As Arendt writes: "man can *do*, and successfully do, what he cannot comprehend and cannot express in everyday human language" (531). It is important to underline that there is nothing historically unique to pushing knowledge beyond the bounds of what is ordinarily available to consciousness. Indeed, action at a distance is one of the defining qualities of magic; the "paranormal" is, precisely, a mode of encounter. What does appear distinctive, to be brief, is the embrace of technoplanetary knowing as a mark of historical progress irrespective of the dangers such powers bring when made pervasive, persistent, and permanent within ordinary life, as in their consolidation in technologies of military power, industrial labor, and bureaucratic accounting.[21]

What does such a slippage of technoplanetary knowing and doing look like? Here is one example: through a process dubbed bioaccumulation, toxic chemicals introduced in one organism travel to others and across generations, their potency persisting if not increasing as a result (Carson 1962). "Slow violence" is what Rob Nixon (2013) calls the gradual and often invisible toll of such cascading damage, which unravels ways of living without a seeming single causal origin. Or consider another planetary object: high-frequency trading. This technique of financialized capital exchange obeys the clock time of global trading infrastructures and so

[21] I can make this distinction plainer by pointing to one relatively contemporaneous example of learned inquiry within the North Atlantic tradition that eschews the phenomenology of everyday life. Psychoanalytic practice has long been sensitive to the dangers of activating the unconscious, which dangers it has always made the express object of inquiry and interest. Crucially, it has not done so as out of "mere" epistemic virtue, but because of a sensitivity to the distinctly human propensity for aggression, destructiveness, shame and other negative emotions. For one book-length example of this method of precaution as an ethical practice and not an abstract principle, see Lear (2015). And for a case study, see Winnicott (1947).

hitches market movements and their effects to a set of actions calibrated to the capabilities of human-machine assemblages that scramble the perceptual capacities of even the fittest financial analysts, let alone the downstream bearers of debt and credit whose fortunes are tied to the ensuing maelstrom (MacKenzie 2021). This might just be what alienation looks like for the actuaries of finance capital and so a version of what Lauren Berlant (2011) calls "cruel optimism," the signature of contemporary relations to capital, wherein the object of one's desire turns out to be an obstacle to one's flourishing.

The psychodynamic play of creativity and destructiveness coursing through these examples is not unique to the historical present. My point is, rather, to suggest that the planetary perspective invites something more than an abstract picture of *what* is happening and instead an account of *why* something is happening, which is to say something in excess of a narrowly rational understanding of reality as some content independently available to objective description.

4. Corals in Space and Time

It is time I presented my object and methods of my inquiry and reviewed this manuscript's chapters. I have been suggesting that the planetary is a way of seeing earth distress and that there is something eminently and immanently excessive to this gaze. The planetary, in this sense, appears to tap into something proper to the human condition that is often elided by technoscience, namely a narrowly rationalist perspective on reality as independent of subjective judgment and, thereby, available to normative adjudication. Philosopher Alice Crary (2007; 2016) refers to this as "restricted objectivity" characterized by a requirement that proper knowledge of reality be abstracted from the practical sensitivities of the knower; historians of science Peter Galison and Lorraine Daston might characterize this as the "aperspectival objectivity" (Daston 1992) of scientific inquiry in the age of mechanization. Criticism of such modes of understanding abound, but what the above discussion of interpretation and the planetary attempt to bring out is that technoplanetary reasoning itself might, by virtue of its resistance to time and space as historically conditioned and conditioning categories, be especially prone to the nonrational. For this reason, in addition the anthropology of science, technology and environment, the present manuscript leans upon media studies, psychoanalytic theory, and so-called ordinary language philosophy. These disciplines present the advantage of being collocated in time and space with the forces of technoplanetary salvage at issue in this dissertation (e.g., coral reef studies, post-war conservation biology, market economics). Thus, they are especially useful for opening up the potential for dialogue with the looping effects at work in the desire for technoplanetary salvage.

This dissertation's argument is a variation on a long-standing preoccupation with crisis, the planetary, and more-than-human encounter within coral reef studies. There is a renewed interest in studying coral reefs and the people attached to them within anthropology and history, notably as a response to their precipitating decline. A recent monograph on 21st century coral reef science by legal scholar Irus Braverman groups scientists into largely opposing emotional camps, one whom earth distress drives towards despair and the other whom it drives towards hope (Braverman 2018). While I admire this work's powerful analysis of these scientists' labors and aspirations and share many of the same interests, I am pursuing a more tendentious reading of the "hopeful" upshot of Braverman's inquiry to push on the underlying shifts in the understandings, practical uses, and politics of global nature so implied. My sense is not so much that Braverman "picks sides" and does not give despair a fair airing. If Braverman sides with anyone it is rather with “corals.”[22] This dissertation does not trash corals. Indeed, I am rather trying to take very seriously the possibility, argued from hope as from despair, that corals are already trashed. But on this basis, then, there are questions to be asked about why and with what consequences this makes corals useful and useable. “Despair” and “hope” may oscillate within coral science in relation to earth distress as an existential threat to coral biology. However, from the moment that coral biology becomes available to technoplanetary salvage, it is not obvious that these are the operative emotions to track. Instead, hope comes to mediate a newly indeterminate relationship between humans and corals, which relationship is intended to stave off despair vis-à-vis earth distress. The practical and moral consequences of this (circular) movement are the subject of the present dissertation.

The difficulty of seeing was a commonplace among presenters at a recent panel at the annual conference of the American Anthropological Association, co-organized by Aida Sofia Rivera Sotelo and Annet Pauwelussen. Discussing her fieldwork in Columbia, Rivera Sotelo (2019) explained that she has come to view corals as inextricably connected to *bajos*. These are fertile fishing waters that one does not sight visually but must sense through material and embodied practices. Cameron McKean (2019), also working on the Great Barrier Reef, described shifts in the scientific gaze as it has scaled over time according to shift dimensions from geology, to biology and then to chemistry. But this visual slippage, the tantalizing beyondness of coral reefs, is not restricted to the scientific gaze. McKean went on to relate his experience guiding tourists on dive trips and how, underwater, they would repeatedly signal their confusion by hand before surfacing to voice their disappointment: “but we came to see *the* Reef, did we see it?” I

[22] As the next chapter will detail, this is a position to which planetary coral science thought collective—which here might include both Braverman’s interlocutors and the author herself—are actively recruiting global publics.

will shortly review this dissertation's chapters, and as will be clear not all of them look to address "The Reef" directly. This is a formal choice on my part to try to track, in my own way, the beyondness I have been discussing—whether to push back against the ahistoricity of technoplanetary salvage, or the territorialization of the Great Barrier Reef Marine Park Area.

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The jurisdictional existence of the Reef as something not only available to but also predicated upon (if only implicitly) the authoritative claims of coral reef science and regulatory administration is of relatively recent construction. It resulted from a successful campaign during the 1960s to "save the Barrier Reef" from oil prospecting and drilling that, with no small irony, was also the first nationwide "bumper sticker campaign." The campaign's success was not just owed to its ability to mobilize mass publics, but rather to a fourfold strategy of: 1) using of the latest techniques in computational ecology to make its case that even though the Reef appeared dead in parts it was, as a whole, very much alive; 2) making direct appeals to leading political figures from both major federal political parties during their own holidays on the Reef; 3) leveraging the power of maritime unions to boycott the incoming shipments of oil prospecting and drilling equipment and so, effectively waylay development; 4) emphasizing the unknowability and hence untapped scientific potential of the Reef. It is difficult, in hindsight, to appreciate just how significant a change the gazetting of the Marine Park Area represents both within and beyond Australia; insofar as it marked an early strategic use of the new United Nations Convention of the Law on the Sea to establish a vastly extended Economic Exclusion Zone into the Coral Sea and so environmentalism as a strategic geopolitical resource.

The Australian state's strategic use of the Reef as a political and economic asset has helped consolidate a profitable domestic and international tourism industry, obfuscating prior political economic regimes, and burnish the nation's credentials as a geopolitical middle power with world-leading environmental science and management capabilities. This same global spotlight, however, helps elevate the Reef's status as a canary in the coalmine of earth distress, not least of which given Australia's own outsized contributions to global markets for coal and natural gas and historical status as something of a global resource entrepot, flipping the Reef from a source of pride to a source of shame if not humiliation. For a sense of this, consider that for the past five years the United Nations Educational, Scientific and Cultural Organization (UNESCO) has been considering placing the Great Barrier Reef on the world heritage in-danger list and the Australian government has been doggedly and systematically lobbying against such a listing for fear of the reputational and economic damage that would accrue from the Reef's loss of standing as the "world's best managed coral reef." The very "manageability" of coral reefs is, accordingly, something that this dissertation attempts to provide some understanding of.

This fieldwork builds upon ethnographic fieldwork with corals and the people attached to them that took place over a four-year period from 2015 to 2018, with extended and intensive fieldwork in the Great Barrier Reef region of Australia throughout 2018. I spent time shadowing coral reef scientists, laboratory technicians, volunteers, interns, aquarists and coral husbandry staff, government officials, marine park rangers, conservation activists, media figures, artists, and seasonal laborers to make sense of their ways of knowing and encountering the Reef under conditions of earth distress. I spent extensive time observing work on technoplanetary salvage experiments taking place at the Australian Institute of Marine Science, a federal research agency, and conducted interviews with unaffiliated coral scientists designing and conducting offshore experiments that were inaccessible to observation at the time. I attempted to reconstitute, through interview, some of the emerging professional networks of the aforementioned coral science thought collective so as to understand the personal and organizational commitments behind some of these consolidated initiatives. Key moments of fieldwork were also, as is often the case in ethnographies of professional milieus, the conferences and other formal meetings of the field, which again given the emerging nature of technoplanetary salvage were often instructive for the kinds of sociological experimentation underway as the previously unthinkable became plausible, possible, actionable, and so forth. Finally, I constituted and have continued to build out an extensive archive of scientific texts, papers, articles, slidedecks, but also media reports, letters, images, films, diaries pertinent to the project.

Finally, this dissertation is nothing if not a dialogue with corals and the Reef itself. I would be remiss if I did not remark that this is, in some respects, unexpected. It was with a degree of resistance towards the Reef that I began this research, mindful of its status as an icon of the Australian nation if not to say Australian nationalism. Undoubtedly this resistance also informs the present manuscript. At the same time, I have become, in my own way, embedded and seduced by the corals as an utterly fascinating and fussy form of life. The resistance of corals to knowing in any narrowly rational sense of the word is, for myself no less than for the scientists I have spent time with, absorbing. In getting to know them better, I have been tutored by my fellow anthropologists of coral along with a variety of scholars past and present, especially queer and feminist thinkers (e.g., Hayward 2007; 2010; Roosth 2013; Vaccaro 2015; Wertheim and Wertheim 2015). It is via corals, in many ways, that have therefore come to understand earth distress as a chronic condition and that I have felt compelled to develop a critical natural history of technoplanetary salvage. If this is a multispecies ethnography, it is one that attempts to acknowledge the ways in which power, too, works through more-than-human relations in ways that can require critical scrutiny.

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The dissertation is structured in two parts. The first part explains that coral reefs are good to think crisis with (Chapter 1) and therefore the ideal global media platform for technoplanetary reasoning (Chapter 2). The second part examines technoplanetary salvage through the close reading of an experiment in coral-human evolution (Chapter 3), the transformation of the Great Barrier Reef into a planetary laboratory (Chapter 4), and, finally, the obstruction of political dialogue (Chapter 5).

The first chapter, “Beyond vertigo (knowing as relating),” travels with corals through time to situate them within the North Atlantic tradition of natural history and philosophy. By explaining the persistent albeit shifting status of human-coral relationality over time, corals turn out to be frequent companions in situations of distress and unknowability. Ultimately, I argue that a broadened conception of human-coral relationality that welcomes non-innocence (i.e., symbiosis *and* dysbiosis) can help to highlight the political, moral, and psychodynamic struggles that subtend competing proposals to “do something about” earth distress.

The second chapter, “Absorbing planetary beings (knowing as absorbing),” explains coral reefs function as an exemplar of earth distress in mass public discourse. I show how the effort to organize coral science at the global scale from the post-war years was propelled by a sense of imminent threat to coral reefs from a lack of knowledge, which led to a tight relationship between coral science and management. Through a discussion of the 2017 Netflix film *Chasing Coral* and its deployment by coral scientists to recruit publics to technoplanetary reasoning, I demonstrate how coral science is seeking to directly evangelize a global public even at the expense of its own prior epistemic—and political—coordinates.

The third chapter, “Do corals dream of simulated seas? (knowing as synthesis),” offers an ethnographic case study of a flagship experiment in technoplanetary salvage known as “Assisted Evolution.” I explain the “last resort” theory of coral holobiont engineering and the experimental forms of sacrifice this requires. I argue that by taking on the duty to render reef-building corals permanently available to human assistance, technoplanetary salvage is altering terms of human evolution and extinction.

The fourth chapter, “Reef Inc. (knowing as luring),” examines the scaling up of so-called interventions throughout the entire Reef ecosystem and the ensuing worries over unintended consequences. By comparing the development of a starfish-killing robot with the cane toad as the historic case of failed intervention, I argue that technoplanetary salvage is monstrous by design and that the mark of its success is not to free the human condition from earth distress but only to further hook us on it.

The fifth and final chapter, “Climate tantrum (knowing as bewildering),” examines intensifying cyclone activity as a feature of earth distress and its socialization. By following a recent major cyclone and its path of destruction across the Reef and into its industrial hinterland, I argue that the (in)adequacy of disaster to characterize earth distress as a chronic historical condition invites expressions of polarized and polarizing public discourse, which are to be understood not as mere “climate denial” but rather indicators of the way earth distress scrambles liberal political rationality.

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Let me close with a remark on some choices I have made regarding reference, acronyms, and naming in the manuscript. It is, in some ways, misleading to refer to the Great Barrier Reef in the singular. The expression suggests a structural uniformity to what is, in fact, a collection of three thousand coral reefs, only some of which are "barrier reefs" as defined by current geology (the rest being "fringing reefs" or "atolls," the two other main types of reef structures). Yet, in everyday language in Australia, the Great Barrier Reef is further shortened yet and, often, is known simply as "The Reef." This reduction conveys the aura of charismatic authority that the Great Barrier Reef throws off by attributing an ordered uniformity to the multitudes teeming within 350,000 square kilometers of Pacific Ocean. It also plays into something akin to environmental superiority if not to say chauvinism, which is to say the somewhat insular notion that the Great Barrier Reef can stand in for all the world's coral reefs: there is only one.

This reduction brings tensions. In the 1980s, an eminent Australian coral scientist determined that the reefs of the so-called Coral Triangle north of Indonesia, Malaysia, and the Philippines were more biodiverse than Australia's. His findings were met with resistance from colleagues and authorities in Australia for the implicit slight against the putative "greatness" of the Great Barrier Reef. At the same time, it is not unusual for researchers to display frustration when colleagues (and especially non-scientists) make claims about the state of "The Reef" that generalize away its multiplicity. Yet I have also witnessed these same scientists object to a perceived lack of generalization, as when tourism operators are selective in which of reefs of "The Reef" they show to customers in ways that risk giving an overly simplified impression of its exposure to earth distress. The part/whole problem is endlessly generative, and indicative of the way coral reef studies mediate epistemic and political tensions. My own difficulty lies in drawing out the intractability of such tensions as they inform the changing practices, tactics, and recruitments to mediating global nature through coral reefs. For example, just as "Save the Reef" was the rallying cry for environmental organizing in the 1960s, it remains so today; the verb and predicate are the same and yet the underlying questions, perceived threats, political economic ordering, and conceptualizations of nature differ.

In writing this manuscript, I have therefore made a choice to level the playing field, so to speak, when it comes to this particular problem of language. I do refer to the Great Barrier Reef as “The Reef,” yet I extend this same contraction to other key entities under discussion. Rather than take up the going convention of the acronym, I write of the Australian Institute of Marine Science as “The Institute” and the Great Barrier Reef Marine Park Authority as “The Authority.” This is not because I object to acronyms in general as so much legalese. Nor is it my way of imputing, critically if not cynically, grandiose designs to the entities in question. Rather, I worry that the use of acronyms in this context risks missing the surplus authority accruing to these representative entities by virtue of their privileged intimacy with “The Reef.”

Just as “The Reef,” a superlative example of the coral reef as a form of earthly life of which there are many historical expressions, traffics in something like exceptionalism so might the key institutions and actors connected with it. Emphasizing the keyword embedded within their usual acronyms is, then, a way of highlighting this responsibility premium and *at the same time* the ordinary mode of knowing and acting to which they aspire. Thus, on the one hand, it is a way of acknowledging the specific politico-epistemic position from which these entities speak and operate (e.g., tropical marine science for “the Institute,” environmental management and regulation for “the Authority”). On the other, it urges an imaginative openness to regarding the mediation of more-than-human nature, whether the rhetorical condensation of three thousand reefs in one or the push for technoplanetary salvage, as a matter of perspective and participation. Put differently, this technique is a way of writing an anthropology of climate action that holds open the question of how, why, and when “the coral representative *is* the coral image.”

CHAPTER ONE: BEYOND VERTIGO

On October 11, 2016, storied US-based travel and adventure magazine *Outside* published a premature online obituary for the world's largest coral reef system with the headline "The Great Barrier Reef (25 million BC-2016)." It went viral. Author Rowan Jacobsen depicted an underwater landscape celebrated for its liveliness and variety using the conventions of the death notice, a genre of retrospection and finality. He wrote in the past tense, crossed natural history with marine biology and Australian politics, and delivered a tale of missed opportunity: "no one knows if a serious effort could have saved the Great Barrier Reef, but it is clear no such effort was made" (Jacobsen 2016). For an imprint that reviews the latest adventure travel destinations and gear, chronicles self-improvement through edge-play in the great outdoors, and upholds long-time publisher Larry Burke's philosophy in business and in life of "just not giving up," the obit was unusually melancholic.[1] Yet it was also one among hundreds of contributions to scientific and mass media from the same period that used Australia's iconic reef system to issue a dire warning: as the global oceans become gradually warmer, more acid, and storm-prone, coral symbiosis is breaking down and reefs are turning to rubble; these tiny creatures are foundational to the web of earthly life and without them the planet will be unrecognizable.

Amidst a public outpouring of grief and disbelief in response to the obituary, many coral scientists took calls from media outlets to angrily rebut what they felt was dangerously exaggerated reporting. Although there is an overwhelming consensus that corals are, today, in grave distress, The Great Barrier Reef is, in fact, not dead yet. Some scientific authorities saw an

[1] Here is how, in 1988, Burke folds inside and outside back upon one another as one and the same stage for the human struggle: "People have a fuzzy concept of what entrepreneurism is all about … But what it comes down to is you've got to be willing to hang on a cliff 100 times, 200 times ... be able to get knocked off and climb back up. I mean, it's *hard*. And the hard part is just not giving up. Your idea can be great, but if you don't have that deep well to draw from—or you're very, very lucky quick—you're just not going to make it." (Beuttler 1988, emphasis in original)

opportunity to school readers on the facts of coral life. “It’s not too late for the Great Barrier Reef, and people who think that have a really profound misconception about what we know and don’t know about coral resilience,” Kim Cobb, a climate scientist from Georgia Tech, told *The Los Angeles Times* (Netburn 2016). Others questioned Jacobsen’s integrity. “You don’t write the obituary of a loved one when they are diagnosed with a terminal illness—you help them fight for their life,” prominent Australian coral scientist Terry Hughes told climate justice website *Grist* (Urry 2016). By depicting corals on life support with people as their caring kin, Hughes swaps one metaphor for another: the funeral becomes the intensive care unit. But he, Cobb, and many other voices did more than rescue the Great Barrier Reef from false prophecy: they reapportioned blame. Where Jacobsen charges authorities, especially economic and political ones, with short-sightedness and a dereliction of duty, the coral scientists charge Jacobsen and his followers with ignorance and/or indecency.

Why did the obituary go viral and invite such scorn? One possibility is that Jacobsen’s reasoning was familiar enough to persuade and his conclusion shocking enough to disturb (i.e., uncanny). Corals and the Great Barrier Reef have earned the dubious title of “canaries in the coalmine of the climate crisis” for their remarkable sensitivity to ongoing and accelerating pressures bearing down upon the web of earthbound life. There is something passing strange to this transposition, I have always felt. It sets up a scenario wherein coral reefs come to die as canaries in the depths of an abyss of human making so as to initiate an historic escape—whither? If the fate of corals is bound up with that of global and therefore human nature, then isn’t the prospect of their finitude *unthinkable* or, in the very least, apt to prompt the mind to recoil?

To be sure, there is a long history to the idea that “nature *as we know it today* is on the verge of dissolution,” to cite Carolyn Merchant’s classic text *Reinventing Eden* (2013, xiii, emphasis in the original). So-called "declensionist" natural histories are foundational to the modern tradition for the way they ground competing visions of human progress towards recovery, whether via technics of total domestication or tactics of radical environmentalism. The *Outside* obituary borrows from yet ultimately breaks with this tradition by casting writer, reader, and corals beyond the verge, *as if together dissolved* in an inhospitable oceanic future. Indeed, the writer later reflected that it was not he but his editors who saw this possibility. They shifted the article from the safety of fictionalized retrospection to the risky terrain of natural history as gothic satire by bringing forward the Great Barrier Reef's time of death:

> I was thinking that a "Ghost of Christmas Future" approach might have more emotional impact: Drag people to the year 2050 (or thereabouts) and show them what the world will be like—and make it a matter-of-fact news story. Of course, I don't know when reefs will go extinct, but all the research and interviews I'd done made it pretty clear that by 2050, they'll mostly be toast, so that was the rough date I had in my head for the obituary. But I left the date blank when I turned in the piece; I thought that might be more ominous. But the online editors saw "The Great Barrier Reef of Australia passed away in 20__ after a long illness" and thought it was a placeholder. They filled in the current date, supplied a headline, and published it. This is how things go in the online world. The rest is history. (Carr 2017)

Jacobsen, it turns out, is versed enough in current biology to inhabit the same position of knowing uncertainty that Cobb and Hughes insist on ("I don't know"; "pretty clear"; "mostly be toast"; "rough date"; "I left the date blank"). Yet he is not bound to this position. Or, perhaps more accurately, in exploring different genre conventions and accepting the constraints of the online publishing industry on his authorship, he surrendered it: "The rest is history." To take this canned expression seriously is to appreciate that *there is something historical to how the life and death of corals can and cannot be told* and not just to whether and why they are dying.[2]

[2] I am picking up, here, on literary scholar Ursula Heise's closing call in her inquiry into cultural framings of the decline of planetary nature: "the goal, then, is to understand how endangered species and extinctions mean—that is, to go beyond understanding *what* they mean ecologically toward understanding *how* they mean culturally. The future of endangered species and of biodiversity conservation is not, in the end, just a matter of science, but also and mainly one of histories, cultures, and values." (Heise 2016, 237, emphasis in the original)

As the global oceans place ongoing and increasing pressure on coral reefs, they have become charismatic entities caught up in disagreements over diagnoses of the earth's troubles and debates over what, if anything, can be done about them. In this context, coral services a planetary imaginary, a set of ideas and feelings about the scale and order of earthly life, which foregrounds mutual exposure and a tenuous future. What, then, makes coral especially apt to crystallize human conceptions of and responsibilities towards global nature? One answer lies in the way the coral form of life involves negotiating the micro and macro scale, notably through a cascade of symbiotic relationships that I will shortly explain. Coral thereby offers a tangible expression of how tenuous arrangements at the smallest scale give rise to the extraordinarily complex phenomena we observe and encounter in the world. Yet coral is not simply a metaphor for complexity. Within the North Atlantic tradition, it has been named, renamed, collected, traded, stolen, copied, pulverized, drilled, mapped, dissected, sculpted, sketched, photographed, mythologized, sermonized, romanticized, demonized, and, indeed, eulogized. These actions are so many human uptakes of the micro-macro activity of coral within practical, political, and moral human projects. Put directly: although corals may have one planetary story, since people have been around, they have had many *histories*.

It may be tempting to think that such past lives are immaterial or trivial at best given that, from a biogeochemical perspective, ongoing and accelerating changes to the global oceans place corals in mortal peril. Yet ocean change is not only a biogeochemical problem. In fact, in a strict sense it is not a "problem" for the global oceans at all. The earth has endured mass extinction events in the past and will continue to host some form of life for millions of years yet—albeit in arrangements quite alien to those that will have gone before. I am not inviting fatalism: one of geology's more terrifying lessons is that the earth's prior five mass extinction events *all* coincide with ocean acidification-induced “reef gaps” in the fossil record, which makes mass coral bleaching nothing short of a planetary omen (Veron 2008). Nor am I suggesting relativism: reef gaps and ocean change bring human history into greater, not lesser, intimacy with the tenuous lives of corals. The question is, rather, how to orient to this rapprochement as a constitutively practical, political, and moral reality. What designs on nature, its workings, and human responsibility have corals upheld? Why, today, is the breakdown of coral symbiosis a problem not just for nature but, also, for human self-understanding? What can corals teach us about how to call earth home, even as it grows increasingly inhospitable?

Any genealogy of human-coral relations requires choices. Given coral’s vast geographic spread, it is central to a great diversity of traditions, past and enduring—from Ancient Egyptian burial rites to Polynesian creation stories and international commerce in South-East Asia before, during, and after colonization. In what follows, I begin by explaining corals and coral reefs as a matter of current biology (<u>Section I</u>). I then selectively retrace the place of corals within the North Atlantic tradition of classical, early modern, and modern natural history and philosophy (<u>Section II</u>). There are two reasons for this choice: First, the North Atlantic tradition achieved global hegemony and so is uniquely responsible for disseminating understandings of nature and its uses that condition present-day disputes over planetary diminishment. Second, this tradition is not self-consistent. Tracking different meanings and uses of coral is one way of catching the interplay of natural history and politics, empiricism and morality, and so putting a question mark over an enduring, albeit contested, aspiration of the North Atlantic tradition: that *its* methods of inquiry and action advance towards *the* total and definitive account of reality and good conduct. I then revisit the “crisis in symbiosis” to bring out the chapter’s argument (<u>Section III</u>). To summarize: 1) Far from peripheral, coral has been a long-term companion to human flourishing and this, notably, under conditions of radical doubt; 2) Even a partial glimpse of human history as a history of human-coral relations shows that more-than-human nature has repeatedly been vested with not only empirical but also political and moral significance; 3) A broadened conception of human-coral relationality that welcomes non-innocence (i.e., symbiosis *and* dysbiosis) can help to highlight the political, moral, and psychodynamic struggles that subtend competing proposals to "do something about" dying nature.

1. Coral as a Living Measure of the Global Oceans

Here is a view from biogeochemistry on the lifeways of coral reefs. Corals are a group of marine invertebrates that thrive in tropical and semi-tropical waters, although lesser-studied deep-sea corals exist at all latitudes. The earliest known corals date back to the Cambrian period some 500 million years and had a different biology from today's, who come to dominate the fossil record from the mid-Triassic some 250 million years ago. At current count, there are nearly a thousand documented species of coral, roughly separated into soft and hard corals. Hard corals extrude a stony skeleton of calcium-carbonate at their base. Some species form plates and others form ruffles or boulders or branches. N ear the surface, their bodies elaborate a reef's patchwork structure while at depth, their skeletons compress to make a reef's limestone foundation. Soft corals do not lay down a calcareous skeleton and augment existing reefs or other submerged structures as fans, whips, bushes, and grasses (Figure 3, Figure 4, Figure 5).

At a general level, corals share the following characteristics. They are sedentary animals that begin life as polyps a few millimeters in diameter and attach to surfaces with their mineral-rich base. Their bodies are composed of digestive and reproductive organs. At the top is an opening to draw food in and out, ringed with stinging tentacles called nematocysts that stun microorganisms and fend off encroaching neighbors. Most corals live as a "colony," a collection

Figure 3. A coral outcrop on Flynn Reef, in the Cairns section of the Great Barrier Reef, shows how different coral colonies combine to form a reef matrix (Source: Toby Hudson, CC 3.0)

of genetically identical polyps with a shared metabolism that forms through asexual reproduction. Single polyps divide or bud new versions of themselves to grow a larger structure, connected via a tissue matrix, which in some cases can weigh in at multiple tons. But corals can also reproduce sexually, either by releasing sperm and egg bundles that fertilize in the water column or "brooding" offspring internally and releasing them as larvae. Some offspring settle besides their parents, while currents carry others away—perhaps to a nearby rock, sponge, or human-made structure, perhaps to an adjacent reef, to open water, or into a predator's mouth. Corals require appropriate ambient conditions to consolidate and form a reef matrix (e.g., temperature, light, depth, turbidity), without which they can nonetheless, as isolated colonies, flourish to greater or lesser extent.

Figure 4. A parrotfish feeds on a soft coral at One Tree Reef, in the Mackay section of the Great Barrier Reef. (Source: Dwayne Meadows, NOAA/NMFS/OPR, CC 2.0)

Like many animals, a variety of beneficial bacteria and fungi colonize corals and keep them alive. More distinctively, the vast majority of reef-building corals bond with microscopic plants, a family of marine algae called "zooxanthellae" (a compound of the Greek for animal (*zōon*) and yellow-brown (*xanthellos*)). Each measuring about 0.01 millimeters in diameter, small clusters of zooxanthellae take up residence in the stomach cells of a coral host with whom

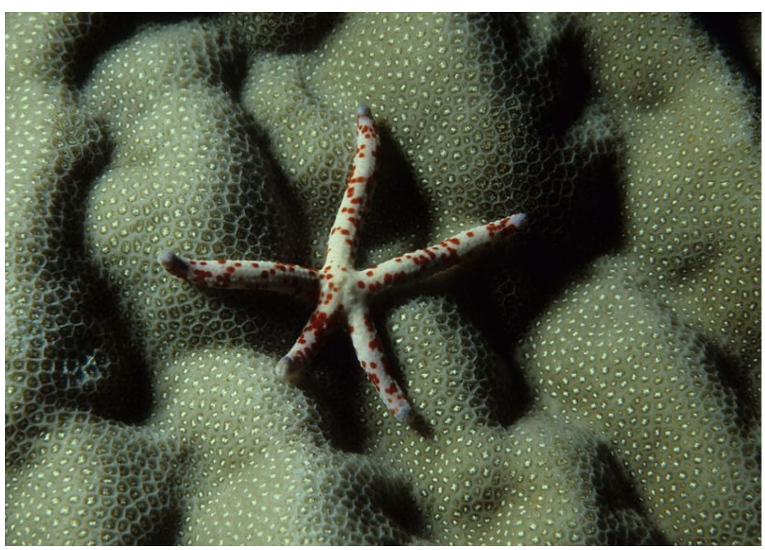

Figure 5. A sea star crawls across a coral on One Tree Reef in the Mackay section of the Great Barrier Reef. Each of the dots are individual polyps. (Source: Dwayne Meadows, NOAA/NMFS/OPR, CC 2.0)

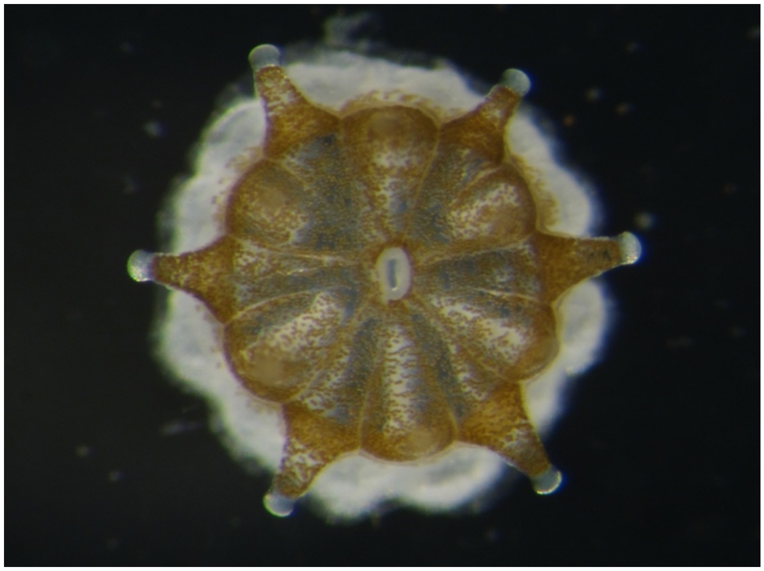

Figure 6. A close-up and overhead view of a coral polyp, showing its distinctive radial body shape, stinging cells, central feeding and waste cavity, as well as tiny endosymbiotic algae—colonies of zooxanthellae. (Source: Narissa Spies, CC 4.0)

they develop a mutually beneficial arrangement known as endosymbiosis. The algae use sunlight to photosynthesize, processing coral waste and producing energy, the vast majority of which they pass onto their host, which dramatically increases the rate of coral and thus reef growth. The relationship is also largely responsible for coral's many hues: coral flesh is clear but, when filled with algae, can flush deep green, tawny brown, burnt umber, blood red, and so on. Under certain conditions, however, corals can make fluorescent proteins to shade themselves—and their onboard algae—from excess light. Together, coral animal and algal plant breathe, feed, and multiply at a scale and pace that would be impossible by themselves (Figure 6).

Time and place mark coral bodies, which makes them a remarkable living measure of their milieu. Corals cover less than 1 per cent of the earth's surface yet over 25 per cent of all marine animals live in, on, and around coral reefs. Coral reefs have long been likened to rainforests, nurseries, or cities because of the diversity of life they support—from flocks of birds to bales of turtles, from casts of crabs to seams of turf algae. This arrangement is dynamic. Wave friction, pressure changes, storm impacts, the feeding and nesting habits of myriad creatures—all this and more condition patterns of coral growth and decay. This goes locally (how a single coral colony forms a patch of reef) and globally (how entire reef systems form in the ocean), with ripple effects on the plants, algae, fish, plants, birds and hence human communities that depend on them. Reefs sustain food webs and migration patterns, ring islands with shelter, and provide offshore breakwaters for coastal protection. To borrow a term from social scientists Frédéric Keck and Andrew Lakoff, corals are therefore powerful “sentinels” of environmental change (Lakoff and Keck 2013). Fossilized reefs have allowed coral scientists to reconstruct a partial picture of the geological record as far back as the Cambrian and ascertain that major extinction events are, invariably, accompanied by “reef gaps,” millions of years in which one set of reef-building organisms disappear from the geological record until new species evolve and begin laying down reef and limestone again. Yet corals are, themselves, a biogeochemical archive. Much like growth rings in tree trunks, corals register ambient environmental conditions in the “bands” of skeleton they are able to extrude annually. “Each band,” Janice Lough and Timothy Cooper explain “is a page in an environmental archive that reveals past responses of growth (linear extension, skeletal density and calcification rate) and provides a basis for prediction of future of coral growth” (Lough and Cooper 2011, 170). Much like pollen cores and ice cores, scientists like these are now reading coral cores for high-resolution demonstration of the subtle yet worrying consequences of ongoing and accelerating ocean change (Figure 7).

Coral can accommodate seasonal fluctuations in light, temperature, and flow, as well as occasional impacts from storms, agricultural runoff, boating accidents, fishing, or coastal development. However, the scale and pace of rapid, ongoing, and accelerating planetary disruption compounds these fluctuations and exceeds coral’s adaptive abilities, and this for three

Figure 7. Christopher Reich, a United States Geological Survey diver, extracts a coral core off the coast of Florida for paleoclimatic analysis. (Source: Don Hickey, USGS, CC 1.0)

principal reasons. First, corals cannot regulate their body temperature, so fluctuating and gradually increasing water temperatures compromise their basic metabolic processes. Second, as carbon dioxide concentrations increase in the ocean so does acidity, which reduces the amount of carbonate ions available for corals to build their skeletons and so compromises reef integrity. Third, higher temperatures and light levels alter the biochemical exchange between coral hosts and plant endosymbionts. The latter produce more oxygen than the former can consume, and the relationship goes from beneficial to toxic. A breakdown results. Coral colonies jettison their symbionts into the water column and take their chances with a drastically reduced food and

Figure 8. The different color morphs of Acropora millepora, each exhibiting a bleaching response during the mass coral bleaching event offshore of Orpheus Island in 2017. (Credit: Gergely Torda, ARC Centre of Excellence for Coral Reef Studies, CC 2.0)

energy supply. This microphenomenon is visible at the macroscale. Without zooxanthellae, corals lose color and expose their underlying mineral skeleton, giving the process its name: "coral bleaching" (Figure 8). Bleaching places corals in considerable distress, compromises immunity to disease as well as reproductive cycles. When bleaching is localized and occasional, it is not always fatal and corals can recover; when it scales in space and time, recovery is increasingly uncertain as corals do not have time to resettle, reproduce, or develop evolutionary adaptations to keep pace with prevailing ambient conditions and stave of territorial competition, notably from fast-growing turf algae. In the past decades, the Great Barrier Reef has experienced mass bleaching six times (1981/92, 1997/98, 2002, 2016/17, 2020, and 2022) and there have been three global mass bleaching events (1998, 2010, 2014-17). In the words of coral scientist Charlie Veron, this makes for "an abrupt event in human time, an *instantaneous* event by any standards of evolution, let alone geology" (2008, 206). For human analogues of these three symptoms, imagine heat stroke, osteoporosis, and shortness of breath—all chronic, increasingly acute, and highly contagious.

As hermit crabs, humpback whales, reef herons and, indeed, human communities depend on corals, these tiny creatures are living proof for contemporary descriptions of planetary nature as bound together in a tenuous, if not terminal, compact. Getting to know coral reefs in this way can be dizzying. It means tracing the strands, nodes, and sweep of the web of life at temporal and spatial scales that defy the everyday coordinates of our experience as biographical individuals. Yet the prospect of greater alignment of human and coral reef lifeways is also deeply anxiogenic—e.g., the abruptness of mass bleaching as an historical event *as if shading before our eyes* into the instantaneousness of mass extinction as a geological event. Anxiety is not apathy; it can bring a restlessness which sponsors repeated and renewed striving for a beyond. Indeed, the manuscript you are reading is, in one sense, an inquiry into such enactments and, in another, its own version thereof. What this looks like for coral scientists, says Irus Braverman, is a process of coming to live "on the brink" with the corals they study, oscillating between hope and despair. Some view their work as testimony to urge political transformation and others as diagnosis to urge experimental intervention. All worry about the danger of indifference. In one interview with Braverman, coral biologist Ruth Gates is adamant: "We've got to stop telling everyone that reefs will all be dead by 2050! People are walking away" (2018, 244).

2. The Many Natural Histories of Coral

Before turning towards the agitated historical present, it is worth taking a longer view of the natural history of corals to understand what they have been within the North Atlantic tradition. How else have people come to make a world with corals? What follows is a review of different conceptualizations of coral within the North Atlantic tradition of natural history and natural philosophy. It is an attempt to understand coral as something other than a harbinger of mass extinction, a problem of abstract nature gone awry. It is an attempt to catch the dizzying shifts in scale and relationality that coral provokes within different visions of global nature and what it is good for.

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Still today, the question arises: is coral an animal, vegetable, or mineral? This is a call back to a tripartite distinction inherited from the classical tradition and suggests two things: First, that echoes of historically antecedent and ostensibly superseded conceptions of nature can, if only in ordinary language, persist in ways that trouble a narrow yet powerful understanding of science as given to linear and progressive development; Second, that some forms of nature may be especially apt at prompting such trouble. What, then, was coral to the classical world?

In *The Veil of Isis*, classicist Pierre Hadot offers a history of the idea of nature in the North Atlantic tradition by showing how centuries of philosophical debates over what human is to non-human nature can be understood as so many attempts at interpreting one beguiling aphorism from pre-Socratic philosopher Heraclitus: "nature loves to hide" (*phusis kruptesthai philei*). To explain what "nature" might have meant at the time, Hadot quotes Empedocles, a contemporary of Heraclitus', who contends that nature is process, the mixing and unmixing of things: "There is absolutely no birth *[phusis]* for all mortal things, nor end, in detested death, but there is only mixture and distinction of mixed-up things, and this is what men call *phusis*" (2006, 8). Given coral's complicated biogeochemistry, so to speak, it is little wonder this form of life drew considerable interest.

Two centuries later and in the Aristotelian tradition, nature is not so much pure process as it is a cosmic unity of things operating according to their own inner principles. Mixing and unmixing still matter, but the stuff of nature can be ordered to some degree. Plants can grow; animals can grow, move, and sense; humans can grow, move, sense, and think. In striving to do these things *well*, all seek to express their own potential or truth and thus the well-ordered universe. And coral? As an admixture of animal and plant and mineral, coral cut an unusual figure within this picture. Red or precious coral, today referred to as the species *Corallium rubrum*, was widespread throughout the Mediterranean and the object of great commercial, medicinal, and literary curiosity. Ovid's *Metamorphoses* (circa 8 CE) offers an origin myth. When the hero Perseus vanquishes Medusa—the only mortal of the three Gorgon sisters, a chthonic monster with venomous snakes for hair, in whose gaze a subject turns to stone—he lays her head on a bed of seagrass.[3] Its serpentine and petrifying qualities transfer upon contact, and red coral comes into being. This thing of roots, blood, and bone delights nearby nymphs, who set to sowing coral throughout the surrounding seas. This transformation myth emphasizes red coral's intimacy with the cosmic forces and mixed but stable nature. In the classical view: the harder, curlier, and redder the coral harvested at sea, the greater its *striving* to express its inner "coralness." Coralness is singular and complex; it allows red coral to evoke mineral strength, plant growth, and animal movement all at once.

As bone, branch, and blood were tropes of vitality and endurance, so coral is a persistent presence in art and handicraft, pharmaceutical and philosophical treatises, along with folklore and religious worship. Historian Shannon Kelley (2014) explains that naturalists, healers, and

[3] When 18th century naturalists later observed the early stages of the coral polyp lifecycle, they referred to the short free-swimming stage before settlement as the "medusa-stage." Then, when they realized the some cnidaria do not settle but rather remain mobile their whole lives, they grouped them in the "Medusozoa" subphylum, more commonly known as jellyfish (Embleton 2021).

poets from Ancient Greece through to the late 16th century lauded coral's power to soothe pain, stanch bleeding, quench fever, help teething, grow orchards, sprout gardens, scatter storms, calm winds, lift melancholy and bring romantic love. These are problems of growth gone awry and health in distress. Such disorderly contexts make it difficult for people to go on; they are situations wherein humans, *in their specificity* are struggling to strive. Newborns wore coral jewelry for patience, farmers used coral tinctures for luck, and lovers cast coral charms for nerve. Patience, luck, nerve: bringing out these human qualities required human effort. Coral could help but was no "miracle cure," indeed, this idea presumes a modern view of nature and medicine. What coral offered, however, in times of strife was the tangible counterpoint of an orderly universe and a trustworthy companion. Red coral, a charismatic example of a form of life achieving its specific potentiality and telos, was, through such actions as those described above, *mixed in with human effort to urge the struggling subject on* in their vital becoming. For some, this may have involved magical thinking, others may have found succor in picturing an example to emulate, and some may simply have lauded coral out of habit or social convention.

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Stable in theory, the boundaries between the classical idea of coral and the early modern idea of coral, to which I now turn, were porous in practice. For instance, one of the ways in which coral's associations with bloody and fertility in the classical tradition endured was via Christian mythology and iconography, notably via depictions of the Madonna and Child, frequently surrounded by red coral tokens (Figure 9). This may help explain why red coral persisted within European child-rearing practices. For instance, coral's therapeutic and apotropaic qualities were lauded within pediatric dentistry through to Victorian England, notably in the form of coral teething devices, themselves often made from shell, ivory, or bone, which were the precursor to the contemporary pacifiers (Ashley 2001). From the 15th century onwards, however, coral came to play a pivotal role in consolidating networks of transnational maritime trade where it functioned as an "exotic" commodity and de facto currency. As Susan Thornton explains: "Coral's rarity, the high costs of dangerous and labor-intensive harvesting, the long time required

Figure 9. Madonna della Vittoria, Andrea Mantegna, ca. 1495. A string of coral beads and a branch of red coral are suspended over the heads of the Madonna and child. (Source: Web Gallery of Art)

for coral to grow to usable size, and the fact that ninety percent of the harvested coral is considered waste, all create a valuable material that compares to the value of gold or diamonds in markets today and historically" (2002, 3). The growth of a veritable industry of coral fishing in the Mediterranean led to bitter territorial disputes as European claimants sought to harvest coral from waters off the North African coast and route it through processing and export facilities based in ports of Genoa, Livorno, Marseille and Cassis. Red coral was crucial to securing the trade in diamonds from India, porcelain from China, and enslaved people from West Africa (Alpern 1995; Raveux 2020; Rijks 2019). One way of appreciating the role of coral in anchoring the commercial imaginary—remaining cautious not to overstate red coral itself as a driving force behind the development of global trade—is that the term "corals" functioned as a generic name for beads of different substance, grade, and quality. This fiduciary abstraction, it should be noted, is a marked shift from notions of specific nature with corresponding inner principles.

Exemplified by the Cartesian tradition, the early modern idea of nature developed in the 16th and 17th centuries largely in the wake of the so-called Scientific Revolution. It prioritized a division between the inquiring human mind and the world of other-than-human matter available to calculation, instrumentation, and experimentation. Under this description, the world obeys an overarching design of mechanical precision. Coral does not strive to express its inner principle, for no such principle exists. The properties and qualities of all things—mineral, vegetable or animal—are the creation of a divine clockmaker whose wisdom only the power of human reason can appreciate and, perhaps, gradually divine.[4] In this view, the hardness, waviness, and redness

[4] The difficulty of settling this triangular relationship between the powers of nature, God, and the mind is one reason why something like metaphysical doubt plays an important role among the small, although ultimately highly influential, group of philosophers, naturalists, and theologians working at this time. As Pierre Hadot contends, an understanding of natural philosophy as a noble but ultimately hypothetical mode of inquiry secured the creative will of God as absolute and, at the same time, human rationality itself as one among God's many creations. "Descartes hints not that he is not affirming that things actually happen as he has tried to demonstrate but that he can only propose a likely rational explanation. This is what Galileo had refused to admit. As Eduard Jan Dijksterhuis rightly

of coral are not indications that nature strives to fulfil an inner principle. Instead, red coral is just one among a myriad of other durable, branching, or colorful things that suggest the need for reasoned inquiry into the mechanisms behind structures, shapes, or human sense perception.

For a sense of what coral becomes in relation to this way of seeing, consider a 1513 treatise for the aspiring sovereign ruler: Machiavelli's *The Prince.* The text offers lessons in how to avoid relying on chance, personified in the unpredictable goddess *Fortuna*, by instead acquiring *virtú*, an allegedly masculine quality of skill, ingenuity, and ability. In a key section, Machiavelli invokes coral reefs to explain how to navigate a likely, but by definition obscure, impediment to power: the contempt of rivals, plotters, and subjects. He writes: "[a prince] arouses contempt if he is considered fickle, frivolous, effeminate, cowardly, or indecisive. A prince must steer clear of these qualities, *as a ship does of a reef*, and strive so that his deeds are manifest in their grandeur, courage, dignity, and strength" (2008, 287–88). As a rhetorical device, analogy works by using something familiar to illustrate something obscure. Here, the author's appeal to coral reefs indicates that readers readily knew them as tangible examples of some hidden, submerged, fatal, yet *frequent* obstacle to seafaring as a collective enterprise; an obstacle, crucially, whose skilled and sanguine avoidance inspires confidence and loyalty. Reefs, whose use lies in their avoidance and so unknowability, provide an object lesson in how to put doubt to use in order to develop a particular form of good judgment: political cunning.[5]

To be sure, the legibility of this example at the time followed from the growing connection between political rule and global maritime navigation. Royal, commercial, and

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notes, Cardinal Bellarmino had indeed advised Galileo to content himself with affirming that apparent motions are better explained mathematically if the earth's revolution around the sun is accepted, and that this was therefore a mere hypothesis, and thus to admit that it could not be affirmed with absolute certainty that things really do occur in that way" (Hadot 2006, 134)

[5] Machiavelli deploys the reef analogy a handful of times in his *Discourses* and, always, as an analogy with some danger that must be intentionally avoided.

popular investments in developing new routes of conquest, smuggling, enslavement, and trade led to countless shipwrecks. In large part, this is because unlike the "soft" red coral of the Mediterranean, the massive, submerged colonies of "hard" reef-building corals of the Atlantic, Pacific, and Indian oceans were a perilous unknown quantity even to seasoned sailors. Before these distinctions were drawn in later centuries, reefs were a generic term for submerged rocky structures and as such acquired uses within mapping, calculation, and prediction—emerging sciences that directed a new outlook on the nature of the world and human action within it. As historian of finance François Ewald points out, when developing "risk," the foundational concept of insurance, Renaissance merchant guilds borrowed the early modern Italian term for reef, *risco*. Under a classical description, the newborn wore coral as an inspiring sign of nature's cosmic order. Under an early modern description, merchants and sailors looked to reefs as a heuristic for touting informed judgments about the most likely or probable path to success in a divinely ordained but only partially knowable world. This shift corresponds to what Ian Hacking terms the "emergence of probability" in his book of the same name: "Probabilism is a token of the loss of certainty that characterizes the Renaissance, and of the readiness, indeed eagerness, of various powers to find a substitute for the older canons of knowledge" (2006, 25).

Yet it was on coral organisms themselves that the early modern view of nature really cut its teeth. Classification was a crucial battleground for naturalists in their efforts to displace classical groupings of nature based inner "principles" or "causes" and, instead, explain nature's diversity as a function of mechanical hierarchies of size, form, and function. Animal, plant, or mineral? Coral's puzzling composition required a new kind of answer. For a time, 18^{th} century naturalists grouped corals with river polyps, sponges, mussels, and sea worms in the category of "zoophytes." Because of their apparent form and behavior, these creatures were deemed "lowly" within the natural order, hence the vernacular term “sea insects.” Yet their workings remained ambiguous and therefore hotly contested. For instance, when William Herschel delivered his first report to the Bath Philosophical Society in 1780, he needed a compelling subject to establish his reputation along with the merits of the microscope, an instrument that he and sister Caroline Herschel largely developed. He selected an unfamiliar topic for him, but one that showcased the instrument and mattered to his audience: the growth and measurement of “corallines.” Throughout the 18th and 19th centuries, self-taught and professional naturalists collected,

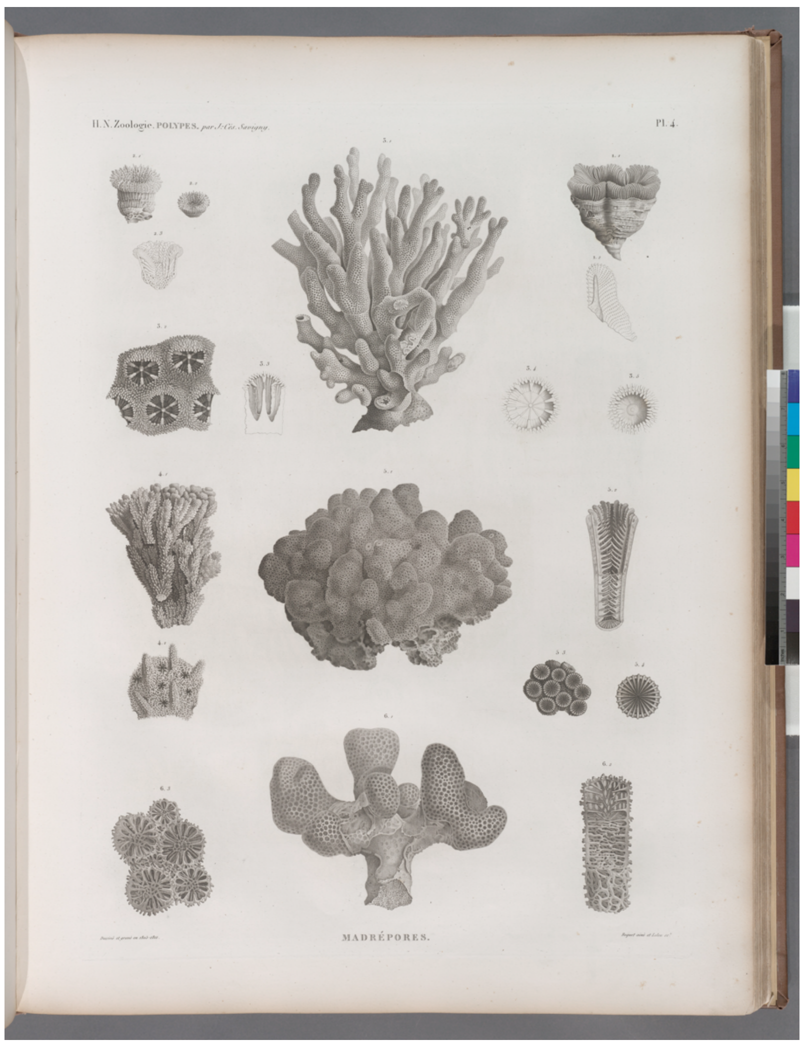

Figure 10. Coral drawings from The Description of Egypt (1809-1829), a multi-volume collaboration based on Napoleon’s 1798-1801 expedition, intending a definitive French claim on knowledge of Egypt, as place, people, and history. (Source: New York Public Library)

sketched, named, and compared a widening array of specimens the better to augment, refine, or challenge an allegedly total and complete taxonomy of nature. Corals' seemingly endless permutations made them a worthy foil in this quest to pull apart the intricate "mechanism" of nature through the power of human reasoning (Figure 10).

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The Renaissance idea of a nature as divinely ordained mechanism gradually gave way to a modern idea of nature as a historical process of constant change over the course of the 19th century, exemplified by the Darwinian tradition. In this view, mineral, vegetable, and animal beings come into and out of existence thanks to *the force of life*, which has no knowable purpose beyond iterating new entities whose survival and flourishing set the stage for subsequent efforts.

Scottish minister and naturalist David Landsborough's 1852 text, *A popular history of British zoophytes, or corallines*, illustrates this shift well (Figure 11). The opening claim is that corals are the most important subject in natural history, not because their structure is a pressing puzzle but because their activity is vitally important: they build reefs. This fact circulated widely in naturalists' papers, travelers' tales, and illustrators' images. Landsborough takes it up as a moral lesson in how nature is not to be studied for what it is but for what it does encouraging his reader to wonder and admire "that the great Creator can, by means that might seem to us the feeblest, work out the most astonishing results" (1852, 10–11). His aim is pastoral, theological *and* civic; he wants his metropolitan audience to go out, look for, and study the corals and other "sea insects" that live and make the local British countryside. As reefs tested the practical limits

Figure 11. Cover illustration of David Landsborough's *A popular history of British zoophytes* (1852) in which the coral polyp is here presented as a specimen type, removed from their watery medium and available to textual circulation and learned inquiry. (Source: Thomas Fisher Rare Book Library, University of Toronto, CC2.0)

of the British Empire's expansion, the lives of corals became an object-lesson for Victorian subjects in how to cultivate and exercise an appreciation for living nature at home.

North Atlantic imperial science established but could not immediately explain the connection between coral biology and reef geology. For imperial authorities and subjects, it was a strategic concern: could corals make reefs so quickly that maps made for one journey would prove useless for the next? Officers in the British Royal Navy and naturalists at the Royal Society worked hand in glove in building out the modern view of nature. One naturalist who took up the puzzle of reef-building corals during his voyage aboard the HMS Beagle was the young Charles Darwin. He combined insights from geology and biology to venture a bold hypothesis in his first monograph from 1842. If there are mountains and valleys in the ocean as there are on land, he ventured, then tiny corals might build reefs layer by layer on bedrock that sinks slowly into the sea. These actions of sinking and building might be constant, gradual, and coordinated enough to sustain a robust reef near the surface that replaces the land mass as it disappears from view.

Historian Alistair Sponsel (2018) explains that the young Darwin was working from a popular assumption that what goes for one reef goes for all corals. He was also following precise instructions from top navy brass. Moreover, he repurposed the tools, techniques, and labor of imperial sailors to devise new data collection methods for coral science. Finally, he benefited greatly from peers and mentors in how to strategically present his findings, and often changed his mind. What this means is that Darwin kickstarted his career by building practical and theoretical claims in lively collaboration with superiors, subordinates, peers *and* a Victorian icon: reef-building corals. His was neither the first nor last modern theory of how corals build reefs—some twenty others would vie for authority at the time. But it did provoke and endure because of the speculation at its center: the scalar powers of reef-building corals show that the world does not simply contain many life histories but, in deep time and at the whole earth scale, *has a life history of its own*. While this history's rhythm and tempo challenge the human senses, they nevertheless have conditions and limits, like the rate at which the seafloor "sinks" or at which corals "build." This also made Darwin's theory testable, albeit with great difficulty. To wit, if geologists drilled the right hole in the right reef, then they could extract a core made of successive layers of coral skeletons right up until a threshold when bedrock takes over. Indeed, coring became a centerpiece of coral science, yet reaching the necessary depths required vast resources. The successful test Darwin imagined ended up waiting until 1952, when US Navy divers drilled a nearly 5,000-foot coral core and, indeed, hit bedrock.

The work of Darwin and his ilk settled the question of whether corals could stymie imperial expansion—whether by rendering maps obsolete or, literally, encircling colonial outposts—in the negative. So, authorities to put corals to work. The modern view of living nature developed alongside imperial efforts to conscript people, land, plants, and animals to increase metropolitan wealth and secure colonial settlement. The thinking went: if nature was alive, it could be "improved" and cultivated for competitive advantage. Hence, William Saville-Kent's 1893 monograph: *Australia's Great Barrier Reef: its products and potentialities*. The 387-page large format volume fascinated Victorian England with its full color plates and black and white photographs; its subtitle reveals the economic priorities of metropole and colony and its author's own administrative duties as fisheries commissioner. "[The Barrier's] waters abound with shoals of fish akin to the European herring, mackerel, anchovy, and pilchard, which up to the present date have been literally allowed to run to waste," he writes. "And yet, with these indigenous supplies swarming at their doors, Queensland and all the neighboring Australian colonies import vast stores of tinned, smoked, and salted fish, from the lordly salmon to the lowly sprat, from Europe and America" (1893, 311). The Great Barrier Reef bears Saville-Kent's enthusiasm as it oscillates between the aesthetic gaze of imperial naturalism and the promissory pride of the self-sustaining settler colonist, yielding a romance of frictionless material and psychosocial renewal.

From the early 19th century, vast industries raided the "resources" Australian reefs: turtles for meat, sea cucumbers for trade, and pearl shell for buttons. Historians Ben Daley and Peter Griggs (2006) document the largely forgotten history of the quantities of phosphate, guano, and lime mined from the Reef to build the inland sugar cane industry (Figure 12). These varied

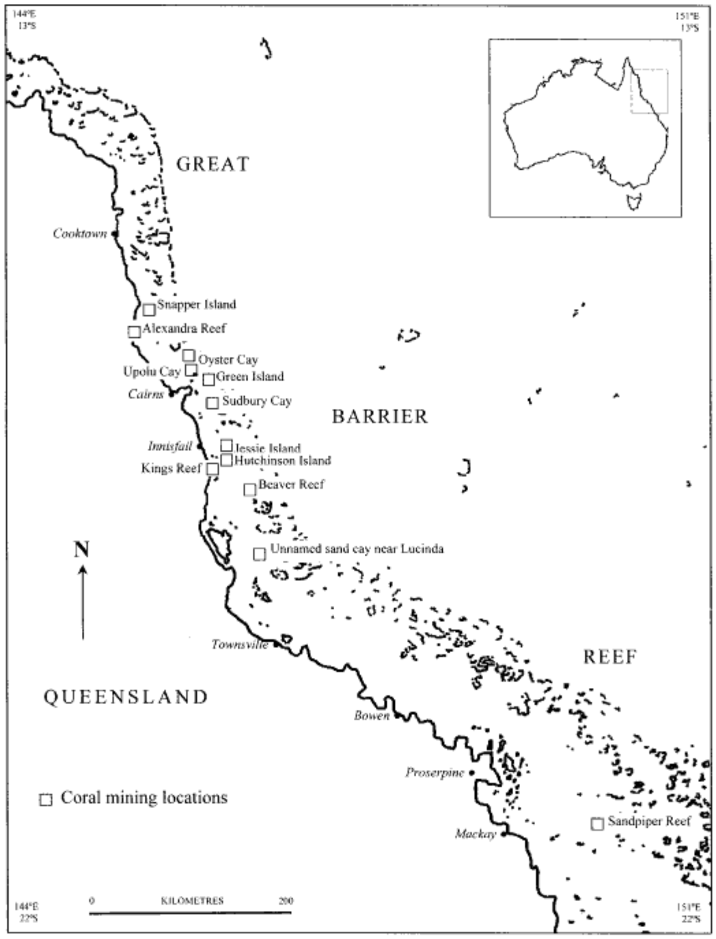

Figure 12. Prospectors obtained licenses to extract thousands of tonnes of phosphate, guano, and coral from the Great Barrier Reef in the century preceding World War II to provide fertilizer for the inland sugar can industry and building materials. The process altered, sometimes dramatically, the integrity of coral reefs then regarded—and regulated—as a mineral resource. (Image reprinted from "Mining the Reefs and Cays: Coral, Guano and Rock Phosphate Extraction in the Great Barrier Reef, Australia, 1844-1940," by Ben Daley and Peter Griggs, 2006, Environment and History, 12(4), 403. Copyright (2006) by White Horse Press.)

projects disrupted spiritual and political bonds that connect First Nations with coral reefs and conscripted residents of the region, including colonized subjects from neighboring countries, to a settler colonial Australia in which nature is something to claim and domesticate in the name of "civilization." Extracting value from corals themselves was less obvious. Corals do not make for eating, nor fleecing, tanning, hunting, distilling—to gesture to some typical economies of nature. Moreover, reefs were treacherous to navigate and continued to wreck ships, and while reefscapes appealed to the eye, they were impossible to capture and transport to the colony. With that said, corals did circulate widely within the Anglo-European world as representations.

Cultural historian Ann Elias (2019) explains how a new visual medium, underwater photography, used colonized subjects and industrial diving technology to produce colorful and often elaborately staged images of an underwater world teeming with "unknown" life. From the 1920s, these images circulated in mass media, museum exhibits, and artistic reproductions and presented nature as alive, untamed and "primitive" yet ripe for domestication through "modern" technologies. Literary scholar Michelle Elleray (2011) documents a quieter but no less powerful example of the social force of such representations. Far beyond the halls of the Royal Society, the origin and development of coral reefs found repeated expression in Victorian children's literature, which celebrated corals as "little builders" of vast ocean worlds. This idea was, for instance, the centerpiece of a set of evangelical periodicals directed at working children, which requested they donate wages to build children's missions in the Pacific. These pamphlets weave imperial subjects at home, missionized colonial subjects abroad, and reef-building Pacific corals into a coming-of-age story of industrious self-improvement. The British Empire becomes a collective monument to the lives of even its "lowest subjects," whose daily hazards may vary yet who share a purpose as "little builders" of a new world-historical order.

In this post-Enlightenment world picture, nature is still mute and without cosmic impulse, but it is also changing and so available for improvement. The task of Britain's seafaring naturalists, for instance, was never simply to catalogue the world, but to secure vigorous living specimens whose cultivation could extend imperial power (Gascoigne 1999). This included people, pressed into service as "guides" in the colonies and then delivered as "curiosities" for public erudition qua entertainment in the metropole. Hence, the name "Great Barrier" given to the reef system occupying the coveted Torres Strait charted between Pacific and Indian oceans and, more gesturally but no less tendentiously, the term “colony” bestowed—approvingly—on the macroform of coral life. Indeed, despite the challenge that evolutionary theory presents to creation myths, Landsborough’s aforementioned text reminds us how readily the two align under the aegis of industrious self-improvement. On the one hand, industrial capital stabilized assumptions that life’s forces are made for labor, be they human, animal, or machinic.[6] Thus, anthropologist Sarah Franklin (2007) explains Australia’s forced settlement as conditional upon the methodical introduction, growth, and enhancement of sheep as imperial “livestock.” On the other, colonial authority readily harnessed the tropes, institutions, and moral reasoning of Christendom to prosecute its martial claim: stolen lands were “natural Edens” lying fallow due to their inhabitants’ “inferior” civilizational development. Imperial Britain and settler colonial Australia’s designs on coral reefs disclose a vision of world-historical superiority that was both cruel and aspirational. Securing it took legal, scientific, and economic experiments that questioned, displaced and destroyed ways of living with land whose pre-existing modes of governance and reasoning threatened a vision of total domestication. The scale of this violence is terrifying. One driving force behind ordinary commitments to raw supremacy was the circulation of an understanding of inimical wild nature in need of taming: biological improvability justified murder and rape and, at the same time, the ethical cultivation of the industrious subject.

3. The Crisis in Symbiosis; or, Human-Coral Relationality in Space and Time

In refracting these genealogies of the idea of nature within the North Atlantic tradition, coral induces something like vertigo: the shard of red coral opens the door to a cosmic order of “inner

[6] In the parlance of physics, “work” is the measure of mechanical force.

principles"; the "sea insect" is a lowly matter in the grand scheme of things but a cunning match for human reason; the coral polyp's living labor builds reef worlds that document earth's deep history and rationalize the barbarity of imperialism. These are dizzying shifts in scale and relationality, that each presuppose a different perspective on nature. However useful the distinction between classical, early modern, and modern traditions may be as guideposts, social life is made of messier stuff. Ideas about how and why people can orient to global nature vie with and fold back upon another, subside at one period to return in altered guise in another, and so on. Coral helps bring this mess alive, in the ordinariness of teething practices and devastation of colonization.

Here are two examples of what this might look like. Michele Navakas (2019) reads textbooks, folksongs, and novels from the antebellum US South to show how the mixed nature of coral sustained a line of flight beyond the hegemony of biological essentialism by offering a

Figure 13. Trading Post (articulated hierarchies and visible displacements), 2015, La Vaughn Belle. Reclaimed coral stones cut by enslaved Africans, encased in plexiglass, 36" x 18" x 18". (Photo credit: Tamia Williams)

concrete example of a form of life that obstinately defied classification. The work of Virgin Islands-based contemporary artist La Vaughn Belle, meanwhile, uses coral as a (material and spiritual) medium in work that summons (corrals?) the assumptions of colonial authorities about race, place, and history the better to interrupt their ongoing hold on (post-)colonial subjectivity. Her 2015 sculpture "Trading Post (articulated hierarchies and visible displacements)" (Figure 13) shows blocks of coral in a plexiglass case from reefs that enslaved Africans cut open and transported to lay the foundations of the French and then Danish plantation architecture of Saint Croix. The 2017 work "Wall Rubbings (record of the work of others)" (Figure 14) iterates these same blocks anew, using a wax rubbing technique that records their textures, pores, and blemishes that would have been, as so many traces of enslaved labor, literally plastered over in the finished colonial infrastructure. Coral is figure and ground in Belle's work, which recalls the unremembered, acknowledges living labor turned against itself, and signals—through titling and

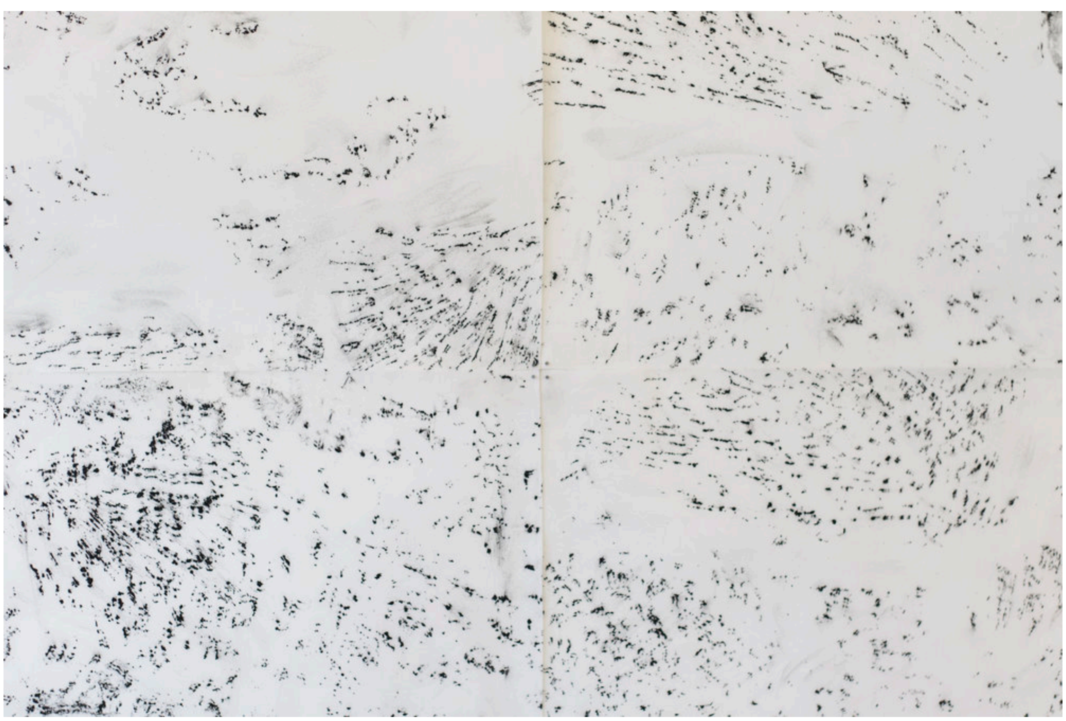

Figure 14. Wall Rubbings (record of the work of others), 2017, La Vaughn Belle, wax rubbings on aquaba paper. (Photo credit: I DO ART Agency)

captioning—that the reparative work of memory will always come up against the silences hewn into the colonial archive. Belle terms her practice "the alchemy of creative resistance," a call-back to discontinuities within North Atlantic natural science, and another cue to the destructiveness of progressive historical accounting. Openings such as these suggest further lines of inquiry that coral might yield into the natural history and counterhistory of our styles of moral and political reasoning.

Today, globalized science, policy makers, conservation NGOs, and popular media elevate the plight of corals as an emergency because the collapse of reefs will spell unimaginable disruption to everyday life the world over, especially for island nations already exposed to rising sea levels and increased storm activity. Yet the ability of these nations to negotiate foreign aid, reparations or anticipatory refugee arrangements remain hampered by power asymmetries proper to a world order scaffolded not on an abstract disregard for or indifference towards global nature, but rather a series of committed uses thereof. Highlighting human-coral relations is a way of insisting that more-than-human nature is political, not with a view to clearing a seat at the United Nations but, rather, to insist that the present-day geopolitical order depends upon putting coral, coral reefs, and the global oceans to some uses and not others. To illustrate, three examples.

First, the conservative Australian federal government has consistently sought to block UNESCO from adding the Great Barrier Reef to its "world heritage in danger" list and thereby stabilize an understanding that, even today, coral reefs are things to manage through scientific research and intervention. Second, China's "Belt and Roads Initiative" is the world's largest infrastructure project intended to connect Asia, Africa, and Europe in a vast new transportation network ringed by a set of deep-water ports dubbed the "string of pearls." The plan involves remaking terrestrial and marine environments along with the political economies of, among others, nations in the South-East Asian "Coral Triangle." Third, more than a material basis for acts of economic production and market exchange, "environment" as a concept is increasingly described *as if it were a market proper*. Policy makers, conservation NGOs, and social scientists are working to redescribe the biogeochemistry of reef-building corals as "ecosystem services." This technique ascribes a dollar value to what coral reefs "give" people (e.g., fishing grounds, coastal protection, tourism revenue) the better to incentivize corporate compliance or social discipline. Critics argue this translation does not alter the status quo but simply renders it measurable, which, moreover, risks substituting climate equity for climate justice by imposing surveillance, disciplinary and auditing requirements on communities directly impacted by reef decline rather than the economic actors driving it, such as fossil fuel producers and consumers.

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Environmental studies scholars have developed a powerful alternative view of corals, namely, that their very form of life offers lessons in compassion and justice that can check the rapacious forces that are distressing the web of earthly life. Corals make home and kin across species boundaries and national borders. They rely not on self-interest but mutual dependency to generate abundance, growth, and change. Accordingly, corals demonstrate that what holds life together is coordination and not hierarchy, that the North Atlantic tradition has no more a natural monopoly on the mind than it does on the heart, and that coral contains much more than the economic or biological value by which policy makers, economists, and NGOs measure reef collapse.

This literature takes especial interest in symbiosis as a radical counterpoint to the damage of our times. German botanists coined "symbiosis" in 1876 to describe the way in which lichen is neither plant nor fungi but a cross-kingdom arrangement between the two. Technically speaking, symbiosis is value-neutral and is used interchangeably to describe relations of predation (e.g., parasitism) or of mutual benefit (e.g., commensalism). Conventionally, however, the term is value-positive and synonymous with the power and necessity of cooperation. Indeed, it is largely in this sense that the concept recurs in critical environmental studies—drawing extensively on the pathbreaking work of evolutionary biologist Lynn Margulis in the 1970s, translated for a general audience from the mid-1980s in collaboration with her son, author and historian of science Dorion Sagan. Whether in anthropologist Donna Haraway's summa of her cosmopolitical theory, *Staying With The Trouble* (2016), or the oft-cited article "A Symbiotic View of Life" from biologist, historian, and philosopher trio Scott Gilbert, Jan Sapp, and Alfred Tauber (2012), symbiosis is often presented as something of a conceptual and therefore political circuit breaker apt to interrupt the hold of individualism and utilitarianism as the false idols of capitalist modernity.

These texts have, without doubt, shaken my assumptions and shaped my current thinking. Indeed, it is in heeding their unwavering focus on relationality that I pursued the above conceptual history. I worry, however, about the risks of underinterpreting symbiosis as a foil to modernity and as proof that it is the dead-end of good judgment. Put directly: as a ground for reasoning, symbiosis is question begging. Symbiosis names but cannot resolve the puzzle of why and how one form of life must act upon, for, with, or against another to achieve its aims. If we—that is, human beings as much as any other form of life—have never been individuals, if we have always been relational, then the most treacherous and enduring of our projects are irreducibly relational as well, whether we grant it or not. Indeed, while the creative power of living labor as a driving force of collective organization is inspirationally democratic and democratically inspiring, nothing guarantees that participation produces respect or that disagreement aims at an otherwise instead of more of the same. It takes creative energy and collective organization to destroy something; it takes even more to keep destroying something.

Again, coral can be instructive. Recall that Darwin's bold hypothesis about the formation of coral reefs received "proof" in 1952 when U.S. Navy divers extracted a 4,152-foot coral core from Eniwetok Atoll in the context of nuclear weapons testing in the Pacific. It is inaccurate, Alistair Sponsel shows, to imagine this proof is isolated or spontaneous. As unprecedented as this coring was and as anticipated its evidence, it was but one component in a joint effort by civilian and military scientists to advance basic research into coral reef composition, morphology, and formation on the one hand, and the offensive and defensive capabilities of nuclear weapons use in a living ecosystem on the other. Were marine scientists troubled by the terms of this cooperation? Or did the destruction of coral islands constitute a useful practical test, albeit "morally regrettable," of the limits to growth that the burgeoning science of ecology sought to define? This symbiosis is difficult to reason through, but it is important to mark it as a moment in which ideas about what corals and by extension the global oceans *are* for scientific and military use were forged in relation to one another.

A broader view of symbiosis therefore opens up rather than shuts down possibilities for critique. The critical environmental studies literature I have mentioned is, within but particularly beyond the academe, frequently dismissed as idealistic not realistic, moral not practical. Hence, for instance, the all but official policy of the conservative-led Australian government towards the Great Barrier Reef through three six mass bleaching events has been to dismiss any expressions, discursive or organizational, of environmentalist "doomsaying." Such descriptions, of course, do not simply pave the way for geoengineering and the redescription of environments as markets for ecosystem services, they make them the *only* options. This makes positivist and critical approaches all but irreconcilable (and perhaps, by extension, "climate justice" and "climate action" as typically understood). But that may be the point: the purpose of political and moral disagreement is to decide how to act, which requires welcoming dissensus and making choices. It is possible to hear the insistence that some ways of orienting to coral reefs are "realistic" and others not is, simply, a defensive countermaneuver to perennialize one version of human-coral "symbiosis" as ahistorical and immune from scrutiny.

One way to push against the tendentious charge of "idealism" is to mark the following powerful presupposition in contemporary evolutionary theory (and revisionist take on the modern of idea of nature in the North Atlantic tradition): that ideals and morals are *optional and superadded* to social life as a matter of belief, custom, ethics, tradition, or opinion, but have no direct bearing on how the world "really" is. The many lives of corals demonstrate otherwise. At the level of concrete experience, whether for the melancholic lover in Ancient Greece or the children's author in Victorian England, what gives meaning, use, and force to coral is *not their mere existence in the world but their ongoing interest to the ordering of social life*. By interest, I do not mean rational individual choice but the ability to draw coral into some transindividuated description of reality, a "becoming-with" as Haraway puts it, the felicity of which seems to be coral's capacity to bear, adapt to and extend different projections of human ability. Again, this comingling is not metaphorical but eminently practical: people don't just point to corals in these moments but cast their lot in with them. One way, *and only one way*, of putting human-coral relationality to use is, precisely, something like "ecosystem services" and why not "corporate social responsibility," "carbon footprints," "emissions accounting," and so on too—all concepts which, it bears noting, are the brainchildren of industry, not civil society.

The fact that coral has "social currency" raises questions about *what people hope to do with coral* as they move through the world rather than answers about *how much people can do to coral* as the world outmaneuvers them. Some of those questions may not find satisfaction: there are limits to human-coral relationality. In my view and to paraphrase anthropologist Hugh Raffles (2011), human-coral relations deserve more than cost-benefit analysis and resilience thresholds; these are frustrating measures of the range of ways that corals and people alike organize life in an unruly world. Moreover, the abstractions of positivist science do not adequately capture the full spectrum of human-coral relationality that informs the historical present. For instance, many coral scientists themselves draw attention—either explicitly or implicitly—to the limitations of a strictly scientific interpretation of the plight of corals. This goes for scientists working at the microscale: among a transnational collaboration working the terms of coral bio- and geoengineering repeatedly characterize their labors as "buying time" for the marine environment in anticipation of more comprehensive political change. This also goes at the macroscale: some coral reef scientists whose early work laid the foundations for understanding the spatial and temporal scale of mass bleaching and ocean acidification are choosing, selectively, to break with the epistemic standard of the peer review process to quickly and directly appeal to public audiences; others are setting aside research altogether and engaging in science diplomacy through the IPCC or developing forms of expressly counterinstitutional citizen science. Not only do these three approaches indicate that there is no one definition of "good conduct" towards corals within the coral science community today, they are a further evidence of the ways that any project to shore up coral reef futures is also a project to advocate for some combination of epistemic, political, and moral becoming-with and not another. To be clear: my insistence on the moral qualities of animal life does not amount to an appeal to higher moral ground than that offered by, for instance, positivist science. It is rather an attempt to set the terms for a political anthropology of environment that adequately tracks the interestedness of environmental actors in setting the terms of social and political life through their descriptions of environment.

Conclusion

The ongoing and mounting distress coursing through the web of life on earth invites a profound reckoning over the human relationships *with* nature that drive and undergird this struggle. An overly general view of coral reefs makes it difficult to think this through, as it readily conjures a description of global society wrought from abstractions such as “trade,” “recreation,” or “research.” Such an approach helps produce coral reefs as subjects of economic and environmental management, yet rests upon a presupposition proper to the modern idea of nature that corals can be reducible to their “products and potentialities,” as Saville-Kent put it, by virtue of their seemingly limitless labor power. Such a description of global nature supports ways of thinking, acting, and feeling that make it difficult to appreciate the ways in which even the most assertive and destructive of human undertakings devolve upon intimacy with more-than-human nature.

I have said that one thing corals do not make for is eating. At yet, if people are to take responsibility for gradually warming oceans, does this not mean accepting that one thing we have come to do with corals is cook them? It strikes me that Rowan Jacobsen made precisely this suggestion in justifying his obituary: “All the research and interviews I’d done made it pretty clear that by 2050, *they’ll mostly be toast*, so that was the rough date I had in my head for the obituary.” Again, it is not necessary to take this expression as simply idiomatic, metaphorical, or the idiosyncratic slip of a writer confused because of his extensive prior writings on oyster reefs. To hunger is to desire is to long for intimacy. We might be living in a world in which we have profoundly destructive ways of sating our hunger for coral reefs. One thing ailing today's corals, for instance, is the insistence that they metabolize their own forebears, generations of reef-building invertebrates whose die-out marked prior mass extinctions and now constitute vast oil reserves that are drilled, depleted, refined, transported, and combusted every minute of the day.

By helping ourselves to a broader understanding of human-coral symbiosis we find a way into questioning our epistemic, political, and moral appetites and understanding the human and more-than-human agreements that have made the world—some creative, many destructive, some to celebrate, some to atone for, some to cultivate, some to ration.

CHAPTER TWO: ABSORBING PLANETARY BEINGS

The following chapter argues that coral reef studies in the 21st century have come to rally around and relay and understanding of corals as absorbing planetary beings, which is to say organisms who in their very form of life condense the complexity of global nature. Central to this absorbing quality, however, is an understanding of planetary nature as fragile and vulnerable in the historical present. This allows reef studies to not only use coral reefs to represent the complex process known as "climate change" to mass publics but furthermore recruit these same publics to relaying the alarm call by imaging the planet through dying corals as well. This amounts to a way of knowing as absorbing, which allows planetary coral science to directly address and recruit mass publics. This power is both a way out of past frustrations and complicities with political and economic actors responsible for reef harm. In so doing, coral reef studies encourage publics to become absorbed in earth distress as a devastating crisis yet without historical coordinates and preconditions. The chapter proceeds by explaining the embrace of a new agenda for coral reef studies at the 2016 International Coral Reef Symposium wherein the leadership team make the case that coral science must eschew the mere description of coral crisis in favor of explicit public recruitment (Section I). I then review the history of the consolidation of reef studies as a field and demonstrate that it has, from the beginning, put anxieties regarding the ignorance of mass publics and powerful political and economic actors to work in extending its remit (Section II). I return to the present and characterize just why the contemporary threat to coral reefs is different and historically existential for the field and its object, reef-building corals, in a way that departs from prior concerns about the "encroachment" on coral reefs by human activity (Section III). I close by analyzing a documentary film produced in close coordination with coral science leaders and with the express purpose of using the coral crisis to initiate a global climate action movement. I explain how the production of doubly moving images is central to this task, but in a way that leaves viewers with limited scope for action beyond reproducing more absorbing images of corals in crisis (Section IV).

1. Mass Bleaching is an Unconventional Foundation for Action

"Whatever we do for coral reefs is good for humanity," says the man at the lectern. His voice reverberates around the auditorium, the PA system reaches out to some thousand bodies seated on plastic fold-out chairs, arranged in uniform lines before a stage set to enthuse, with high ceilings, overhead lighting, twin projection screens, and a panel of the world's leading coral scientists. These are words of praise, praise for good deeds and for abundant oceans and for humanity's better angels. They also amount to a remarkably open-ended warrant for "action" in a time of grave fears over the harm that global society poses to global nature. If I establish a moratorium on tourist charters to Great Barrier Reef, is that good for coral reefs and humanity? What if installed offshore oil drilling equipment that had fail-safes capable of reducing any risk of spill? Or elevated that stature of corals with an ad campaign that showed they are repositories of anti-cancer drugs? Reflecting upon the statement, there seem more questions than answers to what deeds connect humans to corals and to what ends. And the words sounded good, felt good; it was a strikingly unqualified moral high note on which to conclude a crisis summit. I barely get to register a scribble in my increasingly unmanageable notebook before another man takes center stage and summons the audience to its feet, with whom, after a moment's hesitation, I rise as one.

He brandishes a camera and a tripod and encourages us to assemble for a photograph. I know of this man. His kit is professional and talent for rallying the crowd equally practiced. This is no amateur photographer or academic dogsbody. The pose had not been announced in advance, however, and something about the moment feels rushed, unplanned, but also decidedly auspicious. He gestures towards the screens behind him: “if you all agree with the final slide stand up!” I fail to note the exact image, but know it glosses the shared plight of corals and the planet, as so many had before it. The details do not seem important, because it feels like we’re being polled less on the contents of a slide than on our appetite for group activity. We oblige, and he asks for another formation in which we all raise our hands. He uses his own body to show us what to do. It is the familiar gesture of the photographer who poses for their subject to coax an imitation in return, an act of choreography that builds a fleeting intimacy in the moment before people become pixels. There is some murmuring in the crowd, but mirth as well; this is not an occasion for deliberation, we raise our hands. The shutter fires (I presume, I am too far away to hear it, after all) and we disassemble. I feel evangelized.

It is June 2016, and for four days I have circuited in and out of the Hawaii Convention Center as one of two thousand people attending the 13th edition of the world’s largest professional gathering of coral scientists and reef managers, the quadrennial International Coral Reef Symposium (the Symposium). For the better part of the last half century, scientists investigating global coral reefs and their distinctive lifeways have faced a troubling predicament. While their research object is ancient, the result of millions of years of continuous development, its present-day trajectory has become one of gradual, sustained decline pointing to an approaching horizon of total collapse. How are coral reef scientists confronting this prospect? Why are some of the most influential members of its institutionalized form organizing themselves as something of a coral salvage thought collective and to advance call for collective action? What picture of moral good and ethical conduct underwrites this new kind of science? For some sense of why I ask this question, consider the official theme of the 2016 Symposium:

"bridging science to policy." From one aspect, it seems passing strange that veteran and novice members of the International Society for Reef Studies, typically far-flung and with widely divergent disciplinary affiliations, would set a time and place to gather, catch up, and affirm their understanding of coral reefs as a common research object only to point to another kind of practice, policy, as their intended destination. From another aspect, it is possible to read this thematic heading as a familiar story about the proper dispensation of knowledge and authority when it comes to the modern governance of nature. That story goes something like this: Scientists determine the capacities, tendencies, and limits of some set of living things and natural forces; Legislators take up this evidence-base to regulate proper and improper use; Epistemic and political authority thereby align and reinforce one another in persuading publics to maintain good relations with the physical world on which they depend. The fact that science and policy and the general will are far more complicated does not diminish the tenacity of this story.

To take a recent example, throughout the Covid-19 pandemic, political officials and publics have appealed to scientific authority to propone policies whose aim is to configure individuals, families, and society writ large in some durable if strained relation to a novel family of coronaviruses. Such appeals have occurred in a wide variety of cultural and political contexts. Moreover, this form of relation—science as a bridge to policy—has proven capable of accommodating subtle shifts if not outright reversals in content. In the United States, federal authorities have consistently aligned themselves with statements like "science is back," "trust the science," or "the science is clear" even as they repeatedly revise their policy positions. And in response, would-be counter-authorities have consistently burnished their credentials by wheeling out counter-experts, counter-studies, counter-statistics, and counter-policies united behind such statements as "we do our own research."[31] Moving closer to the concerns of coral science, this same authorizing sequence dominates the history of climate science. As historian Joshua Howe demonstrates, from the 1950s onwards researchers working at various international institutions, many based in the United States, viewed the threefold planetary scale, uncertainty, and consequentiality of global warming as the occasion for a new compact between science and society. According to the leadership of the American Academy for the Advancement of Science (the Academy), there is a "forcing function" to knowledge that can alter the terms of political deliberation. The thinking goes like this: an appropriate demonstration of scientific consensus would produce political consensus and thus effective climate policy, no matter the unpalatable disruptions to historically existing norms and forms of governance. Howe cites Robert White, former head of the National Oceanic and Atmospheric Administration, who, in 1977, expressed his hope that the Academy could build "the bridge between the complexities of the science and the general public and the policy-makers" (J. P. Howe 2016, 111). In sum, the "science-to-policy bridge" downplays scientific knowledge as an end it itself while, also and at the same time, installing the epistemic authority of science as a necessary catalyst for political action.

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It is worth appreciating the considerable ambivalence that this elevation of the importance of knowing coral reefs as a precursor to some desired yet open-ended form of action can provoke. The emphasis on "policy" directs the attention of coral scientists away from their traditional interlocutors in reef managers. For decades, a professional distinction separated, on the one hand, researchers responsible for studying the biology, behavior, and evolution of corals, sponges, tropical fish, nudibranchs, turtles, whales, birds, mangrove forests, kelp forests, currents, waves, and so on from, on the other hand, officials responsible for tending to the everyday exposure of the multitudinous reef matrix to shipping, fishing, drilling, construction, agriculture, tourism, poaching, and so on. This division of labor is far from absolute. It is typical for marine park rangers, government bureaucrats, and high-ranking administrators to train in one of coral science's many core disciplines and so, in the course of their work and in their dealings with professional coral biologists, marine toxicologists, and terrestrial ecologists engage in learned debate about coral reefs as "environments" available to direct and indirect acts of human impingement. Reef managers, what's more, continue to pursue their own research agenda, whether through publications in generalist scientific fora or in specialized environmental management journals. The Symposium organizers are quite aware of these dynamics. In his opening address, Bob Richmond proudly noted that gone were the days of the Symposium as a place of "nerds and geeks talking to geeks and nerds." The established norm is that over half of all attendees are reef managers. He went on to explain, moreover, that the conference organizing committee had considered labelling attendee badges with roles such as scientist, manager, educator, policymaker or cultural practitioner only to decide this was a "really dumb idea" given the inherently transdisciplinary nature of the field. This stalled labelling initiative is telling. As with enumerations of the myriad forms of creaturely life that make up the reef matrix, the move to list the diversity of roles gathered under the rubric of "coral science" demonstrates the field's remarkable plasticity when it comes to coordinating differing epistemic and social perspectives. Yet also and in the very same gesture, it draws focus on differences in attention, method, and responsibility that index powerful internal tensions as to what a coral reef is "for."

The 2016 Symposium claims "policy" as its destination in order to harness a political technique that goes beyond the "management" or "administration" of coral reefs as bounded environments and so advance an open-ended call for social change. What bears this out is the conference's second theme, mentioned at the opening plenary session yet silenced in official proceedings, which translates “bridging science to policy” into the more general terms of “moving from knowledge to action.” There is a very practical reason for this generalization. Not only were reef managers present at the Symposium, but so too were policymakers, not least of which the heads of state of Palau, the Federated States of Micronesia, and the Marshall Islands along with members of their cabinets. In lauding their attendance, Richmond emphasized the pressing need for a more capacious understanding of what “knowledge” of coral reefs entails, one that encompasses the cultural and legislative capacities of all the world’s people.

There is a way in which the embrace of so-called “traditional ecological knowledge” by dominant scientific authorities rings hollow, given that the latter’s claims to expertise devolve from a North Atlantic tradition committed to the devaluation if not destruction of epistemological “alternatives” to modernist empiricism. The very need to reach for another term in knowledge, however philosophically rich, is indicative of wish to insist that “science” is not just *any* kind of knowledge. Indeed, many aspects of the conference suggested that this call for a wider understanding of knowledge was largely symbolic. The vast majority of papers, panels, and conversations on display espoused and extended the empirical assumptions of modernist science. For instance, it was not to epistemological syncretism but geopolitical alliance-making that an Administration representative appealed when, giving her version of the knowledge to action theme, she declared: “the days of having four years lag time or more for incorporating those scientific principles and understandings that you all present at this symposium are over. … The high-level representation, having three chief executives of Pacific Islands states present speaks to the urgency and importance of using the scientific information that this meeting brings, and closing the gap of implementation of the message that that science needs to communicate

BRIDGING SCIENCE TO POLICY

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Editors

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Figure 15. The 2016 ICRS logo, seen here on the cover page of the official proceedings, depicts coral reefs held aloft and held together thanks to a syncretic union of different knowledge traditions. (Source: International Society for Reef Studies)

and translate into local action." Cultural difference, here, seems at best an opportunity for multiple reinforcing translations of the same urgent and putatively universal scientific "message."

What the insistence, then, on the open-ended destinations of "policy" and "action" show is a profound faith in the idea that coral reefs have the potential, however seemingly historically foreclosed by the crisis bearing down upon them, to rally multiple traditions of knowledge and inaugurate a new, harmonious, horizon for global society. The conference logo visualizes this aspiration (Figure 15). From the sails of a Polynesian fishing vessel, a double helix structure unfurls and feeds into a pair of open hands that embrace a branching coral, among which fish and a sea turtle glide, surrounded by dancing figures and topped by the changing phases of the moon, all upon a blue gradient. Appropriately, Ruth Gates, president of the International Society for

Reef Studies (the Society) that organizes the Symposium, put words to this wish in her own opening address: "Our society can step up and be something we haven't been in the past and the question is—what might that be?" It is unclear whether "our society" refers here to the Society, a professional organization responsible for producing knowledge of coral reefs, or to global society, the broader collective from which the Society draws its numbers and whose cumulative and ongoing deeds, ostensibly and ultimately, pose a threat to coral reefs. Gates' statement waxes praiseful, much like Richmond's "whatever we do for coral reefs is good for humanity," and the force of that praise again presumes a sense of moral clarity, tutored by coral reefs, capable of averting the manifold minor and major catastrophes that an otherwise open-ended call to action in the name of wholesale societal change invites.

Taken in this broader sense of a call for open-ended action, the closing scene I began this section with—coral scientist and conference host Bob Richmond's words of praise and advertising executive turned ocean conservationist Richard Vevers' commemorative group photograph—performs a version of the conference's message, as if to say: you have all come here to talk, listen, and learn before an abyss, and now we release you, united, to overcome it hereafter. And yet, as with so many other ritual gatherings, the efficacy of the scientific conference, including its closing authorization, depends upon creating its own kind of schism, namely, the motivated suspension the daily deeds and duties of its attendees (Durkheim 1995; V. Turner 1974).[1] When not convening once every four years, the New Caledonian coral biologist labels specimens and responds to emails, the Filipino marine park ranger issues permits and attends meetings, the American PhD student measures fish and submits grants, the Dutch

[1] The professional conference is a frequent locus of ethnographic interest for the anthropology of knowledge. It is a ritual space in which a tradition of inquiry gathers to manifest, exchange and so renew its collective bearings through activities that amplify some questions, assumptions, and interests and downplay others.

geneticist sends off samples and renews their SCUBA credentials, the Palauan politician fields media requests and allocates funding, the British laboratory technician checks water chemistry and orders new inventory, the Australian fisheries scholar reviews media coverage and receives text messages from local contacts. These are so many actions that underwrote countless presentations in the preceding days and are, as such, the very scaffolding of the scientific knowledge that the Symposium legitimates. Even as the gathering itself gives such individuated activities the imprimatur of collective purpose, its theme marks them off as *preliminary*; they fall short of a threshold, towards which a bridge must be built and beyond which lies action *proper*.

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A tweet published to the conference's official social media account provides some sense of the abiding tension this configuration of knowledge and action rouses (Figure 16). It features a photograph of the cavernous ballroom, its seated audience, Bob Richmond as distant speaker, magnified on the split screen and a caption excerpted from his opening address: "Over ½ of the sessions are solutions oriented. I have to be optimistic or I can't get up in the morn." In this 145-character snapshot of Richmond's speech, the host first redescribes the symposium's thousands of sessions as a two-way split between looking for solutions and not, which is to say, presumably, merely posing problems. Then, in a personal aside, he admits that ordinarily, he faces the danger of an existence condemned to inaction, which he overcomes by committing to optimism. There is a "glass half full or else" quality to the description. The threat has a familiar ring, insofar as the purposelessness of the bedridden evokes the curative powers of labor and so the compulsory connection between work and character in the American tradition and perhaps especially the American academe (Livingston 2016; Malesic 2022).

Figure 16. Bob Richmond addresses the audience at the 2016 Symposium, then live-blogged on the official Twitter feed. Just as coral reefs have become media objects, so too has the professional science milieu thereof. (Source: International Society for Reef Studies, Twitter)

Yet this is not, or at least not only, a personal example of existential or even professional doubt. Richmond's spleen is a practical problem that coral science, incarnated in the conference, lifts. What vindicates the host's optimism is the balance of content his guests have produced. In fact, more minimally, it is their mere presence. In his speech, Richmond discloses a recent nightmare in which he turned up to speak only to find the auditorium empty and then declares that, as this has not come to pass, his waking optimism remains steadfast. The fact Richmond's had the nightmare is no cause for concern or further interpretation, it would seem, because what he sees before him is nothing less than a happy ending. This unwavering commitment to not wavering makes it quite hard to discern whether he is persuading the audience to get up and go on, or they him, to wake up or to keep the dream alive. The official tweet, moreover, invites further parties to this communicative interaction which adds further plies to the tangle of authoritative knowledge and authorized purpose. Indeed, there is something almost tragic to imagining the exchange seen, recorded, and released "live" before anyone has a moment to ask (or even think to ask) who is orienting whom, why and where. One thing seems certain, however, from these purposeful if confusing closing moments at the Symposium: the world beyond it is an inhospitable place.

The vocation of coral science is to become a means to some other ends, "solutions" to the problem of a wanting world. This is an appeal that reaches beyond "policy," the ostensibly transformative destination of the Symposium. In collapsing the sentimental and the professional, Richmond signals that to know coral reefs today is to court despair, whose paradoxical upshot is a desire to create a world in which coral reefs—and coral scientists—can live otherwise.[2] Put differently, Richmond is saying that coral science as a vocation involves not only attending to *what coral reefs are now* but solving for *what they—and all of us—might yet be*. Delivered from the authority of the lectern and along with the group photograph and the social media recirculation, these are so many attempts at making this desire a reality. So, what is coral science solving for and why? If not scientific description, then what kind of policy or program of action do the symposium's organizers have in mind? What kind of knowledge leads to it? Is the "bridge" between the two discernable, as if in blueprint form, from the Symposium goings on?

[2] Braverman (2018) documents this oscillation between hope and despair as a recurrent motif of the emotional lives of coral scientists today. My interest lies in locating this desire for an otherwise historically and the authority it seems to give coral science to make pronouncements about the nature and needs of life at the planetary scale.

2. The Making of Reef Studies as a Global Field

Some sense of the 20th century institutionalization of globalized coral science is in order before turning to the nature of the present-day threat to coral reefs and its interpretation by an emerging coral salvage thought collective.

The first Symposium convened in January 1969 at the initiative of the Central Marine Fisheries Institute headquartered at Mandapam Camp in southern India, a complex the British colonial government had constructed at the turn of the 20th century to house plantation workers migrating from present-day Sri Lanka. Part of the meeting's purpose was to begin consolidating coral reef studies as a field socially and epistemically. This meant using the distinctive composition of coral reefs to advance a transnational redescription and reorientation of studies in marine biology, tropical ecology, oceanography, and fisheries management. The initial Symposium's 72 attendees from 12 different nations mobilized their personal and institutional networks, and so the political capital earned in in the course of prior research, to elevate coral reefs as a physically disparate yet conceptually unified object of research. Establishing the coral reef's status as a geographic abstraction might if not supersede then at least temper the urge to regard coral reefs as individuated, local entities impervious to abuse.

Notwithstanding the empirical merits of their findings, foundational inquiries into the lifeways of coral in the modern biological and geological traditions—such as Charles Darwin's 1842 *The Structure and Distribution of Coral Reefs*, the proceedings from the joint British and Australian *Great Barrier Reef Expedition* of 1928, or surveys of Bikini and Enewetak atolls led by the United States Geological Survey (the Survey) following the detonation of 67 nuclear weapons on the Marshall Islands between 1946 and 1958—were largely grounded in national political and military interests (McCalman 2014; Sponsel, Gillis, and Torma 2015; Sponsel

2018). They tended to presume, moreover, that reefs were durable structures perpetually renewed thanks to the indefatigable labor of corals. Coral reefs might be capable of change, they are organic after all, and yet that change was largely a change of form rather than of state. Indeed, it was not the potential threat *to* coral reefs that required study but the potential threat *from* them—e.g., to shipping, commerce, military activity, etc. The Survey's work, for instance, led brothers Eugene Odum and Howard Odum to offer coral reefs as models of self-sustaining ecology: "save for fluctuations the reef seems unchanged year after year, and reefs apparently persist, at least intermittently, for millions of years" (Odum and Odum 1955, 291). Yet as with other "systems" such as lakes, rivers, and forest, the new language of ecology raised questions as to the limits, affordances, and comparability of coral reefs. These questions became especially pressing in the 1960s in light of growing public awareness of the dangers of industrial society to nature. The writings of Rachel Carson and the films of Jacques Cousteau were especially effective at amplifying the "environmental movement" as it began to direct its attention away from policymakers and towards public communication. In Carson's case this also involved alerting publics to the possibility that scientists *themselves* were perfectly capable of harm.

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One of the early milestones of the group organizing to institutionalize a globalized science of coral reefs was the 1978 publication of *Coral Reef Research Methods,* under UNESCO's imprint no less. This show of institutional support marked coral reefs as objects of transnational scientific and cultural value. The publication's ostensible purpose was to fulfil a prerequisite for formalizing coral reef science as a research field, namely, "that some standardization of methods was required to ensure compatibility of results between different areas" (Stoddart and Johannes 1978).[3]

In the preface, UNESCO refrains from endorsing the "opinions" of the volume's authors but nonetheless lists a range of troubling "encroachments" on reefs, from oil spills to spearfishing, and explicitly connects the inherent "complexity" of reefs to their "susceptibility" to external influence. "Despite the considerable research which has been carried out on coral reef communities," the anonymous authors of the UNESCO preface write, "human influence on this environment is proceeding faster than our ecological understandings of the changes that are taking place" (D. R. Stoddart and Johannes 1978). These words reflect a changing understanding of coral reefs, globally connected by the possibility of threatening human influence. They suggest, moreover, a twinning of two orders of uncertainty, epistemic and practical. Complementing this milestone was the launch of two publications. The academic journal *Coral Reefs* intended to complicate the survey-oriented reports of the established *Atoll Research Bulletin*, comprehensive yet locally circumscribed, with more process-oriented studies that might support ecological generalizations. The journal's editorial line marked a move towards studying coral reefs as a dynamic composition of different biological forces with observable temporalities and away from treating them as primarily geographic entities whose rate of change is slow, cyclical, and unamenable to direct inquiry. *Reef Encounter*, the second publication, intended to catalogue the institutional and social life of the society and so provide something of an official backchannel for reproducing anecdotes, testimonies, and snapshots of human interest within a

[3] Stoddart's introduction notes that the idea of such standardization was discussed at the first Symposium in 1969 and then formally endorsed during meetings with the International Association for Biological Oceanography (IABO) and the Scientific Committee on Oceanic Research (SCOR), two international research governance bodies whose support was critical for credentialing coral reef science as a standalone field of study.

historically exoticized field.[4] In Sum, at stake in consolidating coral science from the 1960s onwards is not only the possibility of better descriptions of coral reefs, but the sense that a *current lack of knowledge is, if only indirectly, a threat to coral reefs.*

One of the driving forces behind these efforts was British geographer David Stoddart, whose irreverent reminiscences upon these founding decades demonstrate the extent to which transnational coral reef research evolved in lockstep with geopolitical developments while aspiring, simultaneously, to transcend them (Stoddart 2001). Time and again, the conditions of possibility for Stoddart's research were not only the abstract constants of institutional affiliation and grant funding but the direct and material interests of governments and corporations. What follows is a snapshot of some of Stoddart's research commissions. In 1966, the British government wanted to develop advanced staging posts for naval warfare on Aldabra Atoll in the Indian Ocean yet, after the Royal Society's intercession, assented to first take into consideration the findings of an ecological survey. In 1973 and 1975, US military helicopters airdropped supplies and fieldworkers on the Phoenix Islands in the vicinity of present-day Kiribati to determine the likely impact of developing the area to test intercontinental ballistic missiles. In the late 1970s, the UK foreign office was suspicious of the intentions of a Soviet research vessel operating in British waters in the western Pacific and wanted a British observer aboard. In 1985, insurance broker Lloyds of London wanted to know whether a tanker sank in open water because of prior impact with an Atlantic reef, as the policy holder claimed, or sabotage. Stoddart's many exploits demonstrate that the consolidation of coral science as an independent field of research

[4] *Reef Encounter* was not the first nor the last publication of its kind. More recently, the contributions to "corallist," a public email listserv managed by the US scientific agency National Oceanic and Atmospheric Administration, shuttle between personal anecdote, political opinions, fundraising appeals, and announcements of recent publications both academic and general audience. For a historical investigation of the critical role that shared geographically remote fieldwork experience plays in thickening epistemic solidary before the 20th century, see McCalman's (2009) monograph on the bond of seafaring that committed Joseph Hooker, Thomas Huxley, and Alfred Wallace to Charles Darwin's cause. For an important investigation of exoticism within coral reef research, see Elias (2019).

apt to address "encroachments" on reefs was not removed from geopolitics but thoroughly embedded within it. Coral reef science earned its institutional stripes by proving itself the equal of political economic forces looking to capitalize on a new kind of knowledge in order to advance their claims to power.

If coral reefs make for strange bedfellows, Stoddart is candid and nonchalant about this promiscuity. He records the many ends which his research career served yet does not come across as overmuch proud of this flexibility. Rather, his responsibility, indeed, his loyalty lies with coral reefs and the scientific record. The sense of achievement Stoddart's life in review conveys is to have courted danger and power on the high seas, human and nonhuman, in tenacious pursuit of fieldwork on reefs and the knowledge it yields. The unifying theme of coral science as a higher calling crescendos with his closing reflections on institution-building, from his participation in the Symposium to its consolidation through the academic association launched in 1980 to oversee and extend the first gathering's remit, the International Society for Reef Studies.[5] Yet it is perhaps an anecdote that best sums up this outlook. Having smuggled contraband for a Russian colleague to a 1979 scientific gathering in the far east of the Soviet Union, Stoddart vaunts his willingness to defy the laws of country, enemy, and family in the name of epistemic solidarity: "My wife said, 'You must be a total idiot if you do this,'" he writes, "but then I thought I would trust any reef worker implicitly as members of a common brotherhood" (Stoddart 2001, 258).

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[5] Stoddart is insistent on the sense of moral uplift that an expansive epistemic perspective affords. In the 1986 Carl Sauer memorial lecture in geography at the University of Berkeley, he called for the discipline to "claim the high ground" in not only academic but world affairs (Stoddart 1987). Reconstructing a history of the discipline, he invokes such figures as Kant, Humboldt, and Kropotkin to decry the perceived narrowing of geographic attention to studies of "space" rather than "place," which spells a lack of curiosity and concern for the human doings that depend upon—even and perhaps especially as they can sometimes compromise— "land and life."

Parallel to this transnational institutionalization of science, from the 1950s onwards a singular threat to the integrity of the world's coral reefs helped elevate their status as objects of combined epistemic and public interest. I refer to seemingly inexplicable decadal spikes in populations of the *Acanthaster* family of starfish, more commonly referred to as the crown of thorns starfish, which traversed, smothered, and devoured tropical reefs throughout the Indo-Pacific with astonishing speed.[37] Put briefly, as the same kind of starfish bore down on different reefs around the world, understanding its behavior fostered collaboration across geographies and so supported a comparative approach to studying coral reefs and their conditions of transformation.

As historian Jan Sapp explains in his 1999 monograph on the subject, precisely because the

Post-Courier, Wednesday, March 31, 1971—3

Starfish again

SCIENCE PUPILS IN BIG "FIND"

A group of 23 Port Moresby Technical College science students have brought 24 Crown of Thorns starfish from Local Island.

The students — most of whom are from the Highlands — collected the starfish during a science excursion to the island.

They were accompanied by their science teacher, Mr Bob James, and a Department of Agriculture, Stock and Fisheries officer, Mr Jon Peters.

In one section 50yd x 50yd of the reef, the students found eight of the starfish, Mr James said.

Mr James said the excursion followed approval by the Department of Education for Territory students to do research work on the Crown of Thorns starfish.

"Most of the students are from the Highlands so it was a great experience for them," Mr James said.

"We brought back 24 starfish — we did not expect to get many at all.

"The students found that the starfish moves from one reef to another and hides away from the sun," Mr James said.

Mr James said the students buried some of the starfish and had kept several ...

... had also been circulated to the schools.

Research reports

Reports on the research were being done for future reference.

The college report is expected to be completed and presented to the DASF research and survey section this week.

The Crown of Thorns starfish (Acanthaster planci) feeds on coral and has done extensive damage to sections of the Great Barrier Reef.

It has also devastated a great portion of coral reefs around Guam.

Extensive research work on the creature is being carried out in Australia and Guam.

NZ goods have 'bleak outlook'

By NOEL PASCOE

New Zealand produce has a bleak outlook in Papua-New Guinea following a sharp rise in freight rates.

Frozen foods and hardware could be affected.

But New Zealand producers may gain a reprieve in the Territory if moves to start a new shipping line succeed.

The Territory agents for the New Zealand Export Line, Steamships Trading Company Ltd. announced yesterday that freight rates to Papua-New Guinea had risen by 25 per cent.

Steamships' overseas shipping manager, Mr L. M. Lonngren, said the line increased its rates by 15 per cent last year.

He said New Zealand Export Line's reason for the increase was "economic necessity and continu...

"Now they have dropped behind.

"It's natural that we will look more towards Australia in future," he said.

Looking at possibility

Mr B. C. Goodsell, general manager of Burns Philp, said a New Zealand line was surveying the possibility of running a service to the Territory.

"We should know by May if they will go ahead. Other than that, I can't say anything at this stage."

Mr Goodsell said the future of New Zealand goods in BP stores would lie with the customers.

"If they still want the goods, we will continue to stock them," he said.

"Some people continue to buy things no matter what the price — if they want them, we will try to supply them."

JAILED FOR ASSAULT

THE DRUM

THE council house at Henganofi is about to be rebuilt.

It was burned out earlier this year when some "metho" drinkers let the booze get out of hand. This time the councillors are using bricks — appropriately supplied by the Corrective Institution.

★

SOME of the unrecorded efforts of the Scout-a-bout are coming to light. Kenny Avia, of Hanuabada, finished the 13-mile Port Moresby course in less than three hours. Kenny is only 10.

★

A COLLEAGUE received a letter that had been posted nine days previously in Melbourne. Just as he was calling the Posts and Telegraphs boys a few polite names he noticed on the back of the envelope that it had arrived via Valletta, Malta.

★

WHAT do you do when you ring up Information and cannot get through?

A reader in Port Moresby says he was able to type an 18-line letter with one finger while waiting for Information to answer.

★

AT Panguna Post Office a young worker on the copper project received 52 registered envelopes. The delight was evident in the recipient's eyes until he was told the Customs officer wanted one of the letters opened. Sure enough, one playing card was revealed.

★

DR GUISE is reported as saying in Jakarta that self-government would come into being "like the rising of the sun from the east", no one could prevent "its setting in the west". Some people are wondering if that means its going to be all over in one day.

—James O'Brien

Figure 17. When is a "find" not a finding? A scientific puzzle incarnate, the crown of thorns starfish problem was ready-made for mediation. This article (from a 1971 edition of the Papua New Guinea Post-Courier, then an Australian colony), shows multiple layers thereof: a high school excursion to conduct starfish collection, facilitated by government officials who nevertheless downplay its results, which the reporters use to recast the persistence of the broader puzzle. (Source: "Starfish again," *Papua New Guinea Post-Courier,* March 21, 1971, 3. Copyright (1971) by News Corp)

crown of thorns starfish was well-established as a "natural predator" of coral yet had never been recorded devastating reef flats at such scale, its repeated irruptions raised a troubling prospect. Either there was a profound misunderstanding of the fundamental processes at work in the marine context across time or something historic was happening, perhaps under human influence, to disrupt these processes at a global scale (Sapp 1999). Not unlike an oil spill or overfishing, to reprise UNESCO's terms of reference, this was a patently "deleterious encroachment" upon the complex lifeways of coral reefs. Yet as the ostensible perpetrator here was not human, if there was a social cause for this undesirable turn of events then its operation was indirect and invisible. The search for answers prompted widespread dispute, which played out behind the closed doors of meeting rooms and in the popular press, and ultimately elevated the sense of threat posed by a lack of knowledge about coral reefs. "Starfish again" reads the short headline to one newspaper article, suggesting the frequency of these media mentions, perhaps with a note of exasperation at the endless proliferation of "findings" without a seeming answer in sight (Figure 17).

As the value of coral reefs for supporting fisheries, staging naval operations, and attracting an increasingly diversified leisure class was beginning to supplant their longstanding associations with shipwrecks and colonial rule in the tropics, the crown of thorns starfish served as a charismatic scapegoat in a broader cultural shift towards viewing coral reefs as potentially fragile places. In other words, knowing coral reefs became a moral crusade. Local and global environmentalist organizing would further advance this case through campaigns to "save" coral reefs from the open-ended effects of industrial modernity. In response to these pressure campaigns—often conducted through the media, backed with scientific research, and working in coalition with existing organized political actors such as trade unions—the federal governments of the United States and Australia established marine parks and sanctuaries from the 1950s onwards, including the vast 350,000 km^2 Great Barrier Reef Marine Park Area (Bowen and Bowen 2002). Meanwhile, at the global scale, the United Nations led a decades-long consensus-based process to rewrite international maritime law that culminated in the 1982 Convention on the Law of the Sea. These versions of coral reef and by extension marine governance involved bootstrapping existing notions of territorial sovereignty to demarcate maritime jurisdictions and institute a property relations regime, which gave new powers to state actors to enforce rules of movement, trespass, use and abuse.[6] The compact between coral science and reef regulation that ensued presumed a new kind of action on the part of government authorities, namely that of "managing" and "controlling" for a more or less delimited range of conduct that would preclude identifiable acts of misuse. In conversation, a government official put it to me as follows: "we're in the business of managing people not corals; we can't exactly tell corals what to do, can we?"[7]

*

At the cusp of the 21st century, however, a new kind of threat came to dominate scientific and public understandings of coral reefs, which strained the settlement of regulatory and scientific authorities. That threat is ocean warming and acidification, major drivers of what I have been calling earth distress and to which I will shortly turn. The strain this threat placed on the organization of coral science can once again be observed within the Symposium. In the late 1990s, early reports that gradually rising ocean temperatures were interrupting coral growth and

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[6] For an important discussion of the fault line that runs through the very concept of the environment by virtue of its presupposition of territorialization, see Bond (2018).

[7] It has recently come to my attention that this characterization of conservation management as directed towards "controlling" for people and not for environments is rather widespread and has a specific pedigree, namely the Canadian academic, media personality and environmental activist David Suzuki. Its genealogy would therefore place it within a specific tradition of 1970s environmental conservation as a liberal undertaking. It was the first leader of the Great Barrier Reef Marine Park Authority, Richard Kenchington, who took this expression up as the organization's mot d'ordre, passed on to subsequent generations of officials—including the one I am quoting.

causing large-scale reef decay met incredulity on the part of some members of the coral science community. Some outspoken scientists, such as Dutch-born and Australia-based Ove Hoegh-Guldberg, were reputedly shouted down and called chicken little for extrapolating from local reef studies to predict that coral reefs the world over would collapse within a generation. By 2000, however, the broad thrust of these predictions found generalized agreement and coral science conferences gained a reputation for despondency.

In a recent issue of *Reef Encounter*, another Australian reef scholar, Peter Sale, gives a sense of this mood and its basis in a growing rift between coral science and reef management policy, recalling two presentations delivered at the newly formed 1999 US National Coral Reef institute (Sale 2021). An Administration representative gave the keynote and referenced the recently formed US Coral Reef Task Force but made no mention of the word “climate.” Another plenary, from a Kansas-based hydrologist and chair of an international working group on coral reef responses to global change, was ominously titled “Is it time to give up?” The presenter answered emphatically in the affirmative. In what appears to be a version of the same talk published two years later, he ends with this: “if coral reefs as we presently know them can be preserved at all, they will almost certainly NOT be preserved by our present approach to the problem” (Buddemeier 2001, 325). That approach was to regard reefs as conceptually unified yet available to local governance such that coral scientists could sustain a “go along to get along” relationship with local politicians and administrators in the name of funding, research permitting and professional decorum. The emerging scientific consensus on the planetary scale threat to coral reefs, Buddemeier states, is incompatible with policies that prioritize avoiding short-term risk and maintaining reefs in “good condition.” Under this description, what encroaches upon coral reefs is no longer heedless action in a world without empirical knowledge of biological complexity but, rather, the reckless counteraction of would-be reef managers when presented with undesirable knowledge of planetary-scale change.

As coral reefs gave an empirical window onto the radical dependency of life upon interconnectedness not only at the oceanic but now also at the planetary scale, coral science extended its remit from anticipating direct and indirect encroachments on coral reefs to anticipating direct and indirect encroachments on the whole earth. In 2008, Charlie Veron, known as the "godfather of coral" for his field-defining work in rewriting coral taxonomy and with it natural history (see Veron 1995), published a definitive monograph on the coral reef assemblage that launched his life's work. That book, *A Reef in Time. The Great Barrier Reef From Beginning to End* (2008), again leads from its very title with a sense of finitude. What bears appreciating is that the terminal subject under consideration is less biological (*i.e.* corals as living organisms and reefs as physical structures) than sociological. Put directly, it is the prospect that human beings can *share a world with* coral reefs. A final statement from the same period conveys this point as a matter of overarching concern for the now consolidated interdisciplinary field. In a 2004 issue of *Reef Encounter*, outgoing Society president Terry Done published a statement drawing a line under his tenure and the state of the international coral science. Here is an excerpt:

> "With a much larger and more materially demanding humanity, and with the pressures on coral reefs and their resources multiplying and compounding, the question of why, how and where [coral reefs exist] have an unwelcome companion. What must be done to secure the future of coral reefs? The answer to this question will vary from place to place, and it will have many dimensions that are beyond the present scope of this Society" (Done 2004, 3).

Here, Done offers a version of the field's organizing question (why, how, and where do coral reefs exist?) and a bracing answer: in imminent danger from humanity, the source of a novel and "unwelcome companion" question mark over the future. On the surface, the statement marks a shift in epistemic focus for coral science, away from empirical descriptions of the natural processes that have held reefs together and towards interrupting the social processes that are bringing them undone. And yet, as I have shown, the institutionalization of coral science presumed the entanglement of science and society from the very first and participated, however unsatisfactorily in hindsight, in setting the terms of reef "management." The change that Done's statement evinces is thus rather one of perspective: away from a view of coral reefs as bewitching and life-giving ecosystems threatened by discrete and preventable acts of encroachment and towards a view of coral reefs as mediators of interconnected planetary life in dangerous, exceptional copresence with "humanity" as a historically particular and universally threatening, if not outright malevolent, form of life. This shift in aspect provides the sense of an unbridgeable gap between science and society, a gap held open by the terms of the prevailing compact between transnationally organized research and the very practices they have made available to local and national reef managers.

From its initial gathering of 72 people from 12 countries, the Society has grown into a vast organization with over 2,000 members, four regional chapters, two widely circulated flagship publications, and it continues to serve as a clearing house between empirical science and reef governance. Since the turn of the 21st century, it has accelerated its activity of brokering relationships with international conservation groups, in part under the umbrella of the International Coral Reef Initiative, an UN-sponsored consortium of state, corporate, and non-governmental organizations. And it continues to reassess opportunities to advise on transnational ocean governance whether informally through member initiatives or collectively, including a recent successful petition for the Society to act as an "observer" to the Glasgow COP26 summit. Part of the purpose of this historical review is to serve as a caution. It would be incorrect to state that the coral science community has come belatedly to regard coral reefs as fragile.[8] Indeed, for the large majority of the current membership of the Society, it is under this very description of imminent threat that they came to know their research subject. This is a world away from what the brothers Odum hypothesized in elevating coral reefs as a closed ecological system. The 2016 Symposium commitment to "bridging" science and policy therefore signals a shift in the temporal and spatial scale at which coral science considers the threat of human activity to coral reefs and so the field of application of its own findings. Coral science consolidated its epistemic authority by elevating a form of globalized life alongside and in cooperation, however uneasy, with political forces engaged in globalized struggles over the direction of social change. Yet while coral reefs have become increasingly legitimate objects of research at the planetary scale, they have nonetheless defied legibility to the extent that the shadow of threat hanging over them keeps shifting, if not escalating, to the point where they now exemplify the earth in distress. How are some coral scientists redescribing this particular threat with a view to driving—independently of existing political actors—collective change?

[8] The preface to the Proceedings of the 2016 Symposium seem committed to this view, for instance. It offers a capsule history of the Symposium and, following a review of presentation and publication statistics, notes that "other changes in Proceedings over the decades have been the shift to English and to applied science." Yet, as the Preface itself documents, these shifts largely occur within the first twelve years of the Symposium and are complete by the International Society of Reef Studies is credentialed in 1980. The theme of the 1981 gathering "the reef and man" as well as a keynote by David Stoddart "coral reefs: the coming crisis" are held up as further indications of a pivot, rather than a recapitulation of the founding principles of a rapidly expanding scientific community. Finally, the Preface adds: "In the following symposia through the decades, there has been a general shift away from pure science to an increase in the proportion of papers dealing with problems to coral reefs caused by human activities and how to manage them." Again, the authors' purpose here seems to be to drive a wedge between pure and applied science rather than imagine their coexistence. As I will demonstrate in the coming chapters, even contemporary geo- and bio-engineering efforts have so-called "blue sky" biological research in mind. Of course, my own history of the Symposium is far from exhaustive here and perspectival in its own way. I simply wish to offer an example of the hold of progressivism on self-descriptions of coral science. Indeed, it is possible to imagine that the Preface's "applied/pure science" dichotomy is a redescription of the "science/policy" dichotomy intending, as I have been showing, to give an orientation to the coral science community today predominantly in terms of a negative counterexample, an example of what not to do, a lack to overcome.

3. Mass Bleaching: the Planet "Encroaches" upon Coral Reefs

Oil spills and spearfishing were the canonical harms of direct human encroachment upon coral reefs. The crown of thorns starfish problem raised the prospect that human-caused harm might never be traceable as such, acquiring expression instead in the confounding form of the "side-effect" (Masco 2013). Coral reefs became exemplars of earth distress through a dramatic extension of this same logic: in response to seasonal temperature variations, they began, en masse, to harm themselves. The biggest threat to *reef* complexity today, from a strictly biological perspective, are *corals themselves*. The phenomenon known as "mass bleaching" offers dramatic evidence of this development, and its study gave rise to the current coral science consensus. In point of fact, during the 2016 Symposium, the most destructive planetary mass bleaching event on record was underway—it damaged close to three quarters of the world's corals. Based on the comparison of coral cores from some especially old corals around the world, it was only the third event at such scale in over 500 years of recorded coexistence between humans and corals.

Once localized and occasional, bleaching is now occurring increasingly frequently, affecting more corals on a given reef, and more reefs in the global oceans. Here is what this means for the oceans and for institutionalized coral science. From 2014 onwards, a planetary network of monitoring technologies began recording seasonal variations in ocean temperatures beyond historical maxima, which were then further exacerbated by the El Niño effect in 2015. Warming oceans alter the terms of biochemical exchange between coral hosts and the plant symbionts living within their cells, a family of algae known as zooxanthellae. This relationship shifts from beneficial to toxic, as the latter begin producing more oxygen than the former can consume. To interrupt this process, corals appear to jettison their zooxanthellae into the water column and take their chances with a drastically reduced food and energy supply (Gates, Baghdasarian, and Muscatine 1992).

This stress response is potentially fatal, synchronized among multiple coral species, across vast tracts of reef, and cascades around the world's oceans. But in addition to this metabolic support, symbiosis gives corals their color, meaning that as coral reefs lose their zooxanthellae, they alter their appearance. A diverse reefscape of motley hues and textures gives way to a strikingly uniform scene of corals stripped bare, the white calcium carbonate of their underlying skeletons showing through a thin layer of transparent flesh. This dramatic visual signature gives the phenomenon its name. The crisis of coral reefs today is not only epistemic and political but, also, aesthetic: coral reefs are becoming unrecognizable as objects of wonder.[9]

Because coral reefs are foundational to the web of life in the oceans and thus on earth, their gradual decay is provoking a destructive cascade that disrupts food webs, nesting grounds, and coastal protection and will invariably occasion a profound loss in human terms. At stake are not only the livelihoods of those who work reefs, for instance, but home, habitat, and belonging for those who make sense of the world through coral reefs—in a word, the unspoken but vital compact between global society and the global oceans. Coral reefs thus operate as what social scientists Andrew Lakoff and Frederic Keck call a "sentinel device" of earth distress (Lakoff and Keck 2013), an other-than-human entity whose expressiveness alerts humans to otherwise imperceptible phenomena.[10] It is worth pausing to examine different aspects of this signaling

[9] In revising this chapter, I intend to discuss the multiple valances of the term "mass bleaching" at greater length. It is worth noting, for now, that bleach is an industrial commodity *and* process that is heavily implicated in the standardization of consumer goods and colonial history of capitalism (McClintock 2013). Coral reefs, in bleaching, affirm the planetary reach of both the capitalist mode of production and its visual norms of taste, even as they announce its twilight.

[10] Corals as sentinels turn the unknown known of large-scale planetary change—such as, the five "prior" mass extinction events—into the partially known unknown of earth distress—the coming "sixth mass extinction." It has recently come to my attention that Keck has built on the sentinel device concept with a group of colleagues and developed the idea of the "sentinel territory" (Blanchon et al. 2020). Of interest is the manner in which the territory,

process to appreciate how mass bleaching participates in the construction of coral crisis as a call to climate action.

On the one hand, mass bleaching discloses a cascade of changes to the lifeways of reef-building corals: *e.g.*, their conditions of growth and reproduction, the composition of their internal microbial communities, their capacity to build and maintain a robust reef matrix with implications for their function as a complex marine habitat. Mass bleaching transposes the geophysical process that is earth distress into the descriptive terms of biology, ethology, and ecology. These knowledge formations focus on progressive changes in the relationship between more or less discrete entities—a narrative, that is, concordant with historical time.

On the other hand, this transposition also works in the other direction. Earth distress is a planetary process and not a planetary event, such as a meteor collision. Mass bleaching can only be an expressive response to earth distress if the discrete changes that mass bleaching makes available to description—one coral species facing higher thermal stress than another, single reefs shifting from complex to simplex—can also scale up in spatial complexity and temporal reach.

Thus, for instance, Ove Hoegh-Guldberg's coral bleaching research analyzed a relatively localized expression of the phenomenon on the Great Barrier Reef yet drew far more general conclusions, ultimately predicting a trajectory of global reef decline in decades to come.[11] However vindicated today, the mixed reception he received at the 2000 Symposium turned on the presumed speculative overreach that bet against the global oceans' long-term capacities for adaptability and recovery. In recent years and to reduce this potential discordance (between

here, can refer both to a physical landscape as a sensing device and to the broader social formation so activated. There are connections to be made with coral reefs and the thought collective under description, which merit closer examination.

[11] For a sense of this, once again the title of the original publication suffices: "Climate change, coral bleaching, and the future of the world's coral reefs" (Ove Hoegh-Guldberg 1999).

biological and geophysical change), coral scientists have brought the descriptive claims of the field's broad range of disciplines (e.g., marine biology, geology, oceanography, biogeography, computational modeling) into closer alignment. A cornerstone of these efforts is a renewed interest in one of the foundational techniques of modern coral science: coral coring. Much like trees and ice and pollen, corals register changes in their surrounding milieu through changes in their own metabolic activity, notably the quantity and composition of exoskeleton that they extrude seasonally. Bleaching registers, therefore, in coral cores, either as a drastic interruption of growth with a characteristic signature. Archival and newly drilled coral cores testify, under scientific cross-examination, to a dramatic uptick in mass bleaching events in the last five hundred years. This uptick can even be ranked against other established threats, such as the periodic incursion of crown of thorns starfish (De'ath et al. 2012). In establishing the gravity of mass bleaching as a planetary threat to coral reefs, the phenomenon receives a double reading: it is simultaneously a concrete signal of the fragility of coral reefs in the historical present *and* a confirmation that coral reefs are usefully fragile for the purposes of studying processual change at the planetary scale.

And so, doubly transposed, from the geophysical to the biological and back again, mass bleaching confirms the scale of the threat hanging over coral reefs while at the same time consolidating something like an epistemic dependency upon them, and this not only for some knowing scientists but also, potentially, for any seeing observer. Behind the will to know coral crisis is a chance to sense and relay the *rate and direction* at which earthly life is changing and not the *fact* of it alone. As sentinel devices, in other words, corals as a form of life do not just point to earth distress as some urgent happening out there but, in real time, mediate the urge to measure its speed, extent, and gravity.

During a lunch break on the third day of the Symposium, I found myself sharing a table with J.E.N. Veron, better known to coral science as "Charlie." The nickname was something of a schoolyard baptism, a diminutive that riled classmates gleefully cooked up to give a mocking spin on the alter ego their teacher, Mrs. Collins, had found for the kid who kept bringing spiders and insects to class in glass jars: "Mr. Charles Darwin." Charlie reclaimed it in turn, in part thanks to his father's (creative) recall of a common nominal ancestor, Bonnie Prince Charlie, in a bid to console a bullied child (Veron 2017, 9–11). The breadth and originality of Veron's contributions to documenting the biology, geology, and physical geography of coral reefs over the past half century made good on Mrs. Collins' intuition. What's more, the diminutive and the innocent aura of its oft-repeated origin story, befit Charlie's legendary candor and accessibility. At lunch, surrounded by enthusiastic young marine biologists, I ventured a question that was on my mind given the Symposium's general atmosphere. If the verdict of earth distress is in, do we not have to learn to love ugly reefs? Charlie's response was categorical. He thumped the table in protest, visibly anguished at the question and announced with exasperation that no we could not, must not, give in to such despair. I can still hear the frustration in his voice, an earnestness pained at having to make the point that you cannot compromise on how to appreciate the lifeway of coral reefs.

The next day, Peter Mumby accepted the Society prize for the most promising emerging research in the field, in which he made the case that the changing face of coral reefs, their predicted transition into as yet unknown but decidedly ghastlier organic assemblages, requires that coral scientists let go of assumptions about what a reef can be in order to ask different kinds of questions about what reefs are becoming. And on the final day, in a wrap-up panel preceding Richmond's closing words, the aforementioned Peter Sale opined that "the problem with coral scientists is that we love coral reefs too much. We have to use coral reefs in our messaging as one of the canaries in the coal mine … but there are others." Here are three very different ways of seeing coral reefs under conditions of earth distress: against an ahistorical baseline of invaluable complexity, changing in function and appearance in the historical present, or as one among a range of equally deserving forms of nonhuman life. Yet, behind these variations in temper lies the same desire to use coral reefs to mediate earth distress, to "solve" for a very particular kind of "problem," the problem of the difficulty facing coral scientists as they seek to brook a seeming indifference to planetary-scale change beyond the four walls of the Hawaii Convention Center.

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The scalar difficulty that I am trying to track is something of the inverse of a situation that anthropologist Alex Blanchette (2020) tracks in his recent monograph on industrial pig farming, *Porkopolis*. The managerial class responsible for corporate wellbeing in this world of lively capital and animal death, he explains, oversees and directs the production and reproduction of manifold forms of pork life by appealing to an entity called "the Herd." The Herd is a concrete abstraction that can only be pointed to in discourse, paperwork, statistics and actuarial calculations. Yet The Herd affords managers decisive leverage over planning and directing productivity gains at every point in the "lifecycle" of industrial pig farming. In orienting to The Herd managers no longer seek out and develop attachments to particular animals for their perceived desirable qualities, for instance. Instead, they cultivate, cull, or replace breeding stock thanks to the scalar technology of genetic analysis. Rather than negotiate with workers with established rapport and know-how for how to handle different expressions of porcine at different stages in the production process—sows expecting piglets, piglets expecting suckling, mature pigs expecting (?) slaughter—biosecurity protocols govern employment conditions (and therefore social, family, and political organizing among works) at the whole Herd scale.

But even as The Herd operates as an organizational technology that expands the reach of managerial power across all farming operations, it exerts a form of control over corporate governance itself, as disclosed in this telling aside: "As one veterinarian declared in annoyed opposition to my insistence on his agency, 'No. The Herd is everything. We are slaves to the Herd'" (Blanchette 2020, 63). The Herd empowers managers to organize company life at the species-level and therefore to rationalize decisions that render the everyday goings on of individual pigs, workers, and managers ever more subordinate to abstract calculations of commercial growth and porcine health. In my time with the coral reef science community, I do not recall hearing such language. To be sure, the enthusiasm and anxiety of having to heed coral reefs at the planetary scale suggests a similar conundrum. But the coral scientists who espouse this view and so have come to deprioritize individual reef dynamics and local management decisions do not possess, as it were, the organizing authority of corporate managers. Where Blanchette's industry veterinarian complains about their subordination to The Herd, the scientists I have been citing seem almost to complain about their *in*subordination to coral reefs at the planetary scale, as if to say: "we are *not yet* slaves to The Reef." Here again, the tantalizing fullness of the planetary perspective gives rise to a sense of lack.

It is worth pausing here to acknowledge that coral science does remain, in important ways, localized in its perspectives. At the 2016 Symposium alone, panels included discussions of the fundamental biology of coral reproduction, disease etiology in marine fish communities, machine learning in underwater photography, historical effects of marine reserve policy, comparative policies of illegal fishing, machine learning algorithms for underwater photography, low-cost reef survey techniques for citizen science. As Sale wrote in a blogpost following the event: "I had feared there would be so much focus on bleaching, ocean acidification, overfishing and pollution that there would be scarcely room for talks on any other topics" (Sale 2016). Yet a large number of those same areas of ostensibly climate *unrelated* inquiry were nevertheless framed as of interest, or of concern, or of merit for what they might *relate* about the condition of the oceans as they experience earth distress—for instance, changes in fish behavior in acidifying waters put an established field of study with its experimental protocols and baseline measures to use in testing for earth distress. The dizzying array of topics covered and countries represented at the Symposium does not so much dispel as it does draw out the unavoidability of the specter of earth distress hanging over the gathering. Put differently: the planetary scale does not eclipse local knowledge production, yet it does appear to allow some actors to downplay its salience to the putatively shared project of resetting the terms of co-existence between coral reefs and human beings.

I will close this section with one final example. Before a standing room only crowd in an afternoon parallel session, Terry Hughes presented his findings from aerial surveys of the ongoing wave of mass bleaching. Hughes is the head of James Cook University's Center for Excellence in Coral Reef Studies, an august institution of research into Australia's Great Barrier Reef. He prefaced his remarks by saying that these were as yet unfinished, unpublished, and unprocessed findings but that they had interest enough to warrant this unusual departure from established protocol. Indeed, he had already circulated the standout visual from his slides on Twitter and in subsequent media appearances. As the Tweet shows, Hughes is quite comfortable leading with emotion and once more dramatically opens up a pair-part exchange between professor and student, host and audience, to welcome a broader public into the circle of the "we" shaken by the coral crisis (Figure 18). At the conference's close, he commended the same tactic to junior and senior scholars readying to return to life after the conference. A younger member of the audience objected that not everyone was comfortable or able to present their scientific or personal views on social media, Hughes responded, somewhat dismissively, that this was a squandered opportunity. World leaders are building their power on Twitter, he said, citing the examples of US President Barack Obama and former Australian prime minister Kevin Rudd. "I've often thought that if the Great Barrier Reef were a political lobbyist, it would bleach itself just before an election."

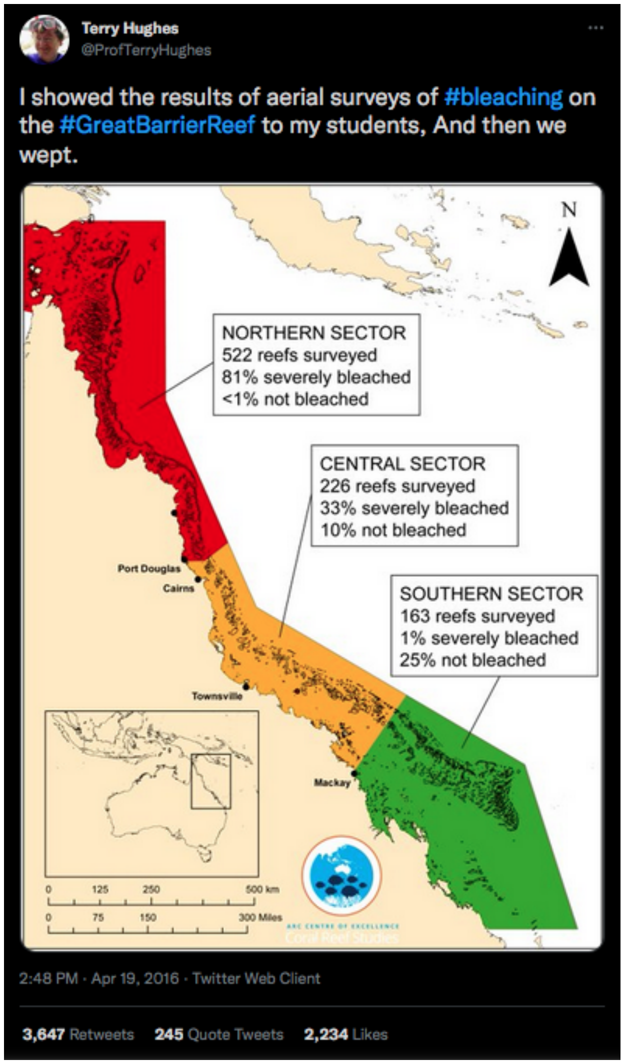

Figure 18. Terry Hughes tweeted this image two months before the 2016 Symposium, and it would be months after that before his findings passed the peer-review process and saw official publication. Inside and outside of institutionalized coral science, the regime of mediation by which some scientists commend knowledge now creates unruly eddies. (Source: Terry Hughes, Twitter)

This is a very odd statement in the midst of a crisis summit on coral reefs ostensibly dedicated to finding solutions to avert their bleaching, among other things. And, given the circumstances, it was less idle speculation than enthusiasm registered before an approaching satisfaction. Because coursing through the conference was a broader sense of historical change and a series of popular, today we might say populist, referenda on the near horizon: the UK's European Union membership referendum (aka "Brexit"), the 2016 Australian federal election, and the 2016 US presidential election. More than once, in the midst of a panel presentation I would hear remarks such as “I’d vote for you for president!” or, even, “What we really need is an autarchic world government, but without that we’ll do what we can.” There is more than a measure of fantasy to these gestures, as if politics is the stuff of dreams not the grunt work of a conference “bridging science to policy.” Moreover, even conversations that ostensibly sought to eschew crisis talk nonetheless struggled to achieve escape velocity from it. Appeals for intellectual succession planning and the need to instill optimism in a younger generation of scholars were legion. Yet even these consolidate the assumption that the coral crisis as a shared empirical problem, if viewed with optimism, could orient those gathered to solving bigger questions about how to go on doing knowledge work in an age of cascading crises. In effect, this puts institutionalized coral science as represented by the Symposium and Society in the same position of aspirational governance towards the planetary as, say, the Intergovernmental Panel on Climate Change and other transnational organizations.

The global mass bleaching which formed the backdrop to the 2016 Symposium was just the latest in a long series of documented fears about the generalized and long-term diminishment of coral reefs. And yet it dominated. Mass bleaching is not the only way in which earth distress bears down upon coral reefs. Increased carbon dioxide concentrations raise the acidity of the global oceans, which reduces the amount of carbonate ions available for corals to build skeletons and so compromises reef integrity. Many coral scientists deem “ocean acidification” the more pernicious threat to marine life given the diffuse yet generalized effects of reduced rates of calcification and the latency of carbon concentrations.[12] Bleaching, however, presents a number

[12] To risk a health metaphor, mass bleaching is an acute symptom of earth distress whereas ocean acidification is a chronic one. Moreover, although mass bleaching has indirect consequences for communities of marine life that depend on coral reefs, ocean acidification directly impacts these organisms, whether their skeletal integrity or their neurological and behavioural changes.

of advantages for both scientific inquiry and political communication. First, ocean temperature variation and the onset of El Niño cycles are, to a large extent, predictable. Second, mass bleaching is dramatically visual in a way that ocean acidification is not. This has encouraged coral scientists to turn reef monitoring and reporting, a method of empirical inquiry cemented during the build-out of reef management from the 1970s onwards, into a method of civic and political engagement by coordinating planetary scale campaigns that commit marine park officials, local communities, and media actors to anticipating the occurrence of coral bleaching then documenting and publicizing it in real-time.

Perhaps the most spectacular example of this is the 2017 Netflix documentary *Chasing Coral*. The film was the brainchild of Richard Vevers who choreographed the Symposium group photograph, it finished filming at a special conference pre-screening that I attended, a chance connection that proved meaningful enough to warrant my invitation to speak at Prairie State College in 2019.

4. Chasing Coral, Crisis, and Clicks.

Chasing Coral is a documentary about documenting earth distress. It is filmmaker Jeff Orlowski's second feature after *Chasing Ice* from 2012, which followed nature photographer James Balog in his quest across icesheets in Greenland, Iceland, and Alaska to produce photographic stills and time-lapse sequences that would convey the majesty of glaciers and their melting due to global warming. *Chasing Coral* follows the same approach. The film presents a moving narrative about the technical and emotional ordeal of producing doubly moving images, specifically time-lapse sequences of coral reefs succumbing to mass bleaching. It conveys the urgency and importance of seeing and showing global warming, by documenting *and* dramatizing the image-making process. To support these and other projects, Orlowski founded a "film and impact company" whose name, Exposure Labs, evokes the admixture of science, discovery, and civic revelation that he and his team pursue or, in a manner of speaking, chase.

In pursuing its aim of revealing the coral crisis "to the world," *Chasing Coral* establishes a dynamic exchange between two sets of protagonists, coral scientists and the crew who are filming them. The first group explains the technical details of coral biology, mass bleaching, and global ocean change. The second group not only represents this explanation through interviews and bespoke infographics, but they also track and film the 2015-16 global mass bleaching event—underwater, close up, in real time, and in high definition. The result is a remediation of the coral crisis, where the worried yet seemingly immobilized authority of official scientific knowledge gives way to the communicative efficacy of the documentary adventure film. What *Chasing Coral* aims to do, then, is move viewers to take a stand against earth distress by becoming disturbed by the revelation of its unfolding in images, which images lay bare an understanding that coral science has hitherto been at best unskilled and at worst unwilling to share. But what does "taking a stand" look like within the film? How does *Chasing Coral* answer the would-be eternal problem: "what is to be done about coral finitude?" The film's answer seems to be: making and sharing images, images that scientists don't know how to make. In this way, the protagonists of the movie are members of the media-savvy film crew while the antagonists are the media-illiterate coral scientists.

One of the film leads, Richard Vevers, is a former "ad man" and longtime SCUBA diver. He describes a conversion moment when realizing that the decline of his beloved sea dragons likely indicated bigger changes to ocean dynamics. "That's when I realized one of the biggest problems with the ocean is that it's out of sight and out of mind," he tells the camera, "and that's an advertising issue." We follow Richard as he founds The Ocean Agency, a PR firm committed to raising awareness about ocean change, and homes in on coral reefs as a planetary scale vehicle to influence mass public opinion. Vevers claims that his advertising mentality allows him to see what scientists cannot, namely, that earth distress is an opportunity to change heart and minds provided it is communicated the right way. In one scene, a scientist pulls out posters of black-and-white historical reef surveys that testify to earlier, richer Caribbean reefs. Vevers' voiceover observes: "his imagery was designed for scientific purpose—it doesn't capture you without explanation."

Vevers' aim, which is also the film's aim, is to make coral images that need no explanation. Or, it might be said, that explain themselves. He bookends this towards the end of the film, as his voice overlays footage of the files bursting from Charlie Veron's bookshelves (Figure 19): "Losing the Great Barrier Reef has actually got to mean something. You can't let it just die and become an old textbook," he intones. "It's got to cause the change that it deserves. Us losing the Great Barrier Reef has got to wake up the world." Given the preceding scene was an ominous exchange between Charlie and the film's young protagonist about what to make of a life, in which the former told the latter that he had no choice but to fight to save coral reefs because otherwise "you're not going to like yourself very much when you're an old man." Charlie's sense of shame is on display, caught in the gaze of a youth who would not see coral reefs as wondrous as he once did, but refracted to by the camera and the awaiting public. Vevers' acousmatic voiceover delivers a double eulogy.

The implication is that scientists have been speaking over corals, and that advertising and communications expertise can allow coral reefs to speak for themselves. What the film chases is the fantasy of the captionless image.[13] To achieve this, however, rather than withdraw from the frame, Vevers and the rest of the film crew saturate it. By making the film a kind of how-to—how-to image coral crisis and collapse—they aim to voice global warming. To illustrate this, here are some salient features of the film's processual syntax:

1) An overall structure that restages Vevers and the film crew's journey from undocumented problem to documenting solution: worry about ocean change, hear about coral bleaching, seek out authorities on coral biology, understand the ecosystem-scale consequences,

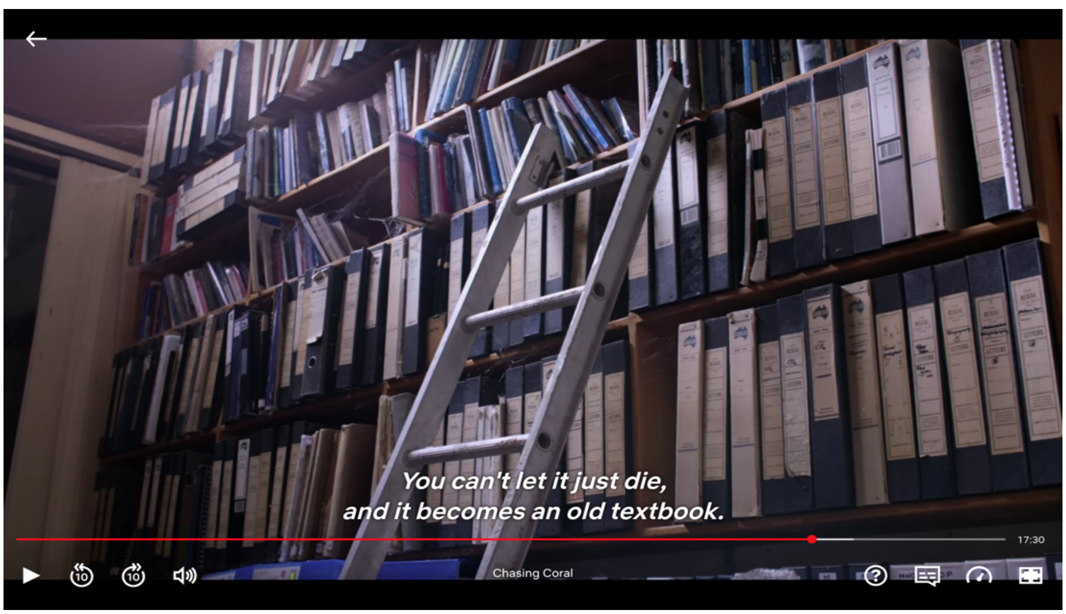

Figure 19. Still from the film Chasing Coral that shows the endless shelves of reports, tables, maps, and—we can only presume—images of corals in Charlie Veron's home office, here rendered as impotently oriented towards producing "an old textbook." (Source: *Chasing Coral*, directed by Jeff Orlowski (2017, Boulder, CO: Exposure Labs), https://www.netflix.com/title/80168188)

[13] I am grateful to Michael Rossi and Emma Pask for this felicitous turn of phrase.

learn that coral bleaching events can be predicted, decide to photograph bleaching in real-time, coordinate with meteorological authorities, learn that audiences are indifferent to still images, decide to film bleaching as a durational process, find sympathetic documentary filmmakers, hire underwater photography specialists, design and build underwater cameras, overcome technical obstacles, travel to identified future bleaching site, record bleaching, obtain endorsement from scientific teachers/experts, disseminate images to the world.

2) The emplotment of the sentimental education of two image-making leads—first Richard Vevers and later Zack Rago—whose movements, decisions, and reactions are show the kinetic and emotional labor of image making. This includes the filming and/or staging their travel in cars, trains, and planes, going to meetings, arriving at labs, boating out to reefs, and solo "confessionals" to the camera.

3) The use of picture-in-picture technique: over and over again the camera films screens (*e.g.,* laptops, skype calls, phones, movies) as well as other cameras (*e.g.,* underwater, on land, in planes). The result is to constantly interrupt the illusion of the screen, to make cameras and images the subjects of the film.

4) On-screen indexing: infographics to explain complex actions, literal acts of pointing, hands bringing equipment close to the lens, after-the-fact interviews to narrate underwater scenes, signing and writing underwater, etc.

5) Use of found media footage from mainstream television agencies to demonstrate growing public awareness of "coral crisis" as cathexis with the film and film-crew's project, which testifies to their powers of persuasion. 6) And, finally, a split tempo that conveys a different historical relationship between the films' two sets of actors and coral reefs, and so a different relationship between their ways of knowing to the urgency of reef decline: a series of

six “science explanations” that use interviews, infographics, and historical footage and so have a nostalgic if not timeless feel to them; and, a single major action sequence, broken up by these explanations, tracking the film-crew and their efforts to produce time-lapse coral footage. The two modes meet at the end of the film, as I’ll discuss shortly.

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From one aspect, *Chasing Coral* starts as one film (a conventional documentary about the biology and beauty of coral reefs) and ends as another (a “making-of” adventure about the civic power of graphic images of earth distress). From another aspect, however, these two films are one and the same and simply woven together. There is no antecedent film to which the making-of corresponds. *Chasing Coral* describes itself as an “adventure,” which partly comes through because the viewer watches a documentary team researching their subject and figuring out how to film it. We follow, that is to say, a processual representation of the practice of representing earth distress. What results is an oscillation between filmmaker and filmed subject, objects of description and the activity of describing them, and thus documentary evidence and storytelling technique.

I have reviewed some of the film’s syntax to emphasize the formal choices that make image-making the real subject of the film, not at the expense of but in order to make good on the goal of presenting earth distress and its potential mass public appeal. The film risks, in other words, aestheticizing bleaching and catastrophe. I would like to pause and underscore that this “making-of” is not merely an editorial conceit. The crew did not connive to flood their equipment or make a faulty prototype for the sake of “drama.” Nor did they exceed their baggage allowance to get B-Roll footage of them stripping plastic from their luggage with a box cutter. And they did not set out to cast, among the camera technicians that join the crew, a charismatic and emotionally vulnerable lifelong coral enthusiast in Zack Rago to become the unlikely lead. Indeed, a constant refrain in reviews and media interviews with the filmmakers' is the need to underscore the film's authenticity. Orlowski tells one film reviewer, for instance, that he cast Rago on the fly after observing the intensity of Rago's response to the bonded fates of bleaching and filming corals: "when the camera box got flooded and he was devastated, that emotional response was like, *well this is great, in this odd, ironic way*. And we just knew we wanted to keep filming Zack's story and we were watching that unfold. And it was really when we were in Australia together when I saw, [first of all], documenting absolutely this massive bleaching event and the tragedy that was, but *more than anything* seeing Zack's emotional response to it and seeing how he felt and the pain that he felt (Allen 2017)". These remarks reflect Orlowski's commitment to persuading a would-be indifferent audience to develop an emotional bond with a vulnerable planet through sympathetic contagion with an already bonded human subject.[45] At the same time, these qualifications seem to highlight a degree of discomfort with the runaway appeal of disturbing images of mass coral death, discomfort with the dramatic effect grounded in the synchronized accidents if not to say tragedies of image making and planetary unmaking, and perhaps even discomfort with, at a further order of remove yet, the "great, odd, ironic" way in which, from the director's chair the ambivalence, *all this just seems to work*.

Within documentary film and especially underwater film making, there is a longer tradition of drawing attention to the image-making process in the course of making hard-to-get images. This was the case in Jacques Cousteau's day, and he borrowed the technique from his many forebears (Bright and Kimmey 2021; Crylen 2018; Elias 2019). Indeed, another recent runaway underwater Netflix documentary hit, the Oscar-winning *My Octopus Teacher*, centers image-making no less than *Chasing Coral* but does so, by and large, by turning the move on its head. The decision to edit out nearly all traces of the film's making-of—extensive pre-production, many scientific advisors, permanent and casual production crew—clears the way for a sense of heightened, fragile intimacy between "Craig" and the octopus with whom he falls in love.[14] In one sense, the technique appears to let the audience in on the secret of how-to make the film moving before their eyes. In another, part of the appeal of this secret hinges upon the remoteness, strangeness, and unusualness of the scene before them. The effect is similar to what John Urry refers to as the "hermeneutic circle" that underwrites the contagious potential of tourism images, which triangulate the viewer into an uncanny intimacy with remote places through token imagery—postcards, brochures, etc.—that they then become compelled to visit, document, and then reissue in circulation, passing on their (invariably only partially satisfied) longing to another would-be sightseer. In the case of *Chasing Coral* (and to a lesser extent *My Octopus Teacher*), however, part of what makes these images alluring is, paradoxically, their patent lack of appeal, even their aura of disgust.

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There is a very specific kind of image that *Chasing Coral* makes: time-lapse sequences of mass bleaching. By showing corals change over time, the film reproduces and amplifies their status as sentinel devices. But change, here, is a change unto death. The film's signature image is the before and after shot, images which graced the pages of hundreds of newspapers the world over thanks to the behind-the-scenes work—not filmed—of Vevers' Ocean Agency. It is the point of the film that such images are moving, effective, and that they can provoke a dramatic change in

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[14] These editorial choices are detailed on the film's website. On the centrality of the erotic within *My Octopus Teacher*, Sophie Turner has a fascinating reading of both this and the harsh criticism she met with when sharing her views online (2021). One question this "erotophobia" raises, to borrow Turner's phrase, is why two films that set out to and succeed in portraying an idiosyncratic, authentic emotional bond with nature in order to solicit, in a manner of speaking, a desire for this same bond on the audience's part need, especially, to be protected from accusations of perversion? What picture of love and its moving principle do these films offer that requires evacuating the role of goal-directed satisfaction?

the viewer. The ultimate evidence of this is a pre-screening held at the International Coral Reef Symposium in Hawaii in 2016, filmed for the film. We see the crew prepare to give a presentation, to launch a screening, all of which is filmed, so that we watch people watching a film in order to become part of the film that we, currently, are watching, which also includes parts of the film they are watching. The very scientific authorities who, earlier in the film, were explaining coral bleaching take in, at the same time we do, the film-crew's time-lapse sequences. The image shifts from time-lapse to audience, audience to time-lapse, as face after face is moved to tears. These image-tears do double-work. On the one hand, as coral experts show their depth of connection to their research subjects, revealed to them as never before, they move the viewer to be moved in turn, in keeping with Orlowski's overall filmmaking strategic of sympathetic contagion. On the other, they rearticulate the implicit message of the film: that scientists know corals are dying but they do not know the power therein, that they have become too depressed by earth distress to see it for the opportunity it is, to show the beauty of corals even in death, which beauty might yet *connect* people to coral reefs and not draw them apart. Again, this is not to say that the film-crew welcomes this diminishment of planetary life. Through confessionals, they describe at length the horror of diving amidst decaying corals, the stench of rot and death that follows them in and out of the water. And yet images and above all image-making as a calling remains unmarked by this sense of abjection. It is as if images and the activity of making them can escape the stuckness that earth distress provokes by virtue of their promise to circulate and move an imagined viewer in turn.

Chasing Coral functions as a "how-to" as film scholar Salomé Skvirsky (2020) uses the term and this despite falling outside of the conventions she lays out in her recent monograph, *The Process Genre*. When films center specific acts of visible, physical movement while aspiring to a degree of generality, she argues, they function as a visual how-to by bequeathing their audience with newfound know-how. Processual representations of studio art-making, conversely, tend to function as demonstrations rather as how-tos. They may train the viewer to understand something about a particular artist yet do not teach them “something consequential about how to make art” in general. Without prescriptive potential, the result is a processual film but not a how-to. *Chasing Coral* strains this definition and therefore some of its implications. Both through discrete acts of meta-communication and an overall structure of triumph over technical adversity and scientific indifference, the film makes a general argument about the virtue and value of image-making in an age of earth distress. This absorbs the viewer, however, in a tangle of emotions: wonder, yes, but horror too; hope, yes, but despair too. This oscillation is symptomatic of earth distress itself, namely, a terrain of moral and epistemic uncertainty the awareness of which only further fastens its grip. Time and again, at screenings of the film, I have witnessed audience members moved to anger and righteousness yet all walk away with the same panic: “this is terrible, but what do we do?” The process genre, Skvirsky writes, trades in epistemophilia, a love of understanding. What is successful about *Chasing Coral*, what has made it a hit with the scientists it indicts and the audiences it appeals to, might be the disconcerting pleasure of acquiring a language for imaging earth distress. But learning a way of imaging is not necessarily the same thing as learning a way of seeing, which is to say a way of understanding earth distress phenomenologically. The prescription *Chasing Coral* seems to carry, the urge it seems to satisfy, is simply a desire for more crisis imagery.

Why does *Chasing Coral* not relay scientists’ frustration with government officials and reef managers? Since as far back as the late 1990s, coral scientists have decried, in so many words, the short-term, narrowminded, and risk-averse setting of political decision-makers empowered to write and enforce the regulation of coral reefs. Arguably, over time the depth of this animus has only increased. This is precisely why in 2016, after four years of increasingly harried communications about the degradation of the state of coral reefs culminating in the ominous mass bleaching event that became the conference's very backdrop, the Symposium took a schism between science and policy as its theme and building a bridge as its purpose. This was not a call for collaboration but for occupation. Yet the omission of this antagonism does not appear to trouble the principal scientific advisors to the film, a veritable who's who of the Society. It is possible to speculate about why this is.

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First and to be perfectly clear, the film is a serious and meticulous example of how-to use cinema for science education. There is a reason that it has taken generations of coral reef scientists working in transnational collaboration to connect geophysical processes working at the whole earth scale to the behavioral decisions of tiny marine organisms. The fact that global mass bleaching is a synchronized planetary display does not give any sense of why it might be happening, which coral science can and which this film, thanks to close collaboration with coral scientists, can too. Does this collaboration, however, go too far? In interview, director Jeff Orlowski explains that the sheer intensity of "fact-checking" involved not only dialing in more complexity than planned but also re-editing sections for accuracy and so compensate for lessons learned in the process of filming. These moments of epistemic failure are not centered in the film for emotional impact. The result, he says, is that "it's effectively a peer-reviewed film" (Allen 2017). Given the scientific advisory committee involved and their editorial responsibilities, it is surely no exaggeration.

But what the statement also suggests is that the film isn't just "science communication" it is "science," it is what science is becoming, what science aspires to be. This turns my interpretation of the struggle between protagonist crew members and antagonist scientists on its head, as the predominantly established researchers teach the film-crew about earth distress in order to film and thereby take up, in an orderly transition of authority, the mantel of coral reef "science." This reading fits, moreover, with the sheer exhaustion of so many coral scientists who, like other scientists involved in the telling of earth distress, are running very low on trust, patience, and faith when it comes to the efficacy of their words, with the moral authority of scientific observation. And yet, cinema is not science, or at least it is not yet science, and to imagine otherwise is entirely misleading. There is no linear trajectory of neophyte to acolyte but a struggle of moral *and* epistemic authority, as the film-crew dramatically reveals the scientists' research object to them as interlopers to their quadrennial meeting, turning a ritual of renewal into, if only momentarily, a rite of passage *for science*. To say nothing of the fact that, beyond the 90 minutes of the film, coral scientists continue to study, write, publish, teach, and worry about the inefficacy of their science, all while maintaining its dominance over other ways of knowing and explaining coral reefs.

Second, the film displays the compulsory optimism of advertising as a genre, however, which might preclude acknowledging that the political actors who authorize coral science are, no less than the coral reefs they study, bringing them to grief. Moreover, the filmmakers are not less beholden to these authorizing agents for funding and filming and access. In adopting a planetary scale view of coral reefs, *Chasing Coral* authorizes its audience—wherever they may be—to feel the loss of corals' as their own. Humanity is the subject responsible for and to the world's coral reefs in the film. Yet rather than a call to mourning, the film urges the audience on to spread word coral crisis, entangling them in the confusing embrace of nostalgia for a time before emergency, and resentment for those who got to enjoy it. Among the many good reasons for scientific silence in the face of this seeming character assassination, then, is the image-fantasy of a form of frictionless politics, a general will inspirited into existence by imagery the same way that, in the past, the images of Jacques Cousteau inspired so many of them.

Conclusion

This chapter has been an attempt to work through the sense of tension that abounds when elevating coral reefs as exemplars of planetary change in the historical present. I have tried to show that a profound sense of worry has become the organizing principle of institutionalized coral science. That worry, specifically, is that the sciences of marine life until now have merely known the global oceans whereas they must henceforth do something about them.[15] The group of coral reef scientists who first gathered under that disciplinary designation at Mandapam Camp in 1969 depended on the support of established international organizations to obtain their credentials, elevate the status of coral reefs as legitimate objects of scientific inquiry, and thereby use the imperative of knowing coral reefs as a bulwark against known and as yet unknown acts of encroachment. The success of this project led to a renewed appreciation for coral reefs, as government officials, corporate interests, and tourism entrepreneurs found ways of enforcing territorial claims, pursuing competitive commerce, or recruiting consumer enthusiasm by relaying the description of coral reefs as complex, wondrous, but fragile earthly neighbors. Even

[15] Of course, this redescription reprises the enigmatic phrasing of the last of Marx's *Theses on Feuerbach*, namely, "Philosophers have only interpreted the world in various ways; the point is to change it." Marx's use of interpretation here would seem to go against my initial claim—that coral science today should be understood as interpretive and not descriptive and that therein lies its claim upon the politics and morality of climate action. Yet this appearance may be misleading. The shortcomings of the idealist philosophers Marx takes aim lies not in the practice of interpretation, for that is the bedrock of all philosophy, but in an unwillingness to confront interpretation with the need for social change.

as a sense of threat motivated the consolidation of international coral science, the shifting nature of this threat has exacerbated a tension internal to this original description, namely the tension between coral flourishing and human flourishing. Today, the concrete abstraction of coral reefs at the whole earth scale has proven especially useful for charting the onset of earth distress and so a bond between the fate of coral reefs and humanity. This scale of threat proves incompatible with local management efforts—the very same institutions and actors and treaties and methods that coral science shepherded into existence—provoking a twofold sense of resentment within the coral science community, on the one hand towards "management" and "policy" and on the other hand towards "humanity" and "public indifference."

Coral scientists are aware of the conundrum this presents, indeed for decades they have worried about coral reefs becoming victims of their own scientific success. As more and more players took up position within the coral reef space, they multiplied the possibilities for "encroachment" upon coral reefs, leading scientists to worry about the need for more effective "communication" about the fragility and value of coral reefs. The problem has come to be described as the dilemma of "shifting baselines," in which the first-time visitor to a coral reef cannot but fail to find their expectations of wonder confirmed for they lack the foundation—cognitive and affective—to appreciate what has already been lost. Thus, when Peter Sale told the Symposium "we love reefs too much," it is possible to hear the first-person plural once again reaching beyond the walls of the conference.

This excess of love is a double diagnosis, naming a blind spot within the scientific community that it has passed on to government-appointed reef managers, tourism operators, marketing agencies, corporate social responsibility officers, artists, and sensitive members of the public. The possible breadth of this "we," the craving for generality that underwrites it and would allow it to scale up to the monolithic historical actor of "humanity" that the Anthropocene indicts is vertiginous and blocks thought. This makes a film, such as *Chasing Coral*, and many coral scientists' own seeming blind spot to its critical bite, a potent example. Undoubtedly, the film is a moving and effective piece of science communication and intended as a learning aid for scientists to explain the nature and importance of their research object.[48] Yet as a "solution," the film orients to a model of moral uplift whose politics are, in so many words, something akin to planetary populism.

The picture of politics behind the film assumes an alignment with the scalar power of coral reefs to mediate earth distress: as go coral reefs, so go the oceans, so goes the planet; the only possible social response, then, the only *reasonable* emotional response, is to institute a new planetary compact between nature and society. It is possible, however, that the manifest lack of such a response in the historical present only fuels a longing for it, installing it as the template against which to evaluate all proposals for action. This resonates with cultural critic Raymond Williams' study *The Country and the City*, in which he explains how the pastoral genre—whose conventions portray the English countryside as a place of beauty, bounty and equality in contradistinction to the wretched and wan drudgery of the modern city—evolves in keeping with the development of industrial and global capitalist production to sustain the fantasy of an unchanging world of timeless satisfaction. This world lies, tantalizingly, beyond reach in poems, postcards, and advertising brochures, urging workers to dream and at the same time lulling them to consent to their complicity with the violent forces holding these fantasies in place. This may be an expression of optimism, but it is also a commitment to misunderstanding. The tableau of coral life that a camera can produce grants access to a particularly important fantasy in the historical present, that of being able to see, in real time, earth distress as it unfolds. The ability to slow down and speed up time, to magnify or miniaturize space, to colorize biochemical reactions are all ways of translating a world of change into a grammar that the seeing human eye can process. And yet seeing earth distress, even in this way, does not tutor us in what to do about it. It does not teach us, for instance, how to come to terms with the limits of our understanding because it sustains the fantasy of their endless technological surpassing.

It is also pointless. The "baseline" of the early years of international coral reef science, when David Stoddart responded to Lloyds of London's call one year and the British Foreign Service the next, has that aura of timelessness today. Yet so too does the "baseline" of tomorrow to which Bob Richmond appeals, a tomorrow in which the adage "whatever we do for coral reefs is good for humanity" comes true. These are not "shifting baselines" but pictures of a world without change, without tension, that have all the stillness and satisfaction of an image. In "Plato's Cave" an important yet devastating essay on photography, cultural critic Susan Sontag writes:

> "Photography implies that we know about the world if we accept it as the camera records it. But this is the opposite of understanding, which starts from not accepting the world as it looks. All possibility of understanding is rooted in the ability to say no. Strictly speaking, one never understands anything from a photograph. The omnipresence of photographs has an incalculable effect on our ethical sensibility. By furnishing this already crowded world with a duplicate one of images, photography makes us feel that the world is more available than it really is" (Sontag 2001, 23–24).

Considered as sentinel devices, coral reefs possess a phenomenological intimacy with earth distress that human beings lack, it is tempting to try and bridge our understanding to theirs, make the best picture of it, so as to *really know* how to confront a shared concern. Praise, if not envy, of phenomenological sensitivity suggests that corals might be more knowledgeable of earth distress than we are and therefore they might know better how to act. But what if this is one thought too many. Is it enough of a bridge, instead, to take what is already available to us? That is not an image of a response but the mere fact of it: for all their phenomenological sensitivity, coral reefs respond to earth distress by, together, risking their lives.

ENTR'ACTE

The image got stuck in my head. I was a few months into a longer stretch of fieldwork at the Australian Institute of Marine Science (the Institute), and, after a series of morning conversations among corals and their experimenters, I found myself wandering the facility one afternoon. I made for the library, a typically deserted patch of open-plan office space on the main building's second floor that surrounds an interior balcony overlooking the ground floor below. Libraries come in different shapes and sizes. This one, I learned, was a scaled down version of its former self, which reflects the needs of a digital-mostly 21st-century research organization that had put the bulk of forty-five years' print matter into basement storage. Still, I was curious about what didn't make the move. I exited the stairwell and headed to the reading corner opposite, past the scale model of the Institute's prized research vessel and the magazine racks displaying recent conference proceedings and industry news. Leading away from the reading corner in the other direction were a dozen or so shelves of official reports, old conference proceedings, thick geographic surveys, ecology textbooks, and general audience readers. I looked over the spines and began to take the Institute's earliest annual reports off the shelf. Soon I got stuck on the image: it's a three-quarter architectural drawing for a structure that was never built and whose purpose is hard to place.

There's something improbable to the design; it's a thing of straight lines, modernist fancy and function in equal measure. The building at the center is a long L-shape tipped on its side and composed of modular blocks. A skinny observation deck juts out in front and there appears to be a helicopter pad atop the second story stacked on the building's right half. The structure is on

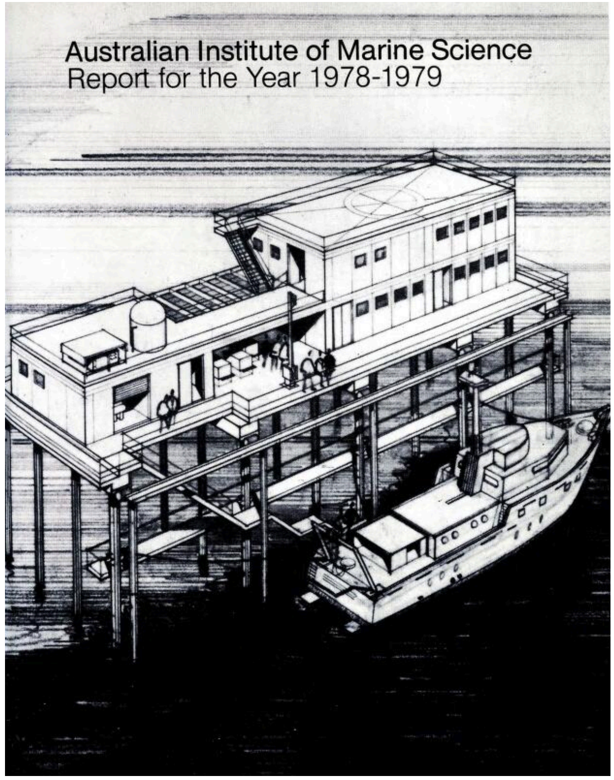

Figure 20. The Britomart Reef Research Platform only ever existed on paper and yet it offers a persistent vision of the unknowable global oceans as a horizon of technically augmented reality. (Source: Australian Institute of Marine Science)

pylons that drop down into the page below, which you can place as water because a stairway leads down from the platform to a boat docked at the base. Thanks to a clever line-drawn gradient, the architectural figure stands out from the background such that the white sky behind gradually shades into a heavy, dark patch of black. The only curved lines are two clusters of figures, ovals with stick legs, who walk the deck. At the top is the title "Australian Institute of Marine Science. Report for the Year 1978-1979" (Figure 20).

The sketch was a design for the "Britomart Reef Research Platform," a proposal the fledgling Institute came up with to advance its remit, namely, to use the Great Barrier Reef as a staging post to study all aspects of the marine milieu systematically and comprehensively:

biology, geology, hydrography, meteorology, toxicology, and so on. The difficulty is not only the Reef's vastness—over 2,000 individual coral reefs stretching across 2,500 kilometers of coastline in a marine park area gazetted at 350,000 square kilometers—but also the fact that much of the Reef lies offshore, tantalizingly beyond the reach of intensive observation. The platform, which was intended for a large mid-shelf reef 120 kilometers from the Institute and close to two other research stations on Orpheus Island and Hinchinbrook Island, would have bridged the spatial divide of the Reef Lagoon, a proverbial barrier to the Barrier Reef (Figure 21). Yet the pitch marks another obstacle to leapfrog, a temporal one bested with the promise of knowledge yet to come: "Britomart is well suited and conveniently located for detailed and long-

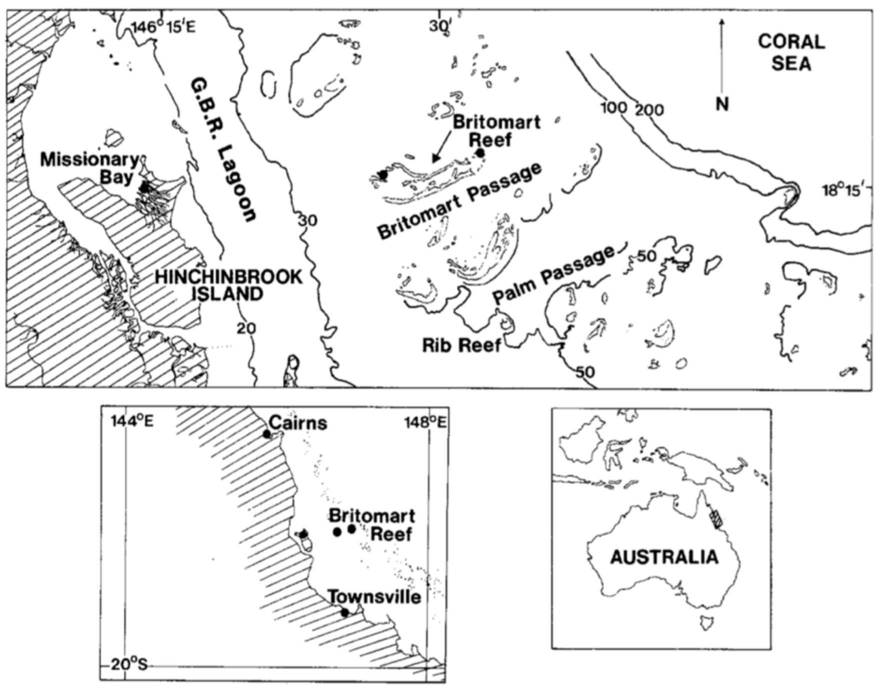

Figure 21. These maps drawn from the field studies mentioned in the annual report show three different scales at which to appreciate the location of Britomart Reef within the global oceans (bottom right), the central section of the Reef (bottom left) and the local reefscape (top). The strategic location of the site is emphasized by indicating (with dots) the spread of additional recording instruments around Britomart and the proverbial reef-less barrier of the "G.B.R. Lagoon" is also highlighted. (Image reprinted from "Currents and Flushing of Britomart Reef Lagoon, Great Barrier Reef," by Eric Wolanski and G. L. Pickard, 1983, *Coral Reefs* 2, 1. Copyright (1983) Springer-Verlag)

term study and for the development and testing of techniques and procedures to be applied at other sites." Well suited and conveniently located where, in space or in time? What is also worth noting is that the report acknowledges the platform's status as something of a fantasy, even as it insists that work is underway. You would expect a newly formed government research agency to mark its early achievements while calling for more researchers, more staff, more equipment, and the like, but why spend precious funds on an image? Here's the quote: "Implementation is at present beyond the resources available. Preliminary field studies, however, are underway to map the reef and establish patterns of water exchange and circulation in the event that a more comprehensive program might be mounted." Those field studies were published and are just a mouse click away today (e.g., Wolanski and Jones 1980). The platform, however, never made it to the present—or did it?

As I lifted my eyes from the page that day, I had the queer feeling that the Institute's cutting-edge research instrument in which I had spent the morning was, in its own way, a massively scaled-up version of the drawing in my hands come to life. Because as I will show in due course, the National Sea Simulator is nothing if not a place that the researchers, staff, regulators, and admirers deem "well-suited and conveniently located for detailed and long-term study and for the development and testing of techniques and procedures to be applied at other sites"—except I could see it out the window, by the carpark, with the Reef still over the horizon. There are a thousand ways to dismiss the comparison as nonsense. But, if only obliquely and for a moment, it shows that the Institute, then in an age of discovery and now in an age of crisis, draws itself into relation with the sea via straight lines that defy the chaos of water, to bridge knowledge across space and time, and with a degree of fantasy. Why and how is this so?

Before I go on, a final word on the Britomart Reef Research Platform. At the Institute, I did ask around about the image. The researchers I spoke to were nonplussed; it was before their time and that's just not what coral reef science looks like now. The Cousteauvian vision of science and society in permanent underwater settlement is no more. The librarians informed me that further archives in the basement were off limits because of flooding; restoring access, regrettably, was not a priority. I looked up the architects, Bernard Ryan & Associates, who went on to work in "site planning," notably for the mining industry. They brought their modular approach to other remote locations, not as single platforms but entire company towns. No offshore platforms prospect for oil or for science on the Reef, but the Australian resource frontier moves on (Figure 22). One of the architects took the philosophy of autarkic building in another direction and founded a green design firm. Before that, he mocked up plans for a different pie-in-the-sky Australian science venture: the Gladstone space port. Where the oceans go, visions of the underground and the cosmos are rarely far behind. In the early 2000s, Bernard Ryan &

Figure 22. An aerial view of the expansion of The Monument, a company town in eastern Queensland nicknamed Phosphate Hill. It was a number of such projects completed by Bernard Ryan and Associates, although in 2013 forty of the housing units were demolished and a further two hundred newly installed. (Source: Bernard Ryan and Associates)

Associates merged with NBRS, a Sydney-based architecture. A couple of years ago, they built a next-generation research and learning center at Taronga Zoo, where corals from the Reef are shipped for cryopreservation in the hopes that they can be revived in a future that won't harm them so—more on this soon enough. And field studies of water exchange and circulation on Britomart Reef? They remain imaged, pressing and intensive, albeit in a different way. During a recent Twitter exchange between Australian scientists live-blogging the Reef's ongoing degradation, one participant shared a temperature profile graph from the underwater glider he had been operating off Britomart for the past ten days. With an emoji, he crossed his fingers "for SE winds to mix it up & cool things down" (Stanley 2022). The key words may have shifted in meaning, but the line from the 1978/79 annual report still resonates: "implementation is at present beyond the resources required."

CHAPTER THREE: DO CORALS DREAM OF SIMULATED SEAS?

In the Winter of 2015, a striking paper appeared in the "Perspectives" section of the esteemed *Proceedings of the National Academy of Sciences*.[1] As per this section's remit, wherein the Editorial board invites authors to showcase current advances and future directions within a given natural science discipline to non-specialists, the article reviews the perilous situation of reef-building corals under conditions of earth distress before describing a radical corrective program termed "Assisted Evolution" (PNAS 2020; van Oppen et al. 2015). More precisely referred to in the paper as "(human-)assisted evolution" and borrowing from work in plant biology, the authors' hypothesis is as follows: if we can accelerate the exposure of reef-building corals to future ocean conditions today, then we might instigate and investigate their evolutionary ability to survive, grow, and reproduce in an otherwise hostile milieu: the future. The authors question can be rephrased as follows: can earth distress be turned into an experimental agent with which to selectively breed a hardier form of coral life (or "super coral") that can supplement and supplant their kin who cannot go on building reefs in the global oceans?

[1] The article is titled "Building coral reef resilience through Assisted Evolution" and was authored by four coral scientists, two based at the Australian Institute of Marine Sciences and two from the Hawaii Institute of Marine Biology. Ruth Gates, one of the lead authors and a crucial figure in securing institutional support from and private funding from the United States, died suddenly from brain cancer in 2018. I also suspect that another of the four original authors, Dr James K. Oliver, former head of the second location of the Australian Institute of Marine Sciences in Western Australia, has passed away. The two remaining authors, Prof. Madeleine van Oppen and Dr. Hollie Putnam, continue to drive the project however they do so at some remove from the host institutions themselves. Prof. van Oppen is largely based at the University of Melbourne, where she chairs the marine biology department, some 1,600 miles from the Great Barrier Reef and the Australian Institute of Marine Science. Dr. Hollie Putnam, formerly of the Gates Lab at the Hawaii Institute of Marine Biology, now leads her own laboratory at the University of Rhode Island, some 5,000 miles from Kane'ohe Bay. Under van Oppen and Putnam's direction, the Assisted Evolution project continues at both of these institutional locations, however, thanks to a distributed network of labor coordinated through regular reporting and video conference calls.

"Assisted Evolution" seems to prompt a way of thinking about corals, oceans, and our knowledge thereof as oriented and orientable.[2] It takes earth distress as a foretold ending to the story of life as we know it and proposes an anticipatory rewrite. It posits technoscience as capable of not only explaining earth distress as an oncoming existential catastrophe but, if only partially, containing the damage so as to be, as it were, less than existential. Here, this means not only sounding the limits to (coral) life but engineering the means to extend them. The possibility of urging coral evolution on to hold back their extinction gives technoscience a reason to go on, to do something other than observe and measure endings and, instead, turn them into the stuff of new beginnings. As corals are *so vital* to the web of earthly life and under the analogy of earth distress as a terminal planetary illness, such powers are life-saving treatment. You get the sense that to the question "why assist evolution?" the answer cannot simply be "because we can" but rather "because we must.

Human health and illness and treatment and cure are nothing if not political and ethical *all the way down*, the same goes for planetary health and illness and treatment and cure (Farman and Rottenburg 2019). It is therefore pressing to attempt to describe, in detail, the theoretical presuppositions and practical specificities of a project such as Assisted Evolution to consider what understandings of human action and responsibility they bring. How and in what ways does Assisted Evolution turn earth distress into something people can not only measure but in some way remedy? What kind of problem does earth distress become—for the flourishing of coral reefs, their science, and its politics—when we respond to it by making "super corals"? This chapter is an attempt at seeing corals as both super and ordinary and, through them, something

[2] By now, it is likely apparent that this chapter is an extended interrogation of Assisted Evolution in theory and practice. Hereafter, I will drop the scare quotes to avoid undue distraction and refrain from using the acronym "AE" to avoid undue abstraction.

like an evolutionary pressure that earth distress itself places upon the epistemic, practical and moral orientations of technoscience itself. In examining Assisted Evolution as a theory, experimental practice, and ethical proposition, I attempt to show what goes into a way of seeing planetary life as knowable and modifiable or, in other words, *as what we make of it*, and the ramifications this has for how we see and what we make of ourselves. The argument is ultimately relatively straightforward: in opening up coral symbiosis to engineering, technoscience is altering our own dependency on reef-building corals and the global oceans, *we are altering the own terms of exposure to and understanding of earthbound evolution and extinction*.

My purpose in this chapter is to investigate, broadly speaking, what a novel form of coral life, one whose evolution is made available to permanent and ongoing human assistance, *is* along three axes: in relation to the biogeochemistry of corals, in relation to fantasies of salvage and obsolescence, and in relation to coral biology as an experimental science. The cursory understanding of Assisted Evolution given so far provides some sense of the difficulty of disentangling these three axes. To do so, I offer a split reading of Assisted Evolution as it becomes thinkable "ex situ" on the one hand and actionable "in situ" on the other. That thought and action become available to one another together in space and time is something this manuscript attempts to repeatedly show. I begin by explaining the biological reasoning behind the need for Assisted Evolution and why it amounts to something like time travel (Section I). I then consider how creating "super" corals to extend the temporal horizon on which ordinary corals can flourish produces a similar split within coral science. Making the case for creating a "reserve" of future-proof corals transforms ideas of what corals *are* to coral science and vice versa (Section II). I then turn to experiments in Assisted Evolution. I relate the technical and everyday difficulties involved in nursing this form of life into existence within a unique marine science research instrument, the National Sea Simulator located at the Australian Institute of Marine Science in Townsville (Section III). Finally, I consider the ways in which the constant shadow of experimental death hangs over Assisted Evolution, which draws out the grammar of sacrifice within bioengineering. This re-enactment of the ongoing exposure of reef-building corals to human harm is an opportunity to draw into view the sacrifice of ethical reasoning that obtains when holobiont engineering is deemed a historical necessity (Section IV).

1. Part One: Thinking Ex Situ

1.1. Assisted Evolution as Time Travel

Assisted Evolution is one real-world instantiation of a broader movement to which different names, orienting questions, ideologies and protagonists apply: ecomodernism, new conservation science, restoration ecology, bio/geo/eco/climate engineering, environmental interventionism, the Good Anthropocene (Asafu-Adjaye et al. 2015; Hobbs et al. 2006; Kareiva et al. 2007). Central to all is the notion that it is now time to deploy a series of hypothetical techniques long-considered “too risky,” “of last resort,” or “desperate,” whose overriding aim is to protect or enhance the ability of more-than-human nature to flourish. Some examples include hybridization, assisted migration, captive breeding, and artificial refugia. Some more recent examples include de-extinction, rewilding, ecosystem reconstruction, genetic engineering, and genetic castration. Their time has come, the argument broadly goes, because of the ongoing and accelerating consequences of earth distress and the ongoing lack of adequate large-scale action from political and economic elites.

In recent years, A number of humanistic and social scientific scholars have engaged and challenged this movement, especially the more explicitly ideological "ecomodernism."[3] Among other things, critics have underlined that the radical hope this movement brings rides on an imperiously narrow political and moral imaginary that denies the historicity of all thought and action. Here is a concise version of the charge: "Not content with the utopianism of modernity—rewilding, decoupling, growing, smoking healthily without smoke—the ecomodernists are also uchronists, as if they were living at a time when they alone were in command" (Latour 2015, 224). I will not expand further on this debate here, as my purpose with this manuscript is to understand *what might be happening as these projects become reality.* So, to appreciate the pre-existing momentum for this movement from another angle, let me introduce a reported conversation awash with epistemic and technical and temporal desires long before anyone penned a "manifesto" in their name. In this excerpt, the narrator reproduces an exchange with a zoologist named Don who is working to forestall the extinction of the kākāpō, a large flightless owl parrot translocated to predator-free island refuges in New Zealand/Aotearoa. The narrator had just reached for an analogy closer to home to make sense of the struggles of conservation scientists, namely, motorcycle enthusiasts. He explained how the devotees of the British motorcycle industry would "remedy" and "re-engineer" their beloved Triumphs and Nortons to

[3] Two representative short examples are Hamilton (2016) and Szerszynski (2016). It is also instructive to read Bruno Latour's (2011; 2015) early equivocation published in The Breakthrough Journal and then later renunciation. Eileen Crist has also been an early vocal critic of the movement, and especially effective at rallying attention within the conservation milieu proper (e.g., Wuerthner, Crist, and Butler 2015). The debate "about" this collection of movements is one extension of the debate "about" the Anthropocene. In that sense, I am both interested in and informed by it, but I also wonder about its status as *an aspect of earth distress aspect* and not only an attempt at putting it into words so as to do something about it. Indeed, in this sense, I cannot help but wonder if the success that "The Ecomodernist Manifesto" had at drawing fire from various quarters did not have the very polarizing effect that the movement takes as axiomatic to make the "radical break" seem more necessary and binding than it actually is. The discussion of history and its breaking in this chapter should clarify this point.

keep them going long after competition with Japanese manufacturers had made them commercially unviable and degraded the ecology of spare parts and repair shops. Snapping back from his "reverie" and to the reality of the kākāpō's plight, the narrator feels the analogy's limit and keeps it to himself. Then his interlocutor gives it new life:

> There are remedies available to motorbike engineers that zoologists do not have. As we tread our way carefully back along the ridge to the helicopter I ask Don what he feels the long-term prospects for the kakapos really are, and his answer is surprisingly apposite. 'Well,' he says in his quiet polite voice, 'anything's possible, and with genetic engineering, who knows. If we can keep them going during our lifespan, it's over to the next generation with its new range of tools and techniques and science to take it from there. All we can do is perpetuate them during our lifetime and try to hand them on in as good a condition as possible to the next generation and hope like heck that they feel the same way about them as we do.'" (Adams and Carwardine 2011).

The narrator is British novelist Douglas Adams, best known for his ribald *Hitchhiker's Guide to the Galaxy Series*.[4] It is excerpted from *Last Chance to See*, a travelogue penned following a series of radio broadcasts Adams produced with collaborator Mark Carwardine who visited, encountered, and documented local efforts to prevent the extinction of especially endangered creatures. The broadcasts are from 1989, the book is from 1992, and "last chance tourism" is today a (somewhat derogatory) expression used to describe those who expressly visit places likely to undergo drastic degradation due to earth distress. "The bucket list" has gone planetary; engineering has too.

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To understand what makes assisting the evolution of reef-building corals thinkable and pressing for coral scientists, allow me to take a moment of your time to parse why corals are biogeochemically terminal today. This will, moreover, explain why I will refer to Assisted Evolution not as "bioengineering" but rather as "holobiont engineering." Corals are often

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[4] I was delighted to learn of Adam and Carwardine's work reading Ursula Heise (2016, 51–54), who takes it up as a rare case of planetary conservation storytelling in the comic mode, whose crucial merit is to welcome failure as something other than a tragedy.

referred to as "holobionts," which is a way of emphasizing that what appears to be a single self-contained entity is also and at the same time a compound form of distinct and more-or-less independent organisms bound together in mutual association. The typical key components of a holobiont are the host animal, the microbiome, virome, and fungi. Today, corals and sponges but also human beings are frequently understood as holobionts, but the concept can be extended to some plants and, even, to the whole earth scale.[5] While the term holobiont is of relatively recent coinage, it was an obvious fit for corals given their early prominence alongside lichens and mycorrhizas (i.e., root fungi) in late 19th-century investigations of parasitism and mutualism, i.e., symbiosis. Indeed, the vast majority of reef-building corals ingest but do not digest members of a group of single-celled microalgae known as *Symbiodinium* or, more colloquially, zooxanthellae. "The co-existence of algae and animals is quite peculiar," explained biologist Karl Brandt in 1881. "From a morphological perspective the algae are parasites, from a physiological perspective the animals are the parasites" (Brandt cited in Bowen 2015, 85).[6] Lodged within the cells of their coral host, the endosymbiotic zooxanthellae photosynthesize and pass on energy, oxygen, and carbon. Although all corals are capable of feeding themselves by catching plankton in the water column (indeed, most of their body mass is made of up stinging arms, mouth/anus,

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[5] Biologist Lynn Margulis is known for popularizing holobiont theory. Her work demonstrated that symbiosis is not just a mode of interaction between evolved organisms but, also and over time, a creative process in its own right that can lead to the evolution of new forms of life. Later in her career, Margulis collaborated with atmospheric chemist James Lovelock to develop his Gaia hypothesis, wherein the whole earth is understood as a self-regulating biogeochemical system.

[6] Brandt is remembered for providing the first decisive explanation of coral-algal symbiosis in an 1881 presentation and paper. He also introduced the term "zooxanthellae," from the Greek *zoōn* (animal) and *xanthellos* (small yellow-brown thing). Historian James Bowen explains that Brandt's work "became the datum point where all papers and books in modern coral reef taxonomy find their origin. The citation beginning such discussion always carries the simple reference 'Brandt 1881,' although it is rarely evident that the modern authors have any acquaintance with the text itself" (2015, 84). A recent effort from one coral biologist, Thomas Krueger (2017), offers a correction of this oversight. In addition to producing an English language translation, Krueger situates Brandt's original text alongside contemporaries such as the Hungarian Géza Entz and German Hertwig brothers, who also explained algal endosymbiosis in marine organisms and with whom Brandt was very likely in correspondence.

and stomach), those with endosymbiotic zooxanthellae receive the considerable resources required to build reefs from their photosynthesizing companions. In return, and provided their coral host does not experience certain forms of stress, what zooxanthellae get from corals are critical nutrients such as nitrogen and a rather stable home within the global oceans (Muscatine and Porter 1977; O. Hoegh-Guldberg, McCloskey, and Muscatine 1987).

In each other's company, coral and algae breathe, feed, grow, and multiply. To build reefs, corals reproduce asexually and so form modular structures of many thousands of polyps known as "colonies" and continually build up an exoskeleton of calcium carbonate. Colonies are mortared together thanks to the presence of coralline algae to form a reef matrix. Corals also reproduce sexually, and subsequent generations of corals released into the water column may go on to settle and build their own colonies, nearby or further afield. Over time, whether due to disease, disturbance from waves and predation, or the gradual subsidence of the oceans, corals recolonize and maintain the upper layer of the reef matrix, which gradually compacts as limestone. Coral reefs, in other words, are composed of a relatively thin layer of living corals growing atop a far deeper foundation of departed kin.

The long-standing companionship between corals and algae has strict enabling conditions (i.e., nutrient levels, ambient temperature, pH, etc.). Although varying from species to species, this arrangement can only endure so much pressure from ambient variation. Today, such changes place considerable strain on coral-algal symbiosis at the planetary scale (O. Hoegh-Guldberg et al. 2007). Notably, at temperatures above or below a given range, coral and zooxanthellae shift their respective metabolic functions and begin to exchange carbon, sugars, nitrogen and oxygen in quantities that lead coral hosts to "jettison" their algal endosymbionts. The exact causes and direction of this breakdown remain contested, but current research suggests that one major source of stress comes when zooxanthellae produce oxygen at rates four or five times in excess of what their coral hosts can metabolize. They draw down on their own carbon reserves to compensate and begin to experience cell damage from oxygen synthesized into reactive oxygen. In language that gives a striking economic twist to the familiar metaphor of corals as aquatic architects and reefs as marine cities, one researcher puts it as follows: "The symbionts are doing good business when the water is warm, … But they are not sharing that wealth with their landlord" (McDermott 2020, 2233).

Let me pause on McDermott's metaphor for a moment. By casting the relationship between coral and symbiont as one of a broken tenancy agreement, corals shelter symbionts on condition that they farm their surrounds and pass on the profits. Thus, corals become entitled to "evict" algae when they fail to do so. To push the analogy, corals grant algae usufruct over the field of sunlight/biochemistry, which is to say a temporary and conditional right of use and profit that leaves corals with the right of alienation or destruction of said field of sunlight/biochemistry. This analogy upholds a picture of corals as sovereign and bacteria as serf, which downplays the injury corals cause algae when they draw down their carbon reserves instead of sharing them. This forces algae to cycle from photosynthesis to photorespiration, thus releasing large amounts of reactive oxygen and nitrogen. Rather than a broken tenancy agreement, this would be more like homewrecking.[7]

Early bleaching studies showed that this led corals to eject some of their own cells, effectively jettisoning zooxanthellae into the water column (Gates, Baghdasarian, and Muscatine

[7] There is a long history of biologists using metaphors from human sociality to explain and make sense of the other-than-human processes they observe. Symbiosis is no exception, becoming union or compact or slavery of tenancy (Sapp 2003, 261–65; cf. Fox Keller 2003). I am interested in how these metaphors are always already historical markers of how technoscience not only fantasizes about biological processes but deems them available to action.

1992). As discussed in the previous chapter, what this looks like is mass bleaching, an arresting display wherein entire reefs part ways with the microalgae that give them energy and color, which turns them ghostly white, compromises their structural integrity and exposes them to erosion, disease, and suffocating turf algae (Oliver, Berkelmans, and Eakin 2009). Once a rare occurrence, this phenomenon is now familiar, both to science and the general public *as a planetary scale gestalt shift*: corals reefs cease to exemplify a romantic ideal of nature as cornucopia, i.e., a perpetual source of endless bounty and variety, and instead exemplify an altogether different aspect of nature, i.e., the terminal endpoint of all life in the sameness of non-life. Thinking earth distress through coral finitude suggests that it is not simply that the Earth is alive and people are killing it; it is that the Earth can die and people are letting it.

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It is time to take a closer look at Assisted Evolution and its relationship to the shifting landscape of conservation science in the historical present. Assisted Evolution draws on biological understandings of selective adaptation and natural selection whereby an organism has the ability to live well within a given range of ambient conditions. Beyond this range, it can only go on provided its biology changes to perform the same basic "functions" with the resources its new circumstances afford. This can happen in different ways. Permanent adaptation, for instance, can occur through random genetic mutation that confers a physiological advantage under new conditions, then inherited and spread through reproduction. Temporary acclimatization refers to nongenetic adjustments to performance and fitness. These can pertain to the messaging pathways that activate as cells divide, which leads to interruptions in the rate and extent of gene expression and effectively turns on or off various physiological traits and processes (this ensemble of processes is typically glossed under the umbrella term "epigenetics"). For corals, this may also involve changes in the composition of sympatric fungi, bacteria, and, especially, their endosymbiotic zooxanthellae.

As I explained in chapter 1, the collapse of coral reefs is an index of mass extinction. The geological record presents "reef gaps" coincident with past mass extinction events, millions of years absent any form of reef-building coral life. At the scale of deep time and the whole earth, some forms of life survive mass extinction events and continue on their evolutionary journey (think crocodiles, cow sharks, coelacanths, horseshoe crabs, ginkgo trees, platypuses, and lice). For the most part, however, biological "recovery" from mass extinction tends to look like the emergence of new forms of life launched on their own evolutionary timelines. So it goes for reef-building corals. Contrary to plant species which persist in the fossil record *across* known extinction events (i.e., as coal), the biology of corals on either side of a "reef gap" does not look the same: "Fossil communities subsequent to mass extinction events show evidence of major taxonomic change—genera, families, classes, and sometimes even complete phyla never reappear after the extinction," explains coral scientist Charlie Veron (2008, 68). The likely explanation for this, and indeed for the temporality of "reef gaps" themselves, is *the evolutionary time required for species of coral and zooxanthellae not only to evolve but to co-evolve*. Both forms of life must adapt and/or acclimate to new surrounding conditions separately and in company so as to establish the working biogeochemical agreement necessary to build reefs at scale (Cowen 1988). In this sense, Assisted Evolution assumes that earth distress will bring about a coming reef gap and attempts to jump over by engineering a coral holobiont capable of enduring tomorrow's oceans today. But it's not just reef-building corals who will be making the jump, but people as well—after all, we are the humans in assistance and the point is to salvage a planetary future. The point, then, is to contain the historical present from a future reef gap. In an interview, project co-author Ruth Gates explained it as follows: "We're doing what nature has done all the time, but just can't do it quickly enough" (243). Ostensibly, this is a description of (assisted) evolution. It strikes me that it could also be a description of earth distress as (assisted) extinction. As I understand it, Assisted Evolution is a kind of technobiological time travel, which makes it difficult to discern whether the historical present is a time of opportunity or loss, a time of evolutionary uplift or devolutionary downturn.

1.2. Super Corals to History's Rescue

In the past seven years, Assisted Evolution has gone from proof of concept (the PNAS publication and scoping experiments in in Australia and Hawaii) to a fully-fledged research program involving a series of interrelated experiments, one the longest continuous coral science laboratory experiment ever, and a mass mediated touchstone for scientific peers, corporate funders, and government regulators looking for proof that technoscience can "do something" about earth distress.[8] In its initial presentation, "Assisted Evolution" catalogues four possible vectors of adaptation and acclimatization and proposes corresponding experiments to trigger them. [9] Ultimately, it aims "to develop a biological tool box for enhancing coral resilience and

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[8] From the outset, Assisted Evolution has been funded by the Paul G. Allen Foundation. A "big ideas" competition was the impetus for the initial research design pitch, while a larger five-year $4 million dollar grant provided the capital to fund the experimental rollout. I will note the appeal that something like the "super coral" has to corporate philanthropy. Beyond green-washing and the possibility of extending the status quo through a technological fix, corporate philanthropy finds an ideological match in such projects. A project manager at the Great Barrier Reef Foundation, a private foundation now responsible for administering the bulk of public funding to Australian coral science research (including to government scientists at the Australian Institute of Marine Science) put it thus: government does not "get" the new conservation science because it is, by nature, "risk averse." This, too, is a form of Assisted Evolution: the state-led institutional landscape that has overseen coral reef science must give way to a new agreement between science and business under the pressure of earth distress.

[9] There are: 1) thermal stress testing within and across generations to prompt genetic and epigenetic adaptations; 2) direct manipulation of coral microbiome, aka "probiotics for corals"; 3) crossbreeding of

stress tolerance" (van Oppen et al. 2015, 2308). What this "tool box" is made of remains enigmatic: does it refer to insights into basic biology gleaned from one set of experimental organisms but applicable to others? Or to the harnessing of earth distress as a research instrument? Or to so-called "super corals" themselves, whose release into the global oceans might allay reef collapse?

From the outset, Gates and Van Oppen were especially mindful of public concerns about "meddling" with nature and insist that their intention is not to produce genetically modified or would-be "Frankenstein corals." One way they counter such perceptions is to stress that their assumptions are based in ecological and evolutionary theory. Natural selection as randomized adaptive sorting implies that a coral equipped for future ocean conditions might already exist, we simply have not yet encountered it.

To get a sense of this, consider the proposal at another order of speculation, not temporal but spatial. Somewhere in the vastness of the global oceans, it is possible that some individual corals have randomly evolved to withstand warmer ocean conditions without our knowledge. Should they have done so under the generalized conditions of earth distress, however, these hardy individuals will be growing amidst a reef matrix composed of less hardy kin, who will continue to bleach and degrade around them, inviting turf algae and other pathogens and so on. This dramatically reduces the likelihood that naturally occurring hardy corals could evolve and reproduce in time or at scale to undertake the kind of reef-building that might constitute a "refuge" from earth distress. They would likely perish, unknown to science, alongside their evolutionary kin. Yet coral reefs do not exist in just any old spatial configuration. Coral

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coral species to test for so-called "hybrid vigor"; 4) thermal stress testing and chemical mutation of zooxanthellae to then be injected into corals.

taxonomy is a dynamic and contested field, and the current number of identified species is close to 1000. This means that even if researchers do locate corals with "enhanced" biology, they cannot simply graft them from one habitat onto another.[10] Hence, Assisted Evolution is a research program that gathers a range of sorting abilities together: collection, selection, and instrumentation. Its project is a matter of temporal, spatial, and biological containment through calibration.

Madeleine van Oppen, from the Australian Institute of Marine Science (THE INSTITUTE) and University of Melbourne, and the late Ruth Gates, from the Hawaii Institute of Marine Biology, are the principal architects of Assisted Evolution. Each brought distinctive skills to the project. Gates was an authority on coral symbiosis and its breakdown, a prolific science communicator, and president of the International Coral Reef Society from 2015 until her sudden passing in October 2018. Van Oppen is a noted coral geneticist whose unusual joint appointment makes her a government scientist mandated to study the Great Barrier Reef and an academic researcher dedicated to pursuing fundamental research. While close collaborators and good friends, one point of disagreement was the use of the term "super coral" to refer to the organisms produced through Assisted Evolution. Gates coined the term to foster institutional and public support for the project, yet van Oppen worried it would present a reductive and even

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[10] For instance, corals in the Red Sea have been known to live at higher temperatures thresholds for some time now, which has provided a practical starting point for untested theories of "assisted geneflow" and "assisted colonization" (Aitken and Whitlock 2013; O. Hoegh-Guldberg et al. 2008). It is worth highlighting that such research locates coral in space and time (i.e., in today's Red Sea) all the better to displace it. Coral thereby comes to function as a natural historical abstraction. Or, to put it more forcefully: coral is thereby made to function natural historically as a concrete abstraction of life itself. Media coverage illustrates this well, in narrating science that satisfies a public desire for salvation. Consider how Australia's public broadcaster twins ecological millenarianism with technoscientific resurrection in the title of a recent online article on Red Sea coral: "Coral around the world is dying, except one reef where it is flourishing." The metatext for the link contains an even more arresting short title that has coral voice this presumed *desire* for earth distress to be something other than a catastrophe: "the coral that loves climate change." (Tlozek, AbuGhosh, and Hamilton-Smith 2019).

unnecessarily provocative idea thereof. I will pause on this disagreement to show how Assisted Evolution and the status of coral reefs open up contemporary debates over the means and ends of conservation.

Gates and Van Oppen's concerns were and remain sensitive to negative public perceptions of scientists "playing God," a frequent comment leveled against experimental biology, and which the initial PNAS article foregrounds in a discussion of the "fears and facts" associated with genetic modification (GM). They articulate two major fears: first, the possibility that GM organisms would outcompete non-GM organisms and so function as what are sometimes known as "invasives;" second, the possibility that GM organisms might distribute parasites, pathogens, or otherwise cause "genetic pollution" within existing communities (van Oppen et al. 2015, 2308).[11] The 2015 article addresses these concerns by insisting that assisted evolution is not genetic modification and welcomes regulatory oversight in such forms as risk-benefit analysis and widespread public consultation—including by writing in a forum such as PNAS. Like many scientists working in this space, Gates and Van Oppen have met fierce criticism from peers, obstruction from regulators, have sought private funding to pursue research deemed "fringe" by public sources, and greet media actors with simultaneous wariness and eagerness at having to make their case again. Indeed, it is also in preparation for the social difficulties of enacting "last resort" technoscience that, in the drawing-board phase, coral scientists have sometimes been at the forefront of drawing up deliberative techniques (Hoegh-Guldberg et al. 2008). This follows from what I discussed in the last chapter, namely, how the

[11] This very expression is a reminder of the extent to which thinking health at the planetary scale requires suspending assumptions about a presumed divide between "natural" and "humanmade" vectors of harm, because the ability to identify the temporal and spatial boundaries necessary to make "pollution" available to something like historical redress (prevention and/or reparation) now, at least partially, devolves upon forms of life with their own power to make history.

science of coral reefs has co-evolved with conservation management science leading to sophisticated engagement with questions of public risk, perception, and use. In conversation, Gates and Van Oppen appear mindful of a more abstract objection to Assisted Evolution in the form of public distrust of GM organisms, which tends to be parsed as an ideological disagreement. Here again, their response is to describe Assisted Evolution as selective breeding or athletic training and center the idea that this is natural selection only on an accelerated timescale. Already in 2015, after emphasizing the "urgent need" for risk-based assessment before Assisted Evolution leaves the laboratory, they observed with their co-authors that "well-established protocols exist for the risk assessment and approval process for the use of GMOs, which can guide this process for coral reefs" (van Oppen et al. 2015, 2308).

There seem to be three temporalities at work here: Assisted Evolution is just natural selection, but accelerated, and so holobiont engineering is *timeless*; Assisted Evolution needs urgent social deliberation but the tools exist and so holobiont engineering is *historically continuous*; Assisted Evolution is an unprecedented application of "last resort" techniques and so is *historically revolutionary*. It would be possible to put some order into these temporalities by pointing out how the technoscientific imaginary overdraws the boundary between science and society, nature and politics, which are always entangled. Very good. Instead, I would like to show this entanglement as it presents in the case of Assisted Evolution. Because if this project is historically revolutionary at the planetary scale, then such entanglement is not academic. For now, let me circle back to the redescription of Assisted Evolution as "natural selection/selective breeding" and suggest that it might downplay three things: first, that it is selective breeding for ecosystems; second, that it is not just making use of natural selection as an idea but accelerating it as a geological process; third, that human beings are *also* a form of life to whom natural selection applies and acquiring the ability to contain it in "tool" alters our own evolutionary trajectory.[12]

It is possible to understand the two collaborators' disagreement over the term "super corals" as stemming from different local ideologies of scientific practice, however. The charge may have been less bothersome to Gates given the 1970s history of successful coral recovery in Kane'ohe Bay following the end of the practice of releasing sewage in public waterways, which an earlier-cited article on coral-algal symbiosis refers to as "an inadvertent man-made experiment" (Cowen 1988, 221). During this same time in Australia, however, the Federal government gazetted the Great Barrier Reef Marine Park Area as a natural preserve and placed it under strict management conditions to be enforced by and through massive public investment in coral science to consolidate Australia's geopolitical and geoscientific importance. Such efforts have yielded fruit, contributing to local, national and global perceptions of Australian nature as uniquely wild and wildly unique. Indeed, as many other researchers working on the Great Barrier Reef, Van Oppen came to Australia from the Netherlands for the express purpose of pursuing her interest and passion for studying coral science. And many coral scientists working outside of Australia remark that the privileged status and sheer size of the Great Barrier Reef has, in effect, sheltered both Australian coral reefs and the researchers who study them from having to take the possibility of coral harm seriously until recently (e.g., Braverman 2018, 47–48). At the same time, and as I shall examine more closely in the next chapter, there is a particular sensitivity in Australia to the unintended consequences that can that accompany biological manipulation, most

[12] This second point also implies a change in the very theory of natural selection itself, whose operations are dictated by processes of genetic mixing, randomized mutation, and environmental conditioning over geological time that are, so to speak, not amenable to consensus. And this is to say nothing of the fact that natural selection is a theory embedded within one epistemic tradition, whose status may be hegemonic, but is a historical and not a metaphysical given.

notably the 1930s introduction of the cane toad in the cane fields inland from the Great Barrier Reef.[13] What this suggests is that the tension roused by the association of "super corals" with GM organisms have external and internal dimensions, stemming from perceptions of the research from an imagined abstract public on the one hand and from the political and epistemic dynamics internal to the practice of coral science itself. What underlies this tension, however, is a historical question about how coral science has made coral reefs available to human understanding.

Recall that scientists have been at the forefront of efforts to stabilize a global description of coral reefs as vulnerable ecosystems in need of protection from the negative effects of industrialized society. This has involved, as it were, embedding something like an ethic of non-intervention at the reef scale into the very practice of coral science, and this often at the expense of other traditions of reef knowledge and use.[14] Indeed, the very power of commending "climate action" under the description of technoscience has involved drawing attention to the simultaneous ubiquity, importance, and vulnerability of the biology of reef-building corals. It is on this basis that Assisted Evolution is more than just a transnational biological research project, i.e., a joint undertaking connecting the Gates' Lab at the Hawaii Institute of Marine Biology and the Australian Institute of Marine Science in Townsville and colleagues in broader scientific networks. *It is also and at the same time a planetary climate action project*, i.e., a proof-of-

[13] The cane toad comparison comes up often in conversation, as attested in a recent Science article that asks: "could some kind of 'super coral,' as some researchers have dubbed them, also run amok in delicate ecosystems?" (Cornwall 2019, 1269). I find this parallel to be a curious one, however, as it uses the concept of the "invasive" to perform a radical shift in valuation of corals. Whereas the cane toad is a notoriously abject creature in the contemporary Australian imaginary (Lewis and Miall 1989), corals today are regarded with wonder and awe. This suggests that it is the very possibility that such status could be lost, that corals could become the object of scorn rather than wonder, that motivates concern over the reframing effect that an "unnatural" coral might occasion.

[14] For an important inquiry into how the history of such conflict continues to intersect with the aims and practices of present day coral science in Columbia, see Rivera Sotelo (2021).

concept for making corals anywhere in the world available to evolutionary assistance from here on out. By seeking not simply to observe coral reefs in distress but outmaneuver them, not simply measure an ending but rewrite it, a project like Assisted Evolution claims a powerful role for technoscience to chart a new course for conservation and its politics.

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As I mentioned at this manuscript's outset, one of the hallmarks of so-called "ecomodernism" and the "new conservation sciences" is the assumption that earth distress amounts to a crisis that renders the politics and ethics of "old" conservation obsolete. One way of opening this movement up to anthropological inquiry is to understand the theory and practice understands such obsolescence. Assisted Evolution is a term of art that Gates and Van Oppen bring into marine biology from terrestrial ecology, and specifically the work of USDA terrestrial ecologists Thomas Jones and Thomas A Monaco (2009). Their paper, "A role for assisted evolution in designing native plant materials for domesticated landscapes," motivates its claims by citing two major references from the "new conservation science" (i.e., Hobbs et al. 2006; Kareiva et al. 2007). Jones and Monaco contend that modified terrestrial ecosystems should not be returned to their historical composition in cases when the ecological niche required by previously endemic plant life has collapsed. Instead, ecologists should make use of a broader set of plant life and restoration techniques to bring such altered landscapes to the point of providing desired "ecological functions." In their case study of the Great Basin area, these might include "controlling wildfire, inhibiting invasive plant populations, and restoring soil structure and nutrient dynamics" (2009, 542). Assisted Evolution for terrestrial and coral reef ecosystems share the same goal of modifying in the biological composition of damaged ecologies to stabilize them as habitat. However the temporal, spatial, and biological calibration of each project is markedly different. The terrestrial ecologists argue for a pragmatic reckoning with permanently displaced plant life due to lost ecological niches *in the name of* enhancing the ecological complexity of this their former habitat. The coral scientists argue for a preemptive reckoning with foreseeably displaced marine life due to collapsing ecological niches *in the name of* making novel organisms that will interrupt this process. This is a significant shift in scale from the situated to the planetary, the lost to the yet-to-be-saved. However, it is in keeping with Jones and Monaco's sense of the capaciousness of their conceptual framework. Indeed, they all but invite such extension, writing:

> "Our comments are based on this region as a case study and must not be construed as generally applicable to more malleable environments that are relatively responsive to restoration treatments; nevertheless, our remarks may apply to other, highly modified systems. In order to determine whether they apply to some other recalcitrant systems, we suggest posing the following questions: Are undesirable modifications reversible? Is it possible to restore species composition, ecological function, and successional and evolutionary processes that prevailed prior to disturbance?" (2009, 546)

Jones and Monaco offer a deceptively simple diagnostic for testing when a damaged ecology requires Assisted Evolution: if a landscape is modified to the point that natural selection now operates to the detriment of previously endemic life forms, then it has crossed an ecological "threshold" and its future evolution is now uncertain. At what timescale is this test intended to apply? From an evolutionary perspective, there are no circumstances in which this test yields a negative result insofar as it is axiomatic that Earth is given to change. The new conservation science understands quite well that people have profoundly shaped the nature of nature for millennia: "all ecosystems can be considered 'novel' when placed in the appropriate temporal context" (Hobbs, Higgs, and Harris 2009, 599). Here, then, is the novelty within the novelty:

> Our current concern with novel ecosystems must thus be set in a longer time-frame, and questions of relative value compared with other ecosystem types should perhaps focus on the services either provided by or lost from particular types of ecosystem. It is, however, clear that rates of change are much faster in modern times and that, for better or for worse, new technologies help to overcome biogeographical and biophysical barriers to establishment (Hobbs et al. 2006, 3).

Calibrating conservation science to “a longer time-frame” means embracing the planetary as a would be apolitical and ahistorical perspective from which to conceive the so-called “geological agency of mankind” not only as the cause of earth distress but its possible interruption, not only as a problem but as a duty à la “we broke it now we have to fix it.” In viewing earth distress as an abstract force to be measured and corrected for through determinations of the relative value of ecosystem “services”, the new conservation science imagines drawing a line under its own historical involvement in making the problem so as to work on a future of ever-accelerating distress and imagine ways that technology might “help.” Our review of coral biogeochemistry and anticipated reef gaps should make it apparent why Jones & Monaco’s test applies. What it yields, moreover, *is a positive anticipatory result and therewith a striking leap*: the global oceans are a single ecological niche undergoing uncertain evolution for which any and all coral-based repair constitutes a welcome correction. This transposition to foreseeably but not yet permanently displaced marine life draws focus on something otherwise blurred in the terrestrial field. It is a problem that has long been a feature of ecological thinking: the interdependency of the living and its milieu and the question of where to locate the force that holds them together.

To get a sense of this, consider that either of the following warrants would be grounds to endorse Assisted Evolution for marine life per Jones & Monaco’s language: “*the global oceans* are recalcitrant, their modification due to earth distress is undesirable and irreversible” or “*corals* are recalcitrant, their modification due to earth distress is undesirable and irreversible.” The term I have swapped out in the two above clauses is not life nor environment nor ecology but “system.” The mutual constitution of ocean and coral as indices of damaged life under conditions of earth distress appears to conform with systems thinking. At the same time, Assisted Evolution seems to repudiate such thinking. It evidences a desire to break the system, as it were, by experimentally reengineering it. By doing so from within—rerouting coral endangerment as an engine not of collapse but renewal—it disavows the presumed necessity of the parts that make up the whole *in the name of* some other, yet to be determined agreement. Here, another sense of the "super coral" comes to the fore: its supernatural powers apt to rescue the secular metaphysics of scientific rationality from its own doubts about the ineffable. Put directly, human-assisted evolution is the coral-assisted re-enchantment of modernity (Farman 2020).[15]

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As casting goes, "super corals" have been a hit. Gates' prediction proved accurate: the name has caught on. One reason for this is that it artfully brings two ideas together: on the one hand, that ordinary corals may no longer be fit for the purpose and, on the other, that extraordinary corals may yet exist. The greater the endangerment of coral reefs, the greater the need for the reversal that Assisted Evolution suggest. The term has gained currency well beyond the work of Jones & Monaco or Gates & Van Oppen and is now, along with re-wilding and de-extinction, a generic expression within conservation ecology. But so too the term "super corals" has caught on, whether by colleagues from the Assisted Evolution project who have gone on to work in other laboratories (Klein 2018), or groups looking to rally publics around the term's proven public appeal (Hannam 2017). The term is almost never used without a disclaimer as to the ambiguity

[15] There is a way in which the very picture of the "super coral" able to withstand earth distress tightly parallels the oceanic origin story of modernist natural history discussed in the previous chapter, namely Charles Darwin's breathless description of the labor of reef-building corals in the face of the ocean's onslaught. However, one stark difference presents itself: whereas Darwin depicts the coral polyp in community, engaging in collective labor, and enacting (animal) survival amidst the perils of the sea, the super coral connotes the superhero, radical individualism, and (human) salvation in the face of mass extinction. To push this further, I would want to reflect upon Sloterdijk's writing on self-help as a dominant genre of vernacular sociological writing today, and the modernist historical ontology it upholds (Sloterdijk 2014) [right]. As an unexpected complement to this characterization, it recently came to my attention that Durkheim explains mechanical solidarity (and thus non-individuated being) by analogy with the coral colony (Durkheim 1973, 77–79).

that the adjective "super" implies. Yet this is surely the point. The very possibility of "super corals" affirms the duty of the new coral science as it moves to collect and analyze forms of coral life that may be able to rescue their endangered kin by confirming the obsolescence of their current biology. The distinction between "super" and "ordinary" coral does not lie so *much* with the global oceans as it does *within* technoscientific practice.

What makes a coral "super" is the fact that it is a desirable experimental subject, collected from the open ocean and cultivated in experimental conditions with the intent of subsequent return to the field as an ecological catalyst. What makes a coral super is not its biology as such but its biological potential that science can deconceal.

There are sound practical reasons for separating out "super" from "ordinary" coral, but when seen in this light something else comes into view. For it is not unusual for researchers to portray "super corals" as something of an evolutionary back-up, a necessary Plan B to prepare in the event that the world's coral reefs collapse, *a reserve*, if you will. Gates did not, Van Oppen does not, and most marine scientists I know do not hold super corals out as a substitute for coordinated and large-scale action to curb the drivers of earth distress. Assisted Evolution, I repeatedly heard, is a way of "buying time" for coral reefs while politics gets its act together. The fact that some of the people who used this expression were, themselves, in positions of considerable power within international and/or Australian coral reef science might seem ironic. But it is also in canny keeping with a definition of modernity, wherein the powers of scientific theory and practice to define social reality are as if removed from politics proper (Latour 1993). The new conservation science carries this assumption over even as it claims a break with its disciplinary history; its purveyors acknowledge that publics will need to be convinced of the need for the "risks" involved, but they do not see the very idea itself as politically consequential under a description of planetary crisis as total existential threat and therefore, as it were, beyond consensus.[16] This makes sense under a description of the politics of earth distress as the politics of distracted planetary sovereignty, wherein the current lack of planetary governance is a "mere" problem of an anticipated but as yet non-existent general will. This seems to assume that when political "levers" arise they will do so in the form of more or less familiar political persons and institutions. But what if the politics of earth distress is not reducible to the politics of carbon emissions budgets and ecosystem services? To rework an expression from Wittgenstein, the technoscientific way of looking at the facts of earth distress may not be the way to look at it as a political problem.[17]

"Buying time," yes, but in what currency? In explaining the tactic of "purification" whereby scientific theories acquire the practical powers to remake relations among people and things, it is the example of Archimedes and so the metaphor of the "lever" that Latour employs, but his point is to say that what Archimedes bequeathed to politics was the very idea and practice of leverage itself. To say that there is a politics to "buying time," then, is observe two things: on the one hand, the possibility of delaying the presumed "tipping point" at which a planetary will will coalesce; on the other, the possibility of altering the nature of nature—what human and more-than-human existents are to one another—whereby a question arises as to whether the planet is or is not at a "tipping point."

To close out this section, let me bring this out more fully. Super corals may be a "reserve" in theory, and yet that does not mean that they are not already *in use*, changing the

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[16] Indeed, it is on this basis that I might explain Latour's early invitation and contribution to The Breakthrough Journal deemed it adequate to commend "care" as a supplement to ecomodernism, as if there were not a politics of care immanent to the very proposition itself. See footnote 11.
[17] "The truth is that the scientific way of looking at a fact is not the way to look at it as a miracle" (Wittgenstein 1965, 11). I return to this expression in the manuscript's conclusion.

meaning, practice and politics of coral reef science in ways both predictable and not. What goes into orienting to marine life as a reserve? Heidegger's writings on technology powerfully discern the conceptual requirement by which more than human nature becomes a human resource. He describes a distinctive relationship between science and technology under conditions of modernist rationality. In the standard version of things, science claims to know foundational generalities about what is while technology (or engineering) applies this knowledge to some particular practical purpose. Yet this belies another order of knowledge production. To wit, the questions that science asks about the foundational properties of the world around us that render it as an abstraction can only be pursued through technologies that show it to be abstract*able*. Together, techno/science suggests a decisive transformation in what we are to be to the world. Heidegger calls this "enframing," and worries that it diminishes our ability to manifest a degree of ethical receptivity and historical reflexivity as we countenance our surrounds. In learning how to access the world as an abstraction, we turn away from its hold upon us as concrete living beings and, in doing so, *from our own full intelligibility as human beings*.

To illustrate this, Heidegger compares two kinds of knowledge undertakings. From a would-be premodern vantage, rivers can be sounded by way of bridges that give us access to a new perspective on their flow, whereas from a modern vantage, rivers are sounded by dams that permanently alter this flow to our benefit. While such infrastructure might occasion deeper insight into fluid dynamics through the precision calibration of the technology required, it also turns water in motion as a power-supply for human extension. What this inaugurates is not simply a new commodity to be trucked, bartered and exchanged but rather a new supply chain to be optimized: "the energy concealed in nature is unlocked, what is unlocked is transformed, what is transformed is stored up, what is stored up is in turn distributed, and what is distributed is switched about ever anew" (Heidegger 1977, 7). Through enframing, the surrounding world ceases to be an object of inquiry whose nature and purpose remains sensed yet unknown and, instead, becomes subject to human design as what Heidegger terms a "standing-reserve." He offers an altogether different image to illustrate this shift in perspective: the airplane. Motionless, the light catching its windows and the heat radiating off the tarmac, the airplane on the runway is an object to us so long as we look upon it unsure of what it might yet do. Under another aspect, however, it becomes a standing-reserve: "inasmuch as it is ordered to ensure the possibility of transportation. For this it must be in its whole structure and in every one of its constituent parts, on call for duty, i.e., ready for takeoff" (Heidegger 1977, 8).

Rather than a reserve in the sense of a "Plan B" to draw on in the absence of planetary governance to salvage human and more-than-human nature, "super corals" may be a standing-reserve in the sense of a "Planet B" that we are designing and scaffolding atop Planet Earth to rescue the human condition from its folly by granting it new powers over more-than-human nature. What makes a coral "super" is not simply thermotolerance nor kinship through natural selection with now obsolete cousins—the biological relations marine science discerns. It is a way of being made ready at hand as a "biological tool" with which to engineer coral symbiosis, reef-building, and global ocean change—i.e., as processes with functions to be optimized.

Heidegger's questioning of technology is often interpreted as a more or less dangerous nostalgia for a bygone "premodern" idyll, which, from the standpoint of new conservation science, would make it just the kind of obsolete political "baseline" that the "old" conservation science clings to. I juxtapose the river and the aircraft examples to underscore that Heidegger is describing a shift in human self-understanding that need not devolve into nostalgic self-loathing. From this it is possible to discern two related tendencies within modernist rationality that remain alive and well within the ecomodernist project: *first, to turn doubt about what is into certainty about what can be used; second, to endow more-than-human nature with moral worth for servicing and extending the human condition, even as it becomes ever more alienated, self-referential and unintelligible to itself*. When viewed as standing-reserve, what matters about the aircraft is less the complete parabola from take-off to landing than the initial vertical delivery, the fulfilment of a promise to defy gravity—as if being earthbound were not, precisely, what defines the human condition.[18] The more-than-human force whose suspension "super corals" promise is not gravity but time. It is not hard to imagine why coral scientists who feel powerless to prevent earth distress would want to find a way to give corals a boost over a coming reef gap, as the previous chapter shows. Yet what comes with the dramatic reversal that Assisted Evolution and other similar projects have performed in recent years is *a new idea of what corals are*. Not too long ago, corals were described as "life support systems for planet earth." Today proponents of the new coral science talk about building "life support systems for coral reefs." Recall Gates & Van Oppen's eagerness to dispel public fears that Assisted Evolution meant "playing God." This could be feigned powerlessness or a deflationary tactic, gestures proper to the repertoire of the new conservation science. It could also be resistance with good reasons.

[18] Another of Latour's texts takes Heidegger's point about the way technology rearranges human potential yet dismisses his critique as contrarian indulgence. Latour's remedy, however, seems to involve charging those taken in by the powers of technology with duplicity or false consciousness, whose dispelling requires a new kind of social science. One example he uses is the 2003 crash of the Columbia space shuttle: "How sad that we need catastrophes to remind us that when Columbia was shown on its launching pad in its complete, autonomous, objective form that such a view was even more of a lie than Mr. Powell's presentation of the "facts" of WMD. It's only *after* the explosion that everyone realized the shuttle's complex technology should have been drawn with the NASA bureaucracy *inside* of it in which they, too, would have to fly" (Latour 2005, 24). The example sticks, indeed, so much so that it came back to me in writing this chapter. My reading of Heidegger's aircraft, however, is that Columbia did not crash because of a bureaucratic misunderstanding or an inadequately assembled or responsible technopublic. It crashed because it was a space shuttle whose overriding purpose is to release the human condition from its earthbound existence, i.e., to ready us for take-off and to jettison the world.

Assisted Evolution might mean *not playing God* precisely because it is hard to imagine wanting to be a God whose idea of play is nursing corals to death.

2. Part Two: Acting In Situ

2.1. SeaSim; or, The Reef Goes Infrastructural

So far, I have been working through some of the assumptions the sciences of marine life are given to make when they use "super corals" to recast the problem of earth distress. I have been suggesting that Assisted Evolution and "super corals" invite manifold calibrations of time, space, nature, and technology to fashion a planetary scale conservation technique from the theory of natural selection. Of course, the theory of natural selection and the practice of selective breeding were coiled around one another from the outset, as numerous accounts of Darwin's familiarity with and experiments on heritability have demonstrated (e.g., Hans-Jörg Rheinberger and McLaughlin 1984; Wilner 2006). Assisted Evolution, however, radically extends this by taking the very wellspring of Darwinian natural philosophy, the reef-building coral, and positing the terms for a sympathetic technobiological evolution away from a predicted total breakdown of human-coral relations. This unsettles understandings of environment as preserve and recasts it as a potential reservoir of a kind of fitter life that can hold open the possibility of future life at all. "Fitter" is relative here, *relative to a baseline of predicted planetary devolution*. That means: fitter than tomorrow will otherwise be; retrofitted for crisis times; fit enough for now. If the wordplay feels gratuitous, it is my attempt to try and capture something of the following: opening evolutionary processes up to human assistance because of anticipated devolution makes time wildly non-linear in ways that strain the usual conception of the initiating concept, evolution. In this context, fitter does not necessarily mean, to (selectively) quote Radiohead, "fitter / happier / more productive / comfortable / at ease / eating well / sleeping well / no paranoia / careful to all animals."

Planetary endangerment renews biology and its objects with purpose, that of attempting to make ailing nature available to repair on the assumption that prevention is not an option.[19] You might call this maintenance. Thus far, I have limited my engagement with debates in conservation over ecocentrism and anthropocentrism. Instead, my intention has been to show how the very idea that life as it stands might not be enough inspires a measure of fear, which measure is expressed as hope in the form of speculative biology. To shift the conversation from theory to practice, from ex situ theoretical spectacle to in situ experimental routine, I now turn to the practice of Assisted Evolution via its flagship long-term experiment within Australia's National Sea Simulator, a unique scientific research instrument intended to host marine life in a physical ocean simulator whose parameters can be changed at will. If Assisted Evolution images a kind of time travel, then SeaSim is a kind of time machine. I will discuss what this kind of total scale of life making looks like in the laboratory, the kind of temporal, spatial, and biological relations it creates.

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Since the summer of 2016, I have been making regular visits to the Australian Institute of Marine Science (the Institute), a forty-five-minute drive from the city of Townsville in Australia's North-East. The Institute is a public marine science research facility announced in 1969, legislated for in 1972, temporarily housed in a former World War I quarantine station at Cape Pallarenda until 1977, then moved to purpose-built facilities at Cape Ferguson where its

[19] "The damage is done," if you will. In the marine context, the example here is not mass bleaching but ocean acidification, a toxic process whose effects will continue working their way through the global oceans regardless if all fossil fuel emissions cease tomorrow.

operations continue today. Cape Ferguson is located at a strategic distance from Townsville, at a remove from concerns over electromagnetic interference, industrial pollution, municipal waste, and urban development that rendered its initial location temporary. Indeed, the move to Cape Ferguson is a striking example of the choices made by Australian authorities to install a *barrier* between the scientific way of seeing, knowing, and using the Great Barrier Reef and that of the general public. When news leaked about the move to Cape Ferguson, developers imagined a flow-over a commercial opportunity and began contacting surrounding landowners. To preempt this, the Institute's Council convinced State and Federal authorities of the merits of zoning the surrounding land and establishing a de facto buffer zone in the form of a National Park (Bell 1998). The arrangement still stands today. It also makes for a decidedly secretive approach, as you gain access to the facility by driving down a well-sealed stretch of 19 kilometer single-carriage highway, with marshes to your left and open scrub to your right, before entering a rise lined with eucalypts and alighting at automated and camera-ready gates declaiming "government research facility, official visitors only." The flipside of the Great Barrier Reef's radical availability to the public gaze appears—even before the conflagration of the 2015-16 mass bleaching event—to be a heightened sensitivity to the exposure of official knowledge thereof.

One morning in the Spring of 2018, I was visiting one of the Institute's microbiology labs to chat with Mia.* Mia is one of a handful of PhD students working on the Assisted Evolution team. She, like Van Oppen, hails from Europe, having moved from the United Kingdom to pursue her ambitions to study coral reefs under the revered institutional and biogeographic conditions in Northeastern Australia. Her task was to investigate whether the algal symbionts that give corals life and breath could be made to tolerate anticipated ocean conditions. This meant trying various techniques to condition different species of zooxanthellae to survive in warmer and more acidic ocean conditions and, more importantly and ideally, to remain a suitable endosymbiotic match for host corals by photosynthesizing without occasioning the kind of stress discussed earlier. At the time, this was one of the four experimental trajectories of Assisted Evolution.

Waiting for Mia to arrive, I looked about, trying to force my eyes to take in some of the distinctiveness of the scene. Over time, I had become accustomed to the sinks and taps, test tubes and beakers, steel work benches clean and cluttered, whiteboards, hazardous waste signs, and lab coat racks all delivered up in the harsh tropical daylight of Northern Queensland. Often, I was terribly worried that I was not seeing Assisted Evolution at all, that I was neither enough of an insider nor enough of an outsider to appreciate the significance of what was going on around me. As I sat there, I began to tune out, and found myself tuning in to the humming and hissing of three large “incubator” units against the room’s back wall. They kept algae samples at the precise temperature settings the experiment required: an ambient temperature corresponding to “present-day” conditions, a “mid-term” setting for predicted 2050 conditions, and an “end-of-century” setting for 2100 conditions. Some shelves had built-in agitators that rocked samples back and forth as they traveled through time. The incubators, I realized, were compressing and decompressing, and sounded for all the world like an iron lung. “Life support” is more than just a metaphor dropped in casual conversation and splashed on posters around the Institute. It is also atmospheric and infrastructural. Much like the “biological tool box,” it is modular and the relations through which it works, i.e., its very organization as “life support *system*,” are indeterminate: What “life” is made available to “support”? The novel organisms that will reseed coral reefs the world over? The very idea that technoscience can help maintain coral reefs? Or the Institute’s official reputation, research facility, water supply, scientific equipment, researchers, staff, volunteers, and experimental marine research subjects—compressing, decompressing, and agitating in company as long as the power stays on?

Mia arrived and interrupted my reverie. As we got to chatting, she opened incubator doors and began updating me on her work. She carefully withdrew some plastic vials from a shelf to show me; they contain tiny specks of coral larvae, about the size of a sesame seed (Figure 23). She points out that you can't see whether they have bleached yet, then hesitates and course corrects. Maybe you can, on some of them. We squint, try and see if the deed is done. Mia is patient with my questions and takes care to explain the critical role that *Symbiodinium* play, the variety of known species thereof, and the challenges of their experimental manipulation. We are both enthusiastic, and a little tentative, and perhaps still figuring things out. At this stage, the experiment needs the corals to bleach so that symbiosis turns to dysbiosis and the coral host jettisons their zooxanthellae into the surrounding medium. Here, bleaching is not an endpoint but

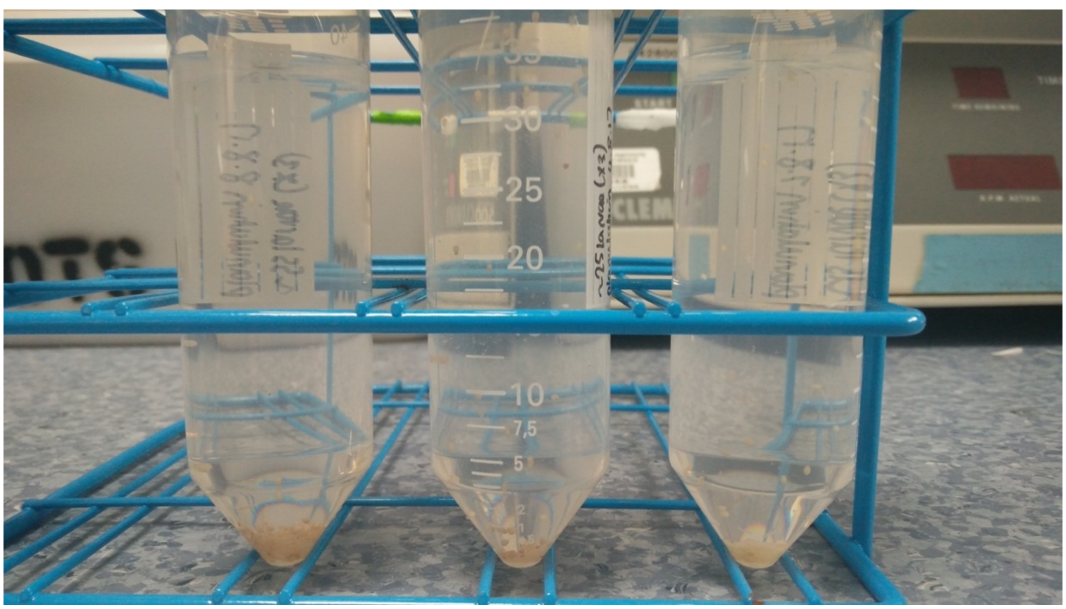

Figure 23. Test tubes containing individual juvenile corals undergoing "stress tests" to trigger a breakdown of coral-algal symbiosis, separating coral host from algal symbionts so that the latter can be collected and manipulated. (Source: Damien Bright)

a starting point. The holobiont needs to stop being a holobiont to see whether, with human assistance, it can become one anew. Or, put differently, coral host and endosymbiotic zooxanthellae must let go of one another so that Mia can hold onto them and try and bring them back together under new conditions in the next experimental stage. Life support is a matter of testing one limit so as to shore up another, and it requires a degree of cooperation. Mia returns the vials to the incubator and shuts the door, the sound of breathing resumes.

*

I first encountered Assisted Evolution on paper in 2015, and it would be another six months until I came to know it as an experimental reality, first during a visit to Ruth Gates' Lab at the Hawaii Institute of Marine Biology, and then at the Institute where Madeleine Van Oppen works as a senior principal research scientist and was beginning to set up the flagship experiment. As Van Oppen also runs a lab and teaches in Melbourne, senior researcher Neal Cantin joined the team as the Institute's on-site lead. Cantin is a Canadian-born senior research scientist with experience running lab experiments and in coral paleobiology, i.e., the short and deep time scales at which Assisted Evolution must work to accelerate natural selection. In the years since, my understanding of what this project is has developed in the shadow of the Institute's flagship research instrument known as the National Sea Simulator or, more colloquially, SeaSim. The naming of this research instrument denotes is pedigree as an official piece of "national research infrastructure" and its construction in 2009 was made possible thanks to a Federal funding program for such projects, launched as a fiscal stimulus vehicle following the global financial crisis. The Institute periodically seeks additional funding from this same program to expand the SeaSim, although day-to-day costs for running experiments themselves often draw on conditional research budgets, which can be a decisive factor in what experiments do and do not take place within the SeaSim. The multi-million dollar grant that Assisted Evolution received from the Paul G. Allen foundation was critical to making the case that the Institute host the long-term Assisted Evolution experiment.

From its very beginnings, marine science has evolved hand in glove with aquarium science and animal husbandry techniques, so all coral science labs will have some kind of aquarium facilities and are often located in proximity to coral reefs for field studies. Until recently, aquarium experiments have been largely descriptive or explanatory, with a view to understanding fundamental biological processes (e.g., reproduction, growth rates, calcification, nutrition, symbiosis) or the reasons for various adverse biological outcomes (e.g., disease, premature death, starvation, stress). Marine organisms can be incredibly sensitive to transfer to aquarium settings due to the complex web of reciprocal biogeochemical relationships at work in the global oceans. This made experimental work difficult for a long time, but also built up a considerable understanding of the effects of various parameters on biological flourishing including those driving earth distress today. One reason mass coral bleaching was explainable as a collective stress response, for instance, was because of the established literature on stressed corals' bleaching when transferred to an aquarium setting. In this tradition, however, SeaSim presents a new way of working. The research instrument is an attempt to bridge the lab/field divide and its design was the result of a global study tour of aquarium facilities the world over. In the early 1970s, the founders of the Institute conducted a global tour as well, visiting Woods Hole in Massachusetts and the Scripps Institution of Oceanography in San Diego. SeaSim team's study tour did not just take them to other coral science facilities, however, but also leading public aquaria and commercial aquaculture facilities in order to learn how to realize their vision.

Figure 24. The Institute campus at Cape Ferguson, with the National Sea Simulator in the foreground. (Source: Australian Institute of Marine Science, CC 4.0)

At the Institute, the area where SeaSim is located is referred to as the "SeaSim Precinct" (Figure 24), which aptly reflects the way in which the institute can sometimes feel like something of a gated community. SeaSim is a research platform for running aquarium-based experiments with unprecedented control over the primary parameters that make the marine environment what it is. These include water temperature, salinity, acidity, and turbidity along with ambient light settings. The instrument's physical footprint comprises an indoor facility that includes an upstairs area with a half dozen small experimental suites, laboratory facilities, the pump house, computer control room, and a downstairs area with four large display tanks for visitors, a vast open space for larger experimental setups, and four smaller rooms for additional experiments. Attached is a similar sized open-space outdoor area for "natural light" experiments. The SeaSim precinct extends beyond this architectural footprint in two ways. First, there is the vast network of supply cables, including electrical wiring connected to the on-site power station, and water pumps, storage areas, and pumps, which run tens of kilometers out the nearshore Great

Barrier Reef to bring in and filter millions of liters of water on site every day. Second, there is the daily labor of a dedicated team of SeaSim staff who maintain, modify, and calibrate the experiments and surrounding workings of the facility. The daily rhythms of technical upkeep are significant and varied, and yet the facility's vast matrix of pumps, cables, and computer controls are a constant reminder of the precision measurements underway. The untutored gaze is a liability here; it is a space for disciplining the very act of observation. "Nothing is secret on this system," a lead technician told me, explaining the computer monitoring system. "I can go back historically and check everything, if someone turned a valve off or something I can see. There's always someone on remote call, and generally these problems can be dealt with remotely."

What is distinctive is not only the precision of the environmental parameters required for aquarium-based experiments on marine life, but the ability to vary them dynamically and on a case-by-case basis for each and every experiment. Experiments at SeaSim are modular, in the sense that technical staff collaborate with researchers, postdocs, and PhD students at the experimental design stage to come up with a plan for the quantity, size, arrangement, and parameters of aquaria required and then provide ongoing support as their work unfolds, often developing the bespoke physical components that these will require. Over the years, SeaSim technicians have developed a number of unique instruments such as aquarium housings, non-toxic coral platforms, lighting rigs, oxygen monitoring assemblies, and so forth. The Institute is in the process of considering how to make these available as products for global marine science, especially as international research teams regularly come through the facility and often return to their home facilities eager to replicate the setup and so be in a position to pursue similar kinds of research.

These technological novelties have only been possible because of the knowhow that

SeaSim staff have gained from parascientific training. Staff often hail from aquaculture or the aquarium industry and are in frequent contact with these professional worlds through industry conferences, trade press, online mailing lists, and so on. One of the preconditions of the development of the new coral science is therefore a degree of knowledge transfer from outside formal research. In this sense, SeaSim has always been a scientific research instrument built partially on parascientific foundations. Much like in other impassioned technical vocations, there is a good deal of pride, envy, and aspiration that washes through the social life of aquarium maintenance and coral husbandry. The direction this takes tends to be tinkering with and optimizing aquaria to *increase* flourishing. This is no simple task and can often involve manipulating the abovementioned parameters to produce idealized conditions that are not those of real-world oceans but a surreal, fantasy milieu. While this technical training is foundational to SeaSim's operations, its typical aims come into tension with SeaSim's research mission, which is to bridge the artificiality of the laboratory to the reality of fieldwork and, further yet, produce ambient conditions designed to place experimental subjects in distress. As many SeaSim staff would tell me, this requires learning to go against their instincts in order to develop and accommodate a counterintuitive vocation for animal husbandry, one that is not dedicated to making sure marine life flourishes but make sure it suffers, repeatedly unto death.

*

The centerpiece of the constellation of Assisted Evolution experiments is known as "trans-generational acclimatization," or "transgen." As its name suggests, the purpose of transgen is to hold, breed, and rear a group of genetically diverse coral colonies of the same species across multiple generations as they experience increasingly distressing conditions (Figure 25). The experiment is split across three sets of aquaria calibrated to "present-day," "mid-century," and

Figure 25. Parent colonies of P. Acutae housed in aquaria within aquaria in order to facilitate the collection of larvae released during monthly spawning to settle and rear subsequent generations in the same simulated ambient "treatment" and so observe transgenerational acclimatization/adaptation. (Source: Damien Bright)

“end-of-century” conditions for a period of five years, during which researchers and technicians will observe and measure them as they struggle to survive and, most importantly, reproduce successive generations of corals that might inherit the adaptations they evolve in order to do so. In short, the hope is that that by exposing parent colonies’ corals to accelerated ocean warming and acidification, some will evolve random genetic mutations or nongenetic adaptations that their offspring will inherit, and the analysis of which will then be replicable in other coral species. Replication is the order of the day in this experiment. The initial group of corals was collected from three different reefs to ensure maximal genetic diversity. These genetically different animals were tagged upon collection, so that each experimental setting would contain at least one genetically identical “parent” colony for evolutionary comparison. The three experimental time signatures were themselves replicated, so that the temperature, salinity, and pH settings for present-day, mid-century, and end-of-century conditions were produced in not one but three large aquaria or mesocosms (Figure 26). The additional two aquaria function as

Figure 26. A second generation of P. Acutae in "2050" oceans. All tanks in the SeaSim include live rock to provide a source of calcium carbonate and herbivorous fish who are sympatric coral grazers. (Source: Damien Bright)

"control" tanks to account for possible "tank effect," a standard procedure in lab-based marine biology, which the modular and networked nature of the SeaSim was again designed to facilitate.

Five years is a long time to run a biology experiment, let alone as unusual an experiment as Assisted Evolution. SeaSim was critical to this in both practical and theoretical terms. On the one hand, through real-time modeling: the ability to calibrate meteorological monitoring taking place offshore with the computer settings for temperature, pH, and salinity within SeaSim to generate three dynamic environmental scenarios. On the other, through simulation: the ability to produce these scenarios as aquarium realities by way of pumps, filters, and biochemistry. This combination of automation and precision ensured experimental results would be robust enough to withstand scrutiny by scientific peers, and that biological responses would be distinct enough to warrant the cost, time, and labor of analysis. SeaSim, then, comes *as a close as technically possible to miniaturizing, replicating and extending the spatial, temporal, and biological reality of the Great Barrier Reef in order to accelerate natural selection and produce "super corals."* It is, in a sense, The Reef *as* research instrument.[20]

Yet it is not just computers, data, pumps, tanks, measurements, technicians, and researchers that make "trans-gen" go. So do corals. Atmospheric concentration of carbon dioxide is earth distress's primary index, generating radiative heat transfer from upper to lower atmospheres and thus the rate of ocean warming, acidification, and in turn coral-algal symbiosis and reef integrity. To simulate this, SeaSim varies the partial pressure of carbon dioxide according to "present-day," "mid-century" and "end-of-century" models. This measure is not a constant but has diurnal and seasonal rhythms that must be replicated using compressors and scrubbers akin to those found in human life support systems. The coral holobiont complicates this by contributing to gas exchange when they breathe. Moreover, they do not do so at a constant rate; they are most active at night and release large amounts of CO_2 at this time, which does not disperse as easily within the aquarium as it would the oceans. As such, CO_2 is pulled out of the "trans-gen" mesocosms during the day so that corals do not locally alter the future global threshold against which they are being tested (Figure 27).

In one sense, this is evidence of the "cyborg" quality of the experimental setup, the fact that this piece of infrastructure is ecologically communicative. In another, it suggests that breathing itself lies somewhere beyond experimental access and troubles research, in relatively ordinary yet conceptually noteworthy ways. SeaSim can simulate the major geochemical

[20] Yet even when such automated management is effective, it can nonetheless foster dread. One afternoon, I found the lead husbandry technician on the "trans-gen" experiment in a state of deep worry, rushing back and forth from tank to tank. "It's really warm," she said, "go on feel it." I reached my hand out and touched the water, sensing indeed a temperature shift yet then questioning whether my senses weren't deferring to her own heightened sense of touch. She rushed upstairs to check the computer readouts and came back with a printout of the month's temperature profile. She was visibly relieved. Her sense of touch had been right, the temperatures were unusually high compared to the previous days, but this was part of the normal monthly temperature profile and a planned final "spike" day before cooling set in. Everything was working: practised touch, SeaSim pumps, coral biology, and yet still the emergency was real.

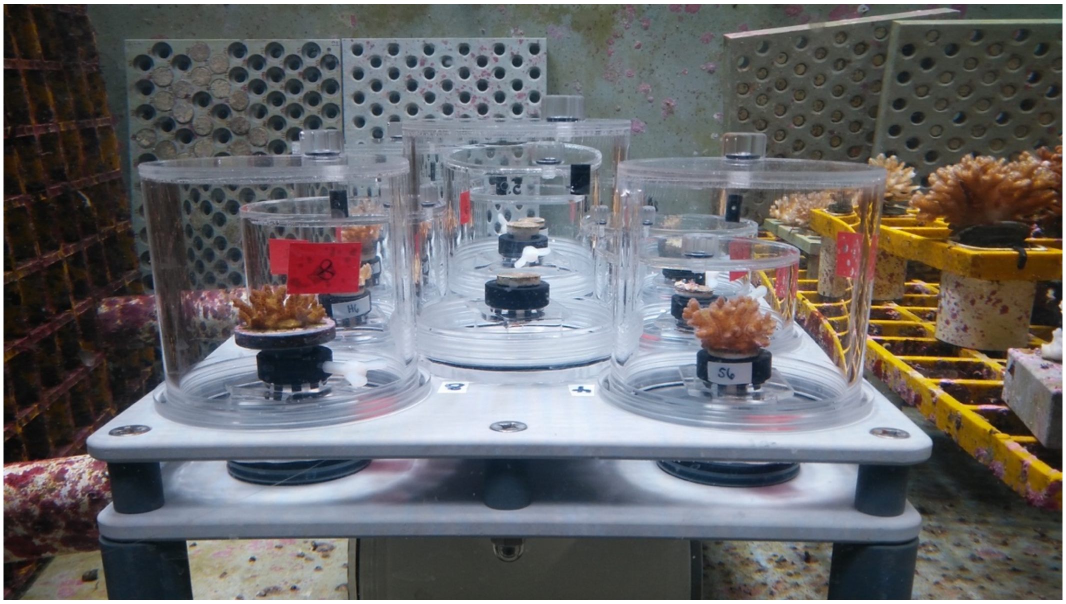

Figure 27. These P. Acutae corals from the trans-gen experiment are undergoing a periodic health check in a bespoke instrument designed by the SeaSim team to keep experimental subjects in aquaria within the aquaria for short periods of time to then test the water for changes in chemical concentrations for relevant biological functions, such as oxygen, carbon dioxide, and nitrogen for breathing. An indication that "health" goes well beyond coloration. (Source: Damien Bright)

parameters proper to ambient conditions in future oceans, yet the biological trajectory of marine organisms themselves will play a role in regulating those conditions. This is the historical "life support" function that coral reefs play after all, not only their existence as physical shelter for supporting various micro- and macro communities but a vital component of the planetary carbon cycle. Recently, a group of infrastructure studies scholars describe the paradoxical quality of the constant maintenance involved in keeping technical systems going. They proposed countering the recurring reality of obsolescence with something other than a human or technical fix: "we like to imagine an infrastructure that is receptive to feedback from biological or natural systems: a more ecologically communicative infrastructure" (C. Howe et al. 2016, 558). The "trans-gen" experiment and SeaSim is ecologically communicative infrastructure, yet it aims at equalizing those channels the better to isolate the experimental variables by which researchers gain access to the productive and reproductive abilities of marine life. What is critical to this is not keeping the global oceans together but figuring out how to get them to get it to break in just the right way. Put differently, earth distress provides the dynamic basis for "climate action" *to become a form of* "climate change."

2.2. Good Enough Coral Death

Assisted Evolution does not just put today's corals in tomorrow's seas, it uses today's corals to make tomorrow's seas an actionable problem for present day biology. What does "trans-gen" show us about earth distress that, for instance, a story or a film cannot? "Trans-gen" exemplifies a scaled up and automated version of the so-called survivorship experiment, wherein mortality is used as a baseline against which to study how environmental changes cause negative biological effects. One might, for instance, expose juveniles of a given species to warmer temperatures to study whether ocean heating presents a threat to the developmental processes of reef-building beyond the known phenomenon of mass bleaching among adults, and at what temperature thresholds such a threat most likely manifests (Randall and Szmant 2009).[21]

Death is a constant at the Institute, and its prevention in the experimental setting is not, strictly speaking, a research priority. By this I am not implying a generalized indifference from researchers, technicians, volunteers and support staff towards marine death, nor a common agreement on what counts as a "good" experimental death. But rather, that marine death is put to

[21] I genealogy of the place of the survivorship experiment within marine science would help discern when it became an enabling as opposed to a limiting constraint. It would also help appreciate the persistent bioavailability of marine life within the practice of laboratory biology. The inability to produce a standardized model marine organism on the one hand, and the value of marine organisms in showing various basic biological processes on the other has licensed a degree of wild harvesting for the better part of 150 years. Another aspect to consider is the role that the milieu itself plays in killing the living, which would connect the particularly high-tech kind of survivorship experiments underway at the SeaSim with, on the one hand, early efforts by 19th century naturalists to build aquaria and, on the other, the frustrations of live anatomical study that Thomas Huxley undertook upon jellyfish and Sigmund Freud upon eels (Wessely 2019; White 2003).

use to various ends, for research and non-research purposes, and this with a striking degree of constancy. Before discussing this in relation to the "trans-gen" experiment, the following two examples are indicative of the distinctive ways in which early-stage scientists are able to internalize and socialize individuated and mass death as a feature of their research development and development as researchers.

It is standard procedure to measure coral growth after a given experimental "treatment" by placing experimental subjects in buckets of bleach. This marks the end point of an experiment, kills corals, and detaches their tissue, with a view to leaving their skeletons intact as a photographically measurable index of growth rate under experimental conditions. Coral skeletons are legion around the Institute. You will see them on windowsills, bookshelves, desks and lab surfaces (Figure 28). Reflecting the wide range of coral species throughout the Great Barrier Reef and the many thousands of animals collected and brought ashore for study during the Institute's forty years of operation, they vary in shape, structure, and size: from three-meter

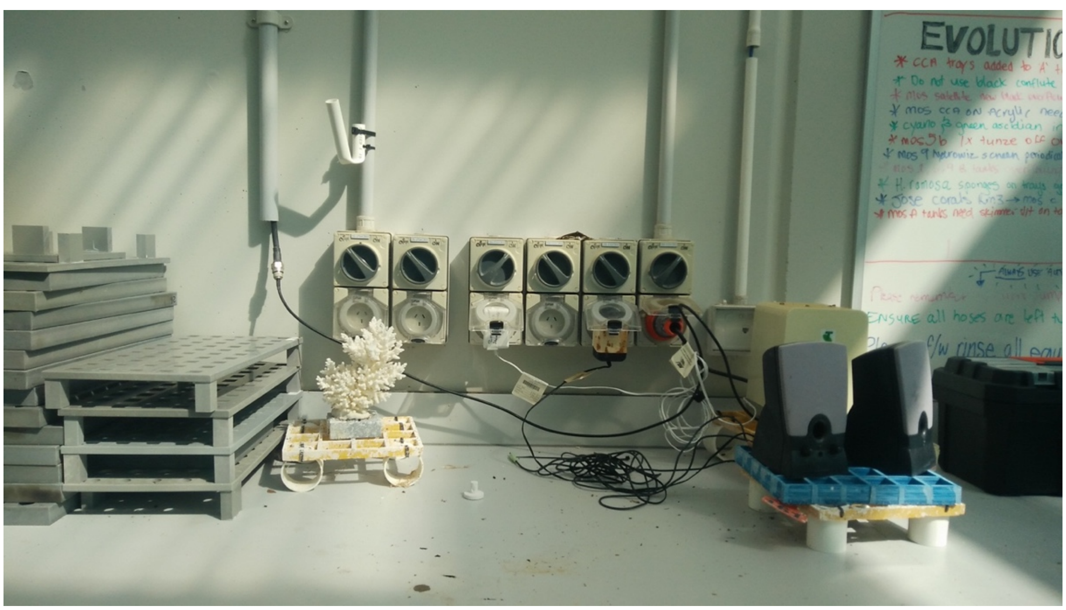

Figure 28. A dead coral sits on a workbench in SeaSim's "natural light" section. It has been dipped in commercial bleach and is still affixed to its base and strapped to the platform on which it would have sat in an aquarium experiment. (Source: Damien Bright)

long cores of *Porites* boulder corals extracted for chronological survey on show near the institute's café to basket-sized bushes of fast-growing *Loripes* corals in display cases outside the conference rooms or, for instance, countless two-inch fragments beneath computer monitors at workstations, minor tokens of ongoing experimentation. Indeed, the Institute's researchers amass their own personal collections of dead corals.

Miguel*, a PhD student and erstwhile member of the "Assisted Evolution" team who came to study in Townsville from Venezuela, was writing up his findings in late 2018. He had kept a "settlement tray" from his experiments. This device is gridded with holes to hold "plugs" on which corals are glued and "settled" for aquarium immersion. Resurfacing on his desk, Miguel had been filling the tray up, week after week, populating it with plugs holding former experimental subjects. He was keeping them, he said, as a reminder of the killing his own research occasioned. While there was no shortage of coral skeletons at the Institute, this experimental apparatus turned memento mori served as an accounting device, a ledger of the no longer living corals of which his PhD was made. Henry, another PhD student far afield from his pre-PhD home in Britain, had an altogether different approach. He was new to working in the SeaSim and anxious to get his coral samples quickly onto plugs and into their tanks. As in much biological research, the experimental phase of research is often quite short relative to data analysis and write-up and can make or break a project. It can feel extremely stressful. Moreover, Henry was learning the ropes of coral fragmentation, by which a researcher runs colonies of branching corals carefully through a bandsaw to cut them into finger-sized nubbins with smooth, flat bases the better to adhere to settlement plugs (Figure 29). Eager not to sever his own fingers, he generated nubbin after nubbin, carefully but quickly applied superglue, fixed them to their

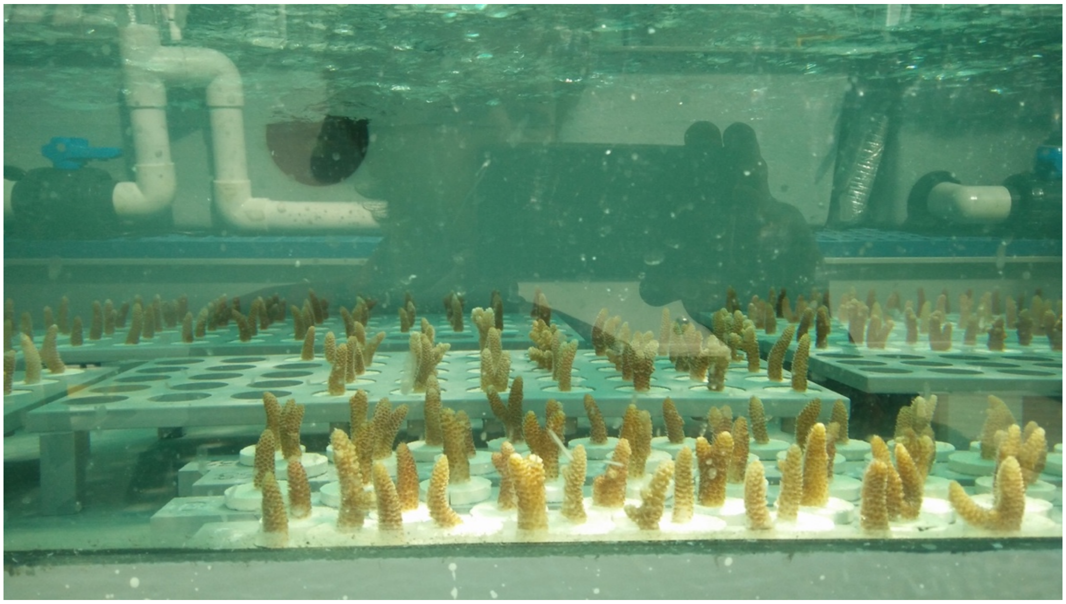

Figure 29. Henry's nubbins of *Loripes sp* corals prepared and arranged in the trays he would use for his survivorship experiment. (Source: Damien Bright)

plugs, and threw leftover colony after leftover colony to a nearby empty tray.

I watched on, horrified, as the corals piled up and formed a heap of discarded but still living coral (Figure 30). I asked him about this move, concerned by the waste and running through my head the myriad other possibilities these corals still of being salvaged, however temporarily, within the Institute's facilities. He hurried to explain that he had produced as many viable nubbins as he could, and that his experiment had no more use for the corals. Later in the day, I found the coral larger fragments carefully laid out, alive for the time being, in one of SeaSim's outside tanks. One of the SeaSim technicians had heard what the student was up to and explained they always found a use for "excess" experimental subjects. Some might be used to add to the SeaSim display, some might help calibrate aquarium husbandry techniques, some might be used in the exploratory phase for a new research project. Some salvage uses can be very short-lived—at least for the corals—and is likely what happened to the smaller fragments of Henry's *Loripes*. The Institute houses a number of crown-of-thorns starfish for display and research, and leftover experimental corals are often quite simply fed to these voracious coral

Figure 30. The rubble heap of Loripes that Henry was discarding, prior to their sorting and relocation. (Source: Damien Bright)

consumers, whom I discuss at length in the next chapter. Marine life, it turns out, can exist in differentiated lifecycles within the broader SeaSim milieu, wherein the limit of experimental subjectivity within the highly codified and results-driven realm of official scientific research is a point of departure for technical research in animal husbandry that, quite literally, gives corals a life after science.[22]

*

The above examples pose the question of the timeliness of marine death and gesture towards different ways in which a student researcher might, as it were, claim responsibility for their

[22] The "sorites paradox" is a philosophical problem, one version of which is: how many stones does it take to make a heap? Or, how many grains of sand does it take to make a pile? I think what also disturbed me was that Henry's stressed gesture replicated, *thoughtlessly and as a trash heap*, a version of the form of coral life, the cornucopian and limitless and unruly and indenumerable reef, that technoscience aims to restore.

experimental subjects. I would like now to consider, however, the way in which marine death is not so much the end point of research but rather *the ends of research itself, i.e., the question that holobiont engineering aims to open up and thus must constantly reappraise*.

Within the simulated, continuous, and comparative "trans-gen" system, experimental death discloses a limit as to what counts as a *useful or practicable way of assisting coral evolution*. It points less to a biological truth (e.g. *P. acuta* juveniles cannot withstand temperatures above such and such a threshold) than to an implied interruption of efficacy and scalability of a given experimental approach (e.g. we cannot submit *P. acuta* juveniles to such and such a threshold temperature without altering our rate of heating, or their zooxanthellae population, or their nutritional inputs, and so on and so forth). Yet before even being able to use death as a fixed variable, it had to first be understood, domesticated.

Coral science experiments that take place in laboratory settings invariably involve collection trips in Great Barrier Reef waters. These trips are carefully regulated by the Great Barrier Reef Marine Park Authority, as coral scientists are considered one among other groups of "users" of The Reef's resources and are therefore subject to zoning restrictions and reporting requirements. As the federal scientific authority on the Great Barrier Reef, the Institute does have some greater freedom of movement in this regard than, say, the researchers and students affiliated with the nearby James Cook University. Nevertheless, Institute researchers are required to prepare and file paperwork to motivate, for instance, the quantity, locations, and intended uses of any collected organisms. Internally, they have to book time on research trips, which are often costly and labor-intensive endeavors, although as in many other disciplines, "fieldwork trips" are a cherished if not to say sacred aspect of the intellectual vocation as an opportunity to experience the coral reef ecosystem in its raw form—unadulterated, for now, by analysis. To my knowledge, researchers do not have to pay for the organisms they collect, who would typically be of considerable commercial value. I never heard anyone put a price on their experimental subjects but suspect that the corals initially collected for the “trans-gen” experiment, for instance, would retail for $250,000 in the United States. Some research subjects are commercially worthless, such as crown-of-thorns starfish, any many cannot be sold on commercial markets, such as the Giant Triton whose numbers collapsed last century due to large-scale harvesting. Regrettably, I have yet to accompany a research trip, perhaps as during my fieldwork trips I was exceedingly self-conscious of my own limited “use” as a non-scientist and non-diver, not to mention poor swimmer. No doubt my heightened epistemic thriftiness and narrowed vocational imaginary owed something to the sense that every such trip today could be the last, a version of what Farman (2022) refers to as “the ticking” proper to the terminal atmosphere of earth distress. Next time, I will offer to cook.

To supply the “trans-gen” experiment with its needed experimental subjects, Neal Cantin and Institute colleagues collected close to a hundred colonies offshore during a seven-day research trip, transferred them to holding aquaria to acclimatize them to laboratory conditions, affixed them to settlement structures and distributed them among the different treatments. Even after taking the precaution of running a year-long prototype before committing collected corals to their five-year tenure in “trans-gen,” researchers and SeaSim technicians had grave doubts about the possibility that corals handled in such a way would survive the transfer. This was made particularly evident when, a few months after their arrival, the prototype corals began showing “rapid tissue necrosis.” One after the other, the small branches of *pocillopora acutae* colonies turned from fleshy pink to milky grey, their living tissue detaching from their skeletons and filling the tanks, before rot set in and algae began to grow over their necrotic limbs. It was an alarming process and for all the world looked like a synchronized immunological response, a rejection of the attempt to transplant corals from The Reef offshore reef to the simulated inland sea. Scientists and technicians made inquiry after inquiry, and the experience rattled many of them. Over and over again, I would hear them speculate about why coral tissue kept "sloughing off" and what could be done about it. Ultimately, some changes to the intake procedures were made, one PhD student recast her research trajectory and ceased working on "trans-gen" altogether, and additional resources emerged to hire a full-time husbandry technician for the project.

While this kind of death is exceedingly important for calibrating the experiment, even for sharing vital intake procedures within the coral science community, *it is not necessarily useful for answering a research question about the limits and non-limits to biological change under conditions of environmental change abstracted from the historical existence of individual corals in the SeaSim.* It is not the kind of death that can be logged, recorded, and plotted to register a "difference that makes a difference" when studying variations in temperature, pH, lighting, etc. Hence, in later years, it would become standard practice to remove parent colonies from the system once they began to show signs of mortality. At this point, the parents had reproduced and a first generation of offspring was growing alongside them in the tanks; these "domesticated" experimental subjects were deemed more stable for the purposes of the experiment, less likely to respond negatively to the "infrastructure effect" of the SeaSim as the rigors of experimentally-induced earth distress wore on. This suggests two ways of engaging virtuously with marine death: finding a technical use for it (viz. SeaSim's calibrations) and finding a scientific use for it (viz. the "Assisted Evolution" experiment).

This has practical ramifications for understanding the terms on which The Reef is shifting from a regulated marine park to a medicalized entity. It also underscores the way in which the new coral biology simultaneously invests in and defers necrology. In order to find "super corals" capable of withstanding earth distress and whose analysis might yield the foundations for reef repair, the experimental subjects within "trans-gen" must first be made immune to the SeaSim itself. What this suggests is the distinctive construction of a "normal" form of laboratory life. This "normal" form of life is not biologically standardized as is the case with off-the-shelf experimental animals fit for predictable manipulation, such as OncoMouse™. Rather, it is a biologically stable enough life form to go on in such a way and until such time that its death can definitively be registered as an index of earth distress *and* its availability to redress.[23] This means that Assisted Evolution is given to inaugurate an indeterminate spatial, temporal, and biological mode of existence according to which we cannot say for sure whether coral reefs are alive or dead, healthy or unhealthy. We do, however, coevolve in an anxious holding pattern wherein the question goes unanswered.

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I would like to close this section by raising the question of whether the "trans-gen" experiment and SeaSim might tutor our understandings of more than human death under conditions of earth distress. Haraway describes "killability" as a condition in which certain ways of dying (e.g. in

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[23] What this suggests is the construction and extension of a norm, which norm is expressed as survival. In genomic medicine, a "wild type" organism is constructed as a baseline against which to measure a presumed "mutant type" (Sunder Rajan 2006, 159–63). Here, the domesticated "trans-gen" coral who learns to go on living comes to function as the "wild type" who might have evolved into an adapted "mutant type." It is the accumulated deaths of its domesticated kin that confirm this possibility, on condition that these deaths do not appear to be the result of SeaSim's "foul play." At the same time, the "wild" and "mutant" constructs of the experiment are only useful in comparison to a presumed "true wild type" of present-day global oceans themselves. This presents two orders of comparison, one within the laboratory setting and another between the laboratory and the field. However, at the same time, the guiding assumption of holobiont engineering itself is that without producing the appropriate "mutant type" in the lab then the "true wild type" of the field is just like its domesticated "wild type" kin—as good as dead.

the name of science, in the name of industrial meat production) are deemed *automatically permissible* and thus distinct from "killing," which continues to entail forms of moral reasoning (Schrader et al. 2017). "Killability" indicates a capacity to interrupt or turn away from avowing one's own capacity to respond ethically to death. One of its conditions is precisely the tempering of ethical sensibility that comes when some forms of life become the useful "standing-reserve" with which to advance technical "progress," as discussed earlier in relation to the damming of rivers or the sacrificing of astronauts. Killability is not an exclusively more-than-human concern, either. Critical black studies scholars have demonstrated that the privileged treatment accorded to white lives devolves upon a historically motivated denial of the ethical standing of black life, which rationalizes forms of mass or social death into the historical present in order to stabilize a racial division of subjectivity (Sharpe 2016). Killability, moreover, often works through the seemingly "indirect" yet always already politically directed (i.e., organized) medium of the environment itself in ways that prop up and police a motivated distribution of power, authority, and voice by making the debilitating and fatal effects of toxicity a condition of ordinary life for some and an aberration for others (Fortun 2001; Jain 2013; Povinelli 2016; Shapiro 2015). What if the new conservation sciences are not, or at least are not only, a rational alternative to "despair," "doomsaying" and "fatalism" as its ideologues imply? What if they are *interested*, i.e., dependent upon and coevolving from, killability and the terms of its extension under a description of earth distress narrowly construed as an existential threat awaiting the arrival of political governance? To be sure, modernist marine science *has* suffered a catastrophe in the past decades and I *have* observed ordinary ethics in laboratory settings. Yet I remain struck by how researchers, technicians, managers, funders, and PR teams do not cease to avow this catastrophe as a regrettable yet simultaneously *studiable* proliferation of possible forms of marine death.

I would like to close this chapter with the following question: do the forms of biological sacrifice that the pursuit of "super corals" makes epistemically and morally necessary suggest a way of understanding earth distress as providing the legitimating grounds for new forms of killability?

Since the Institute's founding in 1972, marine biologists ably used corals as an index of Great Barrier Reef's health, notably through their capacity to bioaccumulate changes in ocean chemistry. Coral coring was central to this undertaking as it provided a rich historical record of the ecosystem-level consequences of development. By way of these cored and no longer living corals, marine science could inform regulators as they set upper limits to industrial development in the name of ecosystem health. This was the picture of science-based management before the "advent" of earth distress: the Reef as a whole would go on living thanks to the no longer living labor of some of its parts who were instrumented as experimental subjects. The same extension of biological ability through no longer living labor occurs in holobiont engineering, yet on new terms. In the "trans-gen" experiment, interns carefully count dead experimental subjects who are the null results that confirm the continued acclimatization and possible permanent adaptation of their kin. Here, no longer living labor does not produce the upper limit to industrial damage but the lower limit to presumed extinction. In the first example, cores extracted from one coral colony (typically the slow-growing and long-lived *Porites*) are extracted from one spot on The Reef and sacrificed to bound marine pollution so that other corals and their dependent communities can go on living on entire reefs or regions of The Reef. In the second example, genomes of dead experimental subjects (from fast-reproducing but short-lived *Pocillopora Acutae*) are discarded to count survivors so that future corals might come into being, unbounded by pollution, and from potentially any species, throughout the global oceans.

The possibilities of coral biology are no longer set by the descriptive practices of science but by its practical ability to anticipate earth distress and make it experimentally useful. That is the point of the "biological tool-box," to scale to as many species of coral as possible wherever they are needed. What will be in it, how it will be put to use, remains indeterminate. The sense of constant and imminent threat that drives the search for "super corals" is thus made practicable in the laboratory setting insofar as coral death—when it is not due to the failure of the SeaSim as infrastructure—has a degree of automaticity. Killability in the idiom of earth distress might, in other words, be a manifestation of the phenomenon otherwise known as extinction. Conducting human-assisted evolution, if nothing else, requires getting used to human-assisted extinction. Among the reasons why technoscientific rationality may be attached to a description of "climate change" indexed upon a future horizon of ultimate catastrophe is the difficulty of acknowledging the sacrificial grammar of earth distress, past and ongoing, that it stabilizes.[24]

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A feral, a rogue, a parasite, a freeloader. Many years before my arrival at the Institute, a technician spent months creating and installing a small aquarium in a shed that, I later learned, was the "SeaSim before SeaSim" (Figure 31). During the years I visited, the sheds have seen limited use; they house research on mangroves, giant clams, and shelves of spare parts. The mesocosms look to be of the same make as those used in the trans-gen experiment but their upkeep is entirely other. Algae grows quickly on the walls of an aquarium and scrubbing it off

[24] Other language exists: omnicide, ecocide, necrocene. "Killability" grounds this phenomenon in a kind of practice, an ability, and thus unsettles the infinite regress of semantic debate. In dialogue with moral philosophy, the point would be to discuss how extinction as risk (another abstraction, as it were) prompts discussion but invites moralistic regress. As "ability" (of earth distress itself, and, by extension, of "Assisted Evolution"), it implies obligatory participation and must provoke a response.

Figure 31. The storage shed towards the back of the SeaSim precinct that housed a variety of experimental animals, including giant clams and ex situ mangrove habitats, and which also functioned as an overflow space. The "rogue" tank is on the bench in the center of the image. (Source: Damien Bright)

can be time-consuming and thankless. A riot of greens, greys, browns, blues, and whites obscured the viewing panes in the shed, covered in pullulating algae. It could feel, sometimes, like stepping into a different time and yet there it was, something like a rough edge in the shadow of the high-tech SeaSim "precinct." There was one particular tank that stood out to me, it was evidently a labor of love, a work of salvage, and a pet project. Aquarium science at the Institute produces animal leftovers that go on living long after peer review goes through and budgets get balanced. The aquarium contained a handful of different corals, sponges, and some grazing fish; these creatures escaped experimental subjectivity, in a sense, through donation and recuperation. Without a use for science or conservation, they had no apparent purpose other than just being there.

The tank was hooked up to water pumps and air filters and received a fresh supply of the SeaSim precinct's water mix (Figure 32). I first came across it when doing the late afternoon feeding rounds, when one of the technicians told me where to go find it and make sure it got whatever was left over from the official rounds. It was not forgotten. When I asked about it, everyone knew which tank I meant, the technician who had set it up, and the fact he had left to

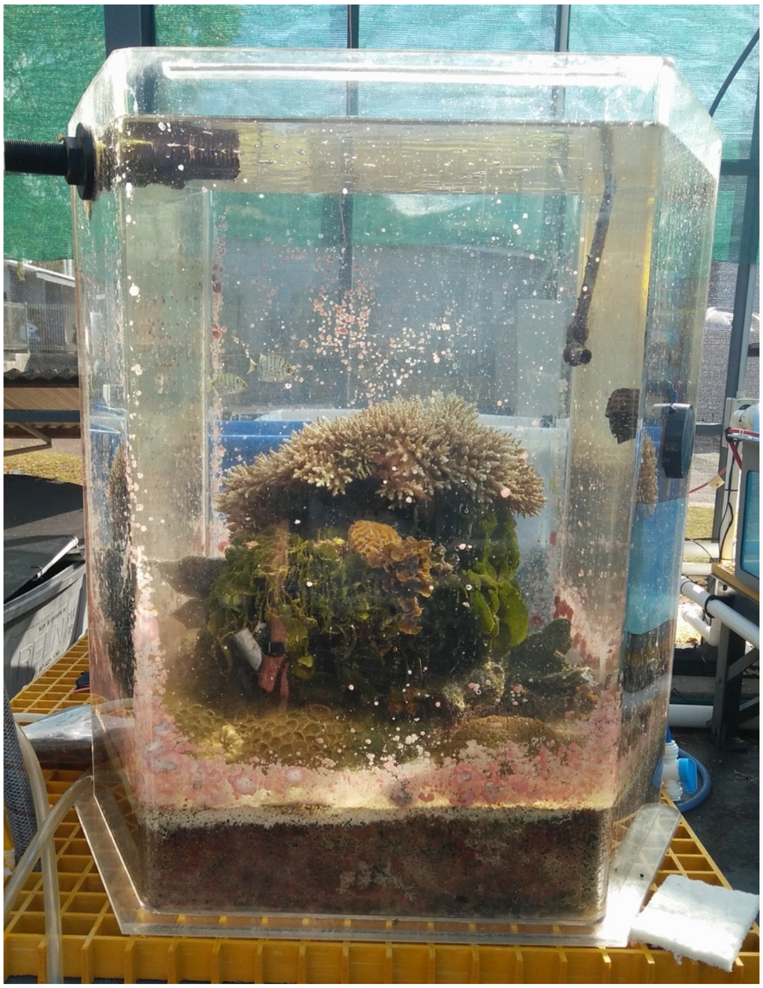

Figure 32. A close-up picture of the "rogue" tank, whose contents resemble a reef outcrop in miniature composed of a handful of different species of coral, turf algae, and some grazing fish. It is a relatively modest tank by current Institute standards and is closer to what a hobbyist "reefer" might aspire to building at home. Yet it is no domestic installation; it has no ostensible "owner," is sustained by its integration with the Institute's water circulation and filtration system, is fed by SeaSim staff, not to mention that its composition is the result of years of living labor by unneeded experimental subjects allowed to keep on keeping on at the periphery of it all in the storage shed. (Source: Damien Bright)

work at the Melbourne Aquarium some years ago. It was not clear to me that the tank inspired strong feelings among the team; it seemed to hover somewhere between a part of the SeaSim network whose upkeep was a routine task and a duty inherited from and owed to a former colleague. In Melbourne, 1,600 miles to the South, the missing technician no doubt makes and maintains display aquaria where marine life gets to flourish, for now at least, at a remove from the pressures of earth distress that bear down upon The Reef and the workaday reality at the Institute.

The rogue tank appeared out of place, out of mind, and was of no obvious use to technoscience. It was feral, not wild. I returned to it often, sometimes daily. If the SeaSim functions as something of a time machine projecting corals forwards and drawing earth distress and extinction into action, perhaps this rogue tank did its own historical work. But if so, then, in the logic of the new conservation, it was a holdover from a bygone era, and thus a distraction at best and, at worst, a regressive goad to nostalgia. After a few months away and before returning to Chicago in late 2018, I stopped in at the Institute. As some had foretold, the SeaSim precinct was expanding and the technicians had begun retrofitting the mangrove shed for a new set of experiments. The feral tank had been moved on.

Conclusion

Assisted Evolution is a speculative yet tractable undertaking, and I have been attempting to describe how it transforms the spatial, temporal, and biological reality of marine life along with human understandings thereof. This emerging formation of technoscience redescribes planetary nature as a technobiological infrastructure and makes evolutionary time available to permanent human assistance. The result is a purposeful and increasing blurring of the laboratory/fieldwork divide, germane to marine science and anthropology both, which, opens up new forms of intimacy with earth distress instead of placing it at an observable distance.

The search for "super corals" posits their existence, which can be made good experimentally, i.e., with difficulty and in unexpected ways and open-ended ways. The SeaSim's recursive operations push anticipated marine death ever closer to the present and cultivate an ethical attitude of willing sacrifice towards past epistemic virtues, present-day living corals, and a non-engineered future in the name of crisis action. The rogue tank's removal offers one example of the extent to which there is no longer space at the Institute for particular forms of leftover, residue, or salvage. "Ordinary" corals are becoming—like stories of older reef-goers of oceans transformed beyond recognition, if not the storytellers themselves—a practical distraction and an alienating moral presence. Gradually but perceptibly, the new marine sciences are altering the nature of technoscience at the Institute—the way you ask questions, run an experiment, communicate your research to colleagues and publics. Consider that a few years ago the Institute announced a new phase in the life of the SeaSim on Twitter, which further evidences the breakdown of the laboratory/field divide. The stress test techniques developed in the "trans-gen" experiment are now being deployed on Australia's West Coast coral reef thanks to a portable SeaSim-In-A-Box. With the initial trajectory of the SeaSim underway—to bring anticipated but as yet unrealized oceans to shore—a second trajectory is now looping back around—to take as yet unrealized oceans onto The Reef—where, at least for the time of a fieldtrip, a possible evolutionary starting point for the world's reef-building corals hovers six feet above their presumed evolutionary dead-end.

The proponents new conservation science are aware that their way of thinking and acting rouses ethical and moral concerns and, in different ways and for different reasons, defend their approach as pragmatic and forward-looking in opposition to a picture of technoscience mired in idealism and nostalgia, unable to let go of a picture of global nature as it can no longer be. Gates and Van Oppen in no way seek to monopolize what coral reefs or coral science are or should be and are quick to insist that earth distress requires putting any and all options on the table. Yet this call for limitless experimentation can make it difficult to recognize the new combinations of capital consolidation, physical harm, ideological control, and psychodynamic deflection that hitch a ride on the most caring conservation work—all of which are the very engine of genuine political and moral deliberation.

What I have been trying to show in this chapter is that the pragmatic case for holobiont engineering is questionable for the way it relies on the presupposed historical necessity of the new conservation science. While there may be sound reasons in coral biology terms for assisted evolution (viz. the biogeochemical abilities of reef-building corals at the whole earth and deep time scale), the sociotechnical reality of the project is doing a lot more than turning a toxic relationship between coral reefs and industrial modernity into mutually beneficial or even slightly less toxic one. It is also dramatically extending the points of contact between humans and corals and so forging a far more complex, sensitive, and risky mutual dependency. At the same time, it introduces a new sense of what earth distress is to human subjectivity as an ethical, moral, and political problem. While holobiont engineering remains controversial today, there is far less resistance on view than ten years ago, and this is not so much a matter of proven efficacy at alleviating earth distress as it is a sociopolitical achievement in producing something like necessity. This includes a lessening if not lifting of the move to euphemize “engineering” as the operating grammar of natural science. It is not obvious that this is in anyway a sign that an imagined lack of planetary governance is any closer to being met and it may, in fact, simply delay its arrival. Put directly: as the new conservation science has built momentum, it has, at least for now, acquired a degree of durability thanks to its embedding within the very worlds of political opinion and corporate interest from which many of its protagonists still claim to await a radical change of heart that will usher in new rules of planetary governance. This durability is not optional but necessary to the success of the new conservation at scale, which makes it also, therefore, a growing force within the actually existing terms of planetary governance, lacking or otherwise.

Assisted Evolution is a remarkable condensation of coral biogeochemistry and an extraordinary collaboration between people, animals, and machines. It is also, in concert with the broader new conservation science movement, altering what is deemed not only epistemically but also politically and morally necessary in the face of earth distress. The would-be “super corals” struggling to come into being within the SeaSim’s replicated future ocean conditions are not androids. Their existence is wholly dependent on efforts to technobiologically contain the dysbiosis of ordinary corals within a humanmade “life support system.” As such, we don’t yet really know if “super corals” exist, but in engineering our way towards them we are changing what corals are to us and what people are to them, i.e., altering the political, moral, and ethical questions that we ask of ourselves under conditions of earth distress.

The title of this chapter replicates that of Phillip K. Dick’s 1968 classic, *Do Androids Dream of Electric Sheep?* The story revolves around protagonist Rick Deckard, the dutiful “blade runner” tasked with killing “replicants,” robot workers who go rogue and refuse to die when their pre-programmed time is up. Thanks to Ridley Scott’s 1982 cinematic adaptation, *Blade Runner*, the novel popularized the problem of more-than-human minds: is Deckard a human or a “replicant”? Dick’s novel puts a question mark over whether Deckard is who—or what—he thinks he is. Knowing Dick's troubles, the question is more than likely self-interested, and so intended for the reader as well. Do corals dream of simulated seas? We are the animals dreaming up simulated seas to carry corals beyond a coming reef gap. We are the holobionts whose dependent relations are being torqued, strained, and broken open by earth distress. The question is not whether "we should be doing this," but how and why this seems like a recognizably human way of coping and what we want to do about that.

CHAPTER FOUR: REEF INC.

In 2015, the Great Barrier Reef Marine Park Authority (the Authority) and the Australian Institute of Marine Science (the Institute) marked their fortieth anniversary as the twin federal government agencies responsible for Reef management and research. The anniversary year had a calendar and a logo and a theme: "Celebrate the Reef." Festivities culminated with a public day of events on October 17th in downtown Townsville along The Strand, a two-mile long strip of foreshore punctuated with permanent and seasonal public amenities. The Strand starts at ReefHQ, an ambitious aquarium inaugurated with much fanfare in 1987 as the "Great Barrier Reef Wonderland," which remains central to the Authority's public outreach efforts and housed their offices until 2018 (Figure 33).[1] It culminates at Garabarra/Kissing Point Fort, a major fishing, foraging, meeting place and trading point known for its medical plants, with ongoing significance to Wulgurukaba and Bindal people and nations, at which a colonial fort was erected in 1870 and a military garrison and staging post during the Battle of the Coral Sea until decommissioning in 2006. Townsville, like so much of the Reef coast, North Queensland, and Australia itself, is a place made up of places whose overlapping historical presences resist disarticulation (McCalman 2014; Neale 2017). The Strand is one of the few parts of the city

[1] The aquarium was the brainchild of the Authority's first chairperson, Graeme Kelleher, and was designed with the superlative qualities of its namesake in mind. It has a 10,000 square meter footprint and took 18 months to build at a cost A$7.2 million (US$15 million today), partially funded by a grant for Australia's bicentennial celebrations. Its centrepiece is a 650 square meter (171600 gallon) marine aquarium that was stocked with 300 tonnes of sand from Flinders Reef, 700 tonnes of coral rock from Hayman Island, and 3 million tonnes of water from Myrmindor Reef. The aquarium also featured the first Omnimax Cinema Theater in the Southern Hemisphere, a super-large format film medium that used ultrawide or "fish-eye" lens technology for capture and a domed screen for projection. In 2012, the theater was closed and was demolished in 2020. Six hundred guests attended the 1987 inauguration, jointly officiated by staunch political enemies then Prime Minister Bob Hawke and Queensland state premier Sir Joh Bjelke-Peterson. "People come to our State and say they have come to see the reef and a lot go home disappointed," observed Russ Hinze, speaking for the Queensland government. "Now we can tell them to come to Townsville and see it at its best, and in comfort" (Australian Fisheries Division 1987)

Figure 33. Construction site for the then "Great Barrier Reef Wonderland," now known as Reef HQ, suggesting some of the scale of the enterprise and the considerable public investment involved. (Source: D. Alcock, Great Barrier Reef Marine Park Authority, CC 4.0)

whose function as something of a commons remains intact after decades of disinvestment, whether despite or because of a proverbial triennial custody battle between the two major parliamentary parties come federal election time. There were a few weeks in mid-2016, for instance, when I remember the foreshore bustling with people ambling solo or in pairs, teens and kids and parents too, all excitedly waving around smartphone screens. Pokemon Go, an augmented reality game, had just been released and all comers hit The Strand to lure out geocoded sprites, the more elusive the better, in an uncanny, wildly popular and seemingly harmless yet exceedingly resource-intensive simulacrum of 18th century natural history collecting.

That day in 2015, close to 2,000 people turned out to “Celebrate the Reef” and participate in citizen science activities, games, speeches and a beach clean-up. The event was free to the public, a departure from the Reef’s typical celebration as a premium tourist destination that

Figure 34. An image of one of the turtles released to conclude “Celebrate the Reef.” The endangered green turtle is a form of charismatic fauna and indexical icon of the Reef as a charismatic ecosystem. (Source: Great Barrier Reef Marine Park Authority)

brings 2,000,000 annual visitors to the region. Ross and MJ closed out the event (Figure 34). They were two green turtles ceremoniously returned to the Reef lagoon after treatment at the Turtle Hospital, a working veterinary clinic and popular attraction at ReefHQ. Ross and MJ’s release was an example of the ongoing aspiration that, even as the causes of their injuries both direct (e.g., plastic pollution, boat strike) and indirect (e.g., overfishing, rookery destruction, earth distress) proliferate out of sight, there is an appeal and a point to discrete acts of human repair vindicated by withdrawal. This is a manifestation of “pristine wilderness” become “pristine-when-managed nature.” There is cause for official celebration—which you might say is a benign form of enjoyment akin to public entertainment—because people have learned how to effect enough of a change to some small but significant part of the Reef to let go for now and return another day. Although there is romance to this conception of the Reef, its enforcement had been the mission of the Authority and the Institute for forty years, and earth distress now appears to overwhelm it.

Even as celebrations began that day in October 2015, scientists and bureaucrats were anxiously aware that a heatwave was wending its way through the global oceans and would soon bring a mass bleaching event to the Reef. By March 2016, close to half of coral cover across the two thousand or more coral reefs that make up the national icon bleached white. Both government agencies became embroiled in private and public skirmishes with scientists, employees, conservationists, and politicians arguing over just how bad things were, and how bad they were going to get. "Celebrate the Reef," it turns out, would be the last event of its kind; an anniversary to mark 40 years of producing the "world's best managed reef" that now looks like a festschrift. What came after was a shift in Reef "governance" in the form of an embrace, hesitant at first but quickly fevered, of the systematic extension of hitherto untested techniques of biological, landscape, and infrastructural engineering aimed at shoring up the Reef's "ecosystem functions." This amounts to a wholesale repudiation of previous boundaries on appropriate "use" in virtue of what proponents view as a now gravely miscalculated threat assessment. In the previous chapter, I explained why and how this happened in relation to holobiont engineering and the resulting dysregulation of human self-understanding in the name of a new coral-human agreement. Now, I show how the generalization of a seemingly new mode of conservation known as "intervention" opens these same forces up at the whole-of-Reef scale.

What is intervention and why has this way of relating to distressed nature achieved such rapid uptake? How does intervention understand felicitous and infelicitous action? Under conditions of earth distress, what kinds of "agents"—pests, enemies, pets, livestock—does intervention make of entire ecosystems and how does this happen? What kind of a description of human need and global nature is this? My argument is as follows: while the effects of intervention's embrace are considerable indeed, the mark of their success is not to free the human condition from earth distress but only to further hook us on it. In other words, *intervention does not break with but reconvenes the drivers of earth distress in ways that are simultaneously unprecedented and possibly more difficult to unwind.* Hence, I will show that a narrowly rational understanding of earth distress is a form of knowing as luring, a verb adapted from the word "lure," which is to say a kind of mimetic technics that simulates some form of prey, used to bait and train an animal such as a hawk or fish, and since extended in ordinary language to the act of trying to draw something or someone out from where they've been hiding.

Once again, I develop this argument in two split but connected parts. The first situates Reef intervention as a radical proposal to break with histories of nature's misuse while the second argues that, in some key respects, intervention merely offers new avenues for rationalizing and extending human claims to harness nature with authority thereby exacerbating the confusion of earth distress. To begin, I describe why "intervention" is, indeed, a new way of knowing what to do with the Reef by providing some sense of the scale of its uptake beyond Assisted Evolution (Section I). I then take a step back from the Reef and provide some sense of why, particularly in the Queensland context, "intervention" as a conservation strategy is historically sensitive if not to say toxic, by recalling the iconic case of an epic failure of so-called "biocontrol" and "pest management" from which Reef actors continue to distance themselves (Section II). Moving onto the second part of the chapter and having framed intervention as a promise and a problem, I return to the Reef and offer a close reading of one example, namely, an autonomous underwater robot designed to identify, track and kill crown-of-thorns starfish (Section III). I situate this particular starfish within globalized coral science and management as both a loathed coral predator capable of decimating entire reefs and, historically, an epistemic puzzle suggesting the limits to human ingenuity (Section IV). What this shows is that the starfish-hunting robot intends, simultaneously, to solve a pre-existing puzzle within contemporary coral science and management *and* anticipate subsequent puzzles that will arise as the conditions of earth distress transform the Reef and the global oceans beyond all recognition (Section V). I then make a final scalar shift by explaining the design of the robot's killing technique, a lethal injection mechanism, which offers some resolution on why "intervention" only further embroils the human condition within earth distress (Section VI). Finally, I return to the initial question of how intervention unsettles convention to highlight the ways in which the starfish-killing robot obliterates the historic doubts that crown of thorns outbreaks raised about the possible excesses of human industry (Section VII).

1. Part One: What Reef Intervention is Not

1.1. Intervention's Shadow

What on earth is a "fevered embrace" of intervention astride the Reef? I have shown you an image of the happy return of a green turtle to the global oceans. It featured in the Authority's 2015/16 annual report where the word "intervention" appears once. Five years and three mass bleaching events later, the concept is legion. The Authority has invited public comment on a draft Intervention Policy, approved permits for ten interventions, hosted an international symposium on coral reef intervention, and is the federal environmental management authority leading the multi-year and multi-agency and multi-million-dollar Reef Restoration and Adaptation Program (hereafter the Program). Not only did the Program draw inspiration from the theory, methods and public reception of Assisted Evolution, it is also the centerpiece of a wholesale overhaul of the Institute's organizational philosophy around the concept of "impact-driven science," the overriding goal of which is to produce global benchmarks for the studied intervention into *any* rapidly changing environment.[2] It is worth emphasizing that, for those involved, this shift or break or turn or embrace is no trifling matter. This is not "mere" discourse, a "simple" rebranding exercise, or, and to use a colloquialism that discloses our abiding interest in discriminating between natural kinds if only to stabilize class distinctions, "mutton dressed up as lamb." To appreciate this, here is what Gregory*, a quantitative ecologist working on his own high-profile and field-defining "intervention," told me at the end of a lengthy interview:

> Twenty years ago, the idea of an [Institute] scientist talking publicly about releasing GM calls onto The Reef. It would have been… you know, they would have been lynched. I mean, it would have been absurd that you even think about doing that sort of thing. It's sacrilegious. And earlier this year, you know Line Bay is on the radio talking about just that to the general public. (Laughs) And that sort of state shift in the past, the more you sort of focus on it, the more you realize that it's this ongoing type of process. It's not just scientists, it's everybody.

Lynched," "absurd," "sacrilegious." By chapter's end, I will have returned to the particularity of these associations and what they indicate about the grammar of intervention. At this stage, however, I want to simply underline something generic to these words and to Gregory's point: *there is something excessive to intervention, even senseless, if only in the very drawing of an equivalence between these three divergent expressions of historical excess*. The statement stands in for what, in my experience, has become a rather difficult thing to articulate *and even think* in relation to the Reef if not global nature. Here is a researcher and fieldworker striving to make the case for intervention only to find himself, at the same time, dumbstruck by the ease with which the case seems, already, to have been made. In fact, it's as if there is no need for his expert findings at all, at least not *some aspect* of them: "It's not just scientists, it's everybody." What's

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[2] In short and to try out a rather strange turn of phrase, whereas the Institute and the Authority's previous mission was to maintain "the world's best managed reef," they are now aiming to scale up to maintain "the world's best managed planet."

more, he was reacting to a specific question that I would occasionally ask towards the end of a conversation, namely, what an example of something like the opposite of “whiplash” might be in his work on the Reef, something that stands out for its ordinariness. What stood out was how seemingly conventional intervention had become.

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Let me approach this from another angle and spell out some examples of intervention in ordinary language. Coral biologists are exposing a handful of coral species to simulated future ocean conditions in the hope of triggering evolutionary adaptation. Aquarists and engineers are designing aquaculture facilities to mass produce any viable genetic strains that result. Museums and zoos are refining cyropreservation techniques to “bank” as many coral species as possible to later retool their biology and mass produce their bodies in the same way. Teams of coral biologists are trialing so-called “coral IVF” during the annual mass spawning event that occurs on the Reef to increase the likelihood of coral gametes successfully pairing when released in the open water. Mechanical engineers have imagined mobile pumping stations to push things further, conceptually and geographically, by vacuuming up gametes released during annual coral spawning and so flex mean survival rates. Geneticists are testing CRISPR-CAS9 and gene drive techniques to try and knock out and knock in the relevant genes that code for key metabolic functions in corals and zooxanthellae and so engineer species capable of enduring harsher ambient conditions without breaking the terms of their symbiotic agreement. Meanwhile, biologists, geneticists, and biogeographers are coordinating the identification, collection, and translocation of “hardy” corals from relatively warm waters in one part of the world to warming waters in another. At the ecosystem scale, coral scientists are working with econometricians to identify a portfolio of reefs warranting high priority attention because of their nodal role in stabilizing food webs, predator-prey relations, and larval dispersion throughout the Reef, and, indeed, the global oceans. A new take on an old technique with a checkered past, namely, the "artificial reef," shows promise: for decades, various interested parties have encouraged corals to settle and grow reefs on concrete blocks, steel crossbeams, tires, decommissioned subway cars, ships, or offshore oil rigs. Today, companies are developing and patenting 3D printing techniques and designer materials to tailor artificial substrates to coral morphology and site specificity. Chemical engineers are developing aerosolized compounds to increase the reflective capacity of clouds over reefs and floating compounds to do the same for the ocean's surface. Roboticists developed an autonomous underwater robot to track and kill a lethal coral predator and are now retrofitting the technology with additional abilities like water monitoring sensors and coral larval dispersal arrays.

This enumeration may be exhausting to read but it is not exhaustive. I draw it from some of the interventions I witnessed some aspect of firsthand during fieldwork, which may, in some respects, have been thinkable before 2015 but would not have been actionable in situ, at scale, and as a loosely coordinated "field" of marine science and management. Consider this: a few years ago, a working group with the U.S. National Academy of Sciences, Engineering and Medicine has identified and assessed twenty-three candidate interventions (NASEM 2019), while the aforementioned Program has reviewed 160 interventions and recommended proceeding with 43 (Anthony et al. 2020). It is difficult to put even a handful of interventions into plain language, let alone discern a through-line to how this field and its proponents understand coral reefs, human action, or moral and political duty. But why stop at the proponents? "It's everybody," says Gregory. In fact, on October 8, 2018, shortly after we spoke—and once more I feel that by writing this sentence I am somehow committing a scholarly own-goal by showing you that I'm incapable of coming at intervention from the right angle—the International Panel on Climate Change (the Panel) released its *Special Report on Global Warming of 1.5º* in which, the intergovernmental body and joint recipient of the 2007 Nobel Peace Prize called for the "widespread adoption of new and possibly disruptive technologies."[3] *What I am trying to say is that it is impossible to keep up with "intervention."* And this might just be the point. It is precisely the fact *of* multiplication that makes intervention, in the special sense used here, apt to "keep up" with earth distress. This is what is called "scale," in the idiom of so-called "tech." By contrast, the idea of "keeping up" with intervention in some other way, as if to surround it with a causal explanation, might be a desire of mine that draws on some presupposition about how best to characterize its effects. Although, as Gregory's own words indicate, this desire and its disturbance are not mine alone. Indeed, it is possible that some of the very people responsible for developing intervention are especially sensitive to and perturbed by the runaway quality not only of earth distress but also and at the same time of their own way of responding to it.

To close out this overview, here is one final perspective on intervention, namely some ordinary uses of the word that suggest why it might be alluring under a description of crisis. I have just said that intervention avows a break with the Institute and the Authority's commitment to "hands-off management" in the name of a seemingly necessary and systemic change in knowing what to do about the Reef. In this sense, the object of "intervention" is not only the

[3] The paragraph is worth reading in full: "The systems transitions consistent with adapting to and limiting global warming to 1.5°C include the widespread adoption of new and possibly disruptive technologies and practices and enhanced climate-driven innovation. These imply enhanced technological innovation capabilities, including in industry and finance. Both national innovation policies and international cooperation can contribute to the development, commercialization and widespread adoption of mitigation and adaptation technologies. Innovation policies may be more effective when they combine public support for research and development with policy mixes that provide incentives for technology diffusion. (high confidence)" (IPCC 2018, 24). Observe the grammar of systems theory, the harnessing of "climate" as a disruptive technique to keep that same system within 1.5ºC, and the deferral, from an "intergovernmental panel" no less, to industry as the responsible party for these earth-saving innovations, all with "high confidence." In what vision of the human condition does this paragraph confide?

Reef but, also and at the same time, the Institute and the Authority. In common parlance, intervention refers to the act of giving redress, reform, or relief in dangerous or otherwise problematic circumstances. Hence, a person's close kin might intervene when they sense that a loved one is in jeopardy, that they are in some ways leading the wrong kind of life. In such cases, friends and family might organize to elicit, with some degree of force, a change in their loved one's perspective on the world and what, accordingly, they are capable of. Yet an intervention can also take the form of a question or a comment, and still retain this decisive aura. A person can be said to intervene in the course of a conversation when they offer an interpretation angular enough to provide a new direction, and thus fresh understanding to speaker and audience. This usage is frequent in professional circles. This pair of examples raises the question of whether intervention always intends "progress" or whether it simply intends change, if not expressly moralized correction.[4]

Taken literally, inter/vention is the action of "coming between" and so stands in contrast to con/vention as the action of "coming together." This is distinction is not one of absolute but of dynamic opposition. Intervention registers as the breaking open of convention, as what happens when a given situation, entity, or process allows for hitherto unconsidered possibilities of interpretation and action. It is, in other words, a way of recasting conventionality, because otherwise it would be invention—the *ex nihilo* creation of a situation, entity or process.

[4] It might be further necessary to distinguish between *intervention from within* (revolution? renewal? relief?), which reorganizes existing conventions the better to grapple with a given situation, and *intervention from without* (disruption? salvation? colonization?), which rewrites conventions the better to settle a given situation. In drawing these distinctions, I am once more indebted to the writings of Stanley Cavell. For him, conventions are not the arbitrary signs of some cultural framework, rather they are the practical preconditions for carrying out a given action, such as how *and why* to notate a musical composition thus and so, or conduct a biological experiment, or respond to distress (Cavell 1979, 120–22).

1.2. *Bufo Marinus*, the "Never Again" Intervention

Soon enough, I will slow down and pull focus on an automated "pest management" intervention on the Reef. To appreciate the politics and history thereof, however, it is helpful to first step back from the coral crisis and consider a quite different landscape of intervention: the introduction of *Bufo marinus* into Queensland in the 1930s, today known simply as "the cane toad," and which in contemporary parlance looks a lot like "Assisted Migration." I alluded to this animal in the previous chapter. Because of its importance to Australia's settler natural history, it persists as something of an obligatory point of reference in discussions of coral intervention—as in an early technical discussion of "Assisted Colonization" (O. Hoegh-Guldberg et al. 2008), a feature article on Assisted Evolution in *Science* (Cornwall 2019), or recent social scientific and general audience publications on bio/geo/chemoengineering (Carter et al. 2021; Kolbert 2021). Here, for instance, is a representative example from the *Science* article in a section listing associated "difficulties" and "discomfort":

> Then there's the "cane toad" question. In Australia, the toad looms over talk of introducing any new organism into the nation's territory. First released in Australia in 1935 to combat beetles that damaged sugarcane, the cane toad quickly morphed into a toxic pest that poisoned native wildlife and showed little appetite for the beetles. Could some kind of "super coral," as some researchers have dubbed them, also run amok in delicate coral ecosystems?

The typical answer to the journalist's rhetorical question—in print and in my experience—goes something like this: no, but we will do the risk assessment.[5] One of the substantive grounds for dismissing the comparison is the following: intervention aims to increase coral reef flourishing and therefore shore up planetary health, not introduce a new predator. Curiously, what this opens up is the possibility of using the cane toad as a concrete historical example from which to abstract the idea of intervention, and this typically with a view to underlining that coral

[5] Overheard at a paper presentation on a Reef intervention in 2016: "No idea is too stupid. It's just then doing the risk analysis and assessing the benefits."

intervention will be different from cane toad introduction: ameliorative rather than degrading, sensible rather than reckless, enabling rather than predatory. Intervention in the 21st century insists that it breaks, so to speak, with the conventions of 20th century intervention—it is an epistemic claim with a moralizing edge. At the same time, it would seem to be only in the most abstract sense that the two are even comparable. In practical terms, do they not correspond to entirely different problems of environmental disturbance and therefore call on entirely different conventions of thought and action? The cane toad represents a failed attempt to "control" a single beetle whereas the Reef intervention is a proposed attempt to forestall planetary collapse. It seems *strange* that the comparison is available to the imagination at all, let alone seemingly obligatory. Figuring out why that may be will help draw something important into view about intervention.

*

"Do you hear that?" asks Simon[*], and I pause to train my senses on the scene before us. The question comes matter-of-factly, it's almost a statement. In the twilight, what I see are mostly silhouettes of trees and bushes, pressing in upon the familiar final paces of an overgrown dirt driveway that rises towards a latched but rarely locked gate. The bulldozers clearing the neighboring block for construction have turned in for the night. So have the trail bikes over the ridgeline, whose throaty pitch and yaw counts the daylight hours ripe for combustion once their riders clock off from school. With the dampening effect of nocturnal domesticity dialed in, in my gut not least after a hearty evening passing stories and curry around the table, what I hear is largely ambient nature. Frogs croak and crickets chirp at an unplaceable distance, mosquitoes buzz nearby. And then, surely enough, I catch a few soft thumps and gather that something else lies closer under foot.

I cast my torch about and spot the source, a creature whose pocked and muddy coloring is a good match for the driveway's dugout clay. Simon and I take a minute to assess the situation. We're purposeful but also idling, as if picking at the leftovers from our earlier conversation about local conservation politics. For a moment, the conclusion is less than foregone, until he says, encouragingly, "keep it steady, would you." I do my best. The thin beam gives him a decent view and holds the creature's attention, the better to put the spade in Simon's hand to use. He adjusts his grip and, in one swift movement, brings the flat head down and strikes the creature dead. We replay our parts a few more times—croak, thump, whack, croaked—before parting ways at the gate. I drive off home for the night. In the minutes of road that lead to the highway, my headlights fix more cane toads in their gaze and my hands tense on the steering wheel. I realize I am as one with the car and hesitate, unsure, whether to direct my tires towards or away from the rogue biocontrol agents.

Simon took no pleasure in killing cane toads yet had a straightforward justification for it: if the creatures made their way to the pond by the house or the stream that runs through the back of the property, then one would become many and many would become many more. They would croak and lure their mates, gorge on passing spiders, fish, tree frogs, goannas, and, thanks to a potent toxin lodged beneath their shoulders, thwart and kill any bird, possum, wallaby, lizard, or dog that tried to thin their numbers. It had happened once and would happen again. He and spouse Laura[*] own a small acreage in Boronells[*] that serves as a home cum permaculture orchard cum wildlife refuge cum dog rescue.[6] Self-proclaimed "greenies" who earned their

[6] Boronells is one of many rural townships along the coastline of North-Eastern Australia, connected on land by the Bruce Highway. Such places are known for channelling travellers as well as residents from larger cities (in this instance nearby Townsville) into tracts of national or state park equipped with parking lots, walking tracks, barbecue facilities and campgrounds. They are, no less than an icon such as the Great Barrier Reef, integral to the tourism infrastructure of the state of Queensland as so many ready-at-hand waypoints of abundant nature made available to local residents, interstate, and international visitors. The existence, curation, and maintenance of such spaces underwrites the state motto ("The Sunshine State") and successive tourism slogans such as "off to the North for

stripes in the anti-nuclear movement in the 1970s and wear the title, the couple remain active in a marginalized but tight-knit local conservation movement. Their primary focus today is the unrelenting surge in natural gas exports and open-cut coal mining, particularly the Carmichael Mine set to open a new coal frontier to the southeast to be shipped through the Reef—but that's a story for the next chapter. Simon and Laura's views put them at odds with many neighbors in the area, who have been struggling in the bust that followed the 2000-2010 mining boom. Through to 2017, unemployment soared, housing prices plummeted, and the major newspapers still in daily circulation—the Townsville Bulletin and Queensland's Courier Mail, both of which are run by the Murdoch family's News Corp Australia—never missed an opportunity to stoke economic panic and moral outrage about "the climate question." For their part, Simon and Laura focus their worries on the hellscape that capitalist modernity makes for the living, which they channel into copious organizing and ordinary acts of hospitality, whose limitations they acknowledge.

Simon's actions on the driveway that night reflect a dominant attitude towards the cane toad in North Queensland: *the cane toad is something you kill.* This statement is jarring. I would find it no less so if I replaced the word "kill" with "cull," the conventional jargon of so-called "pest management." This is not because I am unmoved by the figurative relief of a well-placed euphemism but rather that I would find it troubling to seek relief while writing from the thought I am trying to convey. What I find jarring is the sense of this sentence, which has in part to do with the sense it made in me, which led me to write it, which emerged on that driveway, which Simon and I did not walk in the aim of culling or thinning or reducing cane toad "numbers." Nor is that how we talked about what we were set to doing, and yet kill cane toads we did. What I find jarring in this statement, in other words, is that it is, in some important respects, true. I can

warmth," "the tropics at your door," "the tropical wonderland," "where Australia shines," or the current "beautiful one day, perfect the next." (Cantrell 2018) generalize about the kind of things people are likely to do to cane toads in Northern Queensland insofar as, on the basis of the above anecdote, I can count myself among them. To understand what makes such killing conventional requires a review of the creature's central and notorious role in Australia's settler natural history. Here is what happened.

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Sugar cane played a major role in the colonization of Australia's eastern coastline and transformed the landscape inland of the Reef, much of which is irrigated by a rambling network of rivers and estuaries[7] From 1860 onwards, a wholescale logging enterprise cleared land adjacent to water to establish sugar plantations. In the early decades, the people who worked these novel ecosystems, so to speak, were multiethnic. Anglo-European settler, Chinese, Javanese, and Indian workers alongside some local First Nations people built out the plantations, although the vast majority of the labor force was drawn from offshore Pacific Islands, especially Vanuatu and the Solomon Islands. These workers were variously conscripted to the project of settling Australia by connecting it the global political economy, often through illegal yet long-lived practices of human trafficking and slave labor, so-called "black-birding," germane to Australia's northern colonial industries. Among those who made a reputation and fortune during this time was Robert Towns, a colonial merchant and broker whose estate was situated in the town that would later take his name: Townsville.[8]

In a bid to grow the sugar industry rapidly and compete with established plantations overseas, Australian colonial administrators established "experimental stations" throughout the

[7] The following history is drawn from Griggs (2011), Shine (2018; 2020), Turvey (2013).
[8] Among the memorials, artwork, and historical signage at Garabarra/Kissing Point, there is a historical timeline of the region inlaid along a walking path. Embedded in the concrete are successive key dates annotated as giant bronze captions which you cross like successive cultural historical strata. Towns' commercial achievements are acknowledged, however his de facto status as a beneficiary of slave labor is translated into the same ambiguous idiom of economic development: "Robert Towns brings in Pacific Islander laborers – 1863."

cane-growing region and sought advice from abroad on how to improve crop yields by altering soil composition, administering chemicals, adjusting crop layout or irrigation strategy and so on (Figure 35). After Federation in 1901 and the immediate introduction of the White Australia Policy, which legislated the exclusion of non-white workers from the settler economy,[9] the sugar industry became dominated by smallholding settler farmers organized in cooperatives, sharing milling, refinery, and export facilities. Growers routed their product through the quasi-monopolistic Colonial Sugar Refining Company, a joint-stock company established in 1855 in Sydney, publicly listed from 1887, which later became CSR Limited in 1973, before it was spun off in 2009 as the short-lived Sucrogen and sold to Singaporean agroindustrial giant Wilmar International Limited the following year.[10] In the early 20th century, the cane-sugar industry became heavily mechanized and the former colonial "experimental stations" continued to play a key role in devising tactics for increasing crop yields, notably through repeated inquiries into how to remove a number of insect and animal "pests," typically through chemical means or biological means. The cane toad arrived under these auspices.

At the height of the Great Depression, state and national boosters of the sugar cane industry were desperate to quell the havoc wrought on crop yields by beetles, some pre-existing the industry and some subsequently introduced. Government entomologists at different

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[9] One important exception was the pearling industry, as Roy Kimmey and I examine elsewhere (Bright and Kimmey 2021). See also Ganter (1994).

[10] Sucrogen, as a subsidiary of Wilmar, remains Australia's largest sugar producer. The name change to CSR Limited was intended to reflect the company's voracious post-war diversification into the production of building, construction, and mining materials, which came to comprise four-fifths of the company revenue and remain its core business today. CSR Limited was responsible for Australia's greatest single "industrial disaster" for its operation of the Wittenoom blue-asbestos mine in Western Australia between 1948 and 1966. Workers and their families—many of whom were migrants—along with managers, tourists and official visitors were exposed to contamination levels orders of magnitude in excess of legal limits, precipitating fatal mesothelioma, leukemia, prostate, brain, and colorectal cancer along with diseases of the circulatory and nervous systems. Wittenoom, the former company town where the mine operated, is sometimes referred to as "Australia's Chernobyl" for the persistent contamination levels. It has been officially degazetted, removed from maps, although visitors still make their way to the place as a form of "extreme tourism" (Heinrich 2013; Musk et al. 2020; Surber 2018).

experimental stations tried soil fumigation, chemical sprays, colored light application, biological control with a species of fly imported from Canada, as well as manual removal with the rotary hoe (Griggs 2011, 528–58). The results were middling. Inspired by the hype from a 1932 international conference in Puerto Rico, entomologist Reginal Mungomery went over his superiors' heads and decided to import specimens of *Bufo marinus* from Hawaii.

So-called "biological control" is an attempt at parasitic contamination, wherein human actors identify and introduce a "predator" suited to tracking and killing some "prey" currently degrading crop yields, whose historical relationship to the landscape may be a pre- or post-industrial (i.e., "native" or "introduced"). The appeal of biological control is that it not only "disrupts" or "offsets" a perceived imbalance but does so in a way that seems all but self-perpetuating, indeed *automatic*, as the predator sustains their numbers by reducing their prey. The predator is not just cheap but costless labor in that it secures its own means of subsistence through its "work." Its creaturely status adds a final allure, as compared with chemical treatments whose side-effects—if only on crop yields—were undesirable. The model for successful biological control in Australia (then and now) was the *Cactoblastus cactorum* moth, introduced from Argentina a decade earlier to do what slashing, burning, and poisoning could not, namely, stop the prickly pear's unchecked advance since its disembarkation with Governor Phillip in 1788, who fancied using the cactus to fence property and host cochineal beetles for a colonial dye industry. In 1935, with such a precedent in mind and rave peer reviews, Mungomery brought a hundred and one toads in a suitcase to Meringa Sugar Experiment Station, roughly two hundred miles north of where Simon and I found ourselves that evening (Figure 36).

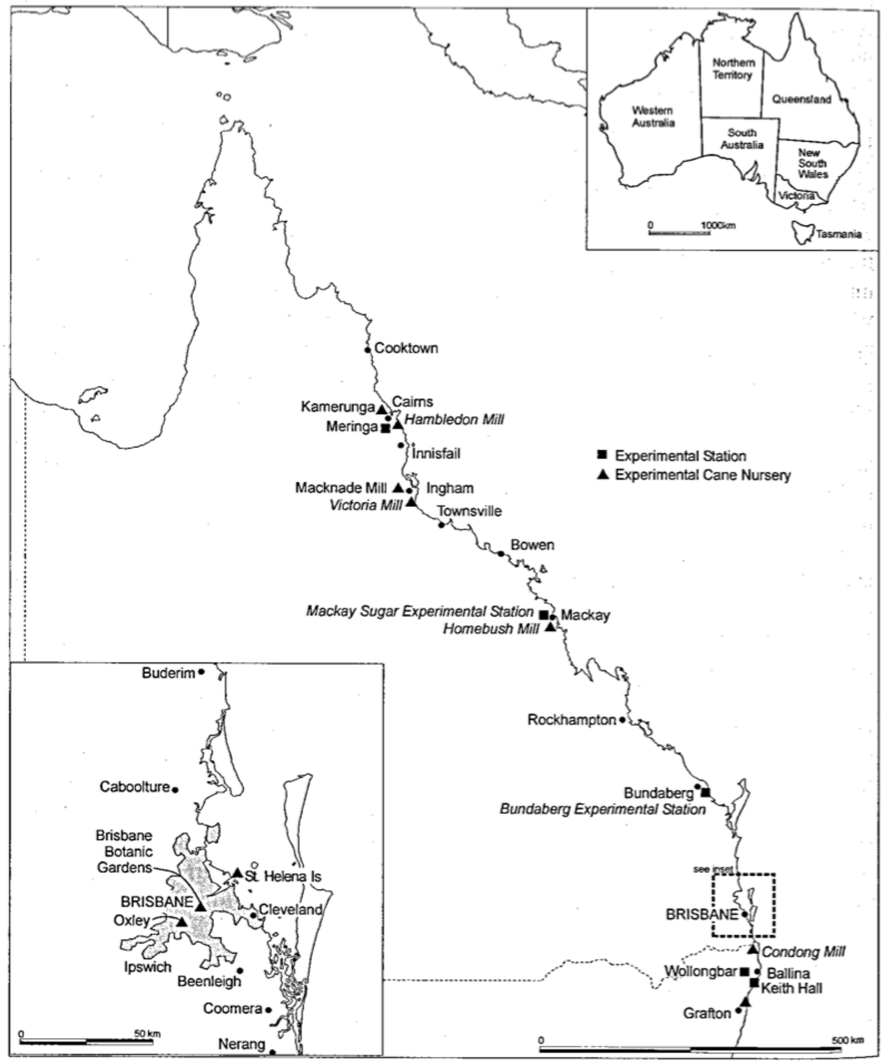

Figure 35. Experimental sugar stations were established, staffed, and networked along the Queensland coast in order to trial, calibrate, and disseminate new techniques and additives to improve the cane yield. This map indicates their locations from 1870-1914. (Image reprinted from "Australian Scientists, Sugar Cane Growers and the Search for New Gummosis-resistant and Sucrose-rich Varieties of Sugar Cane, 1890–1920," by Peter Griggs, 2003, *Historical Records of Australian Science* 14, 294. Copyright (2003) by CSIRO)

The cane toads thrived in their new setting, thanks to the loving attention of the research team and regular releases of toadlets into nearby streams. Their labor was rewarded as *Bufo marinus* did not acclimate but learned to flourish in its new home. Already by December 1936, the Queensland government grew worried and banned residents from "liberating" the toad pending further research into its behavior under local conditions (*The Northern Herald* 1936).

Bufo marinus soon settled in but seemed utterly indifferent to the cane beetle. Frustrated, government officials gave up on "biological control" and focused their attention on chemical treatment. The "American toad" had made landing as a revered "ally" in the 1930s; by the 1950s, the "Cane Toad" was a reviled "enemy."

Not only did cane toads prove unable to bring down the beetle population and so protect the cane crops from "injury," they moved into the landscape and began directly and indirectly remaking it. This was in large part due to the novelty of their toxic defenses to local predators great and small—the Australian continent knew no other toad species at the time. Early on, for instance, beekeepers sounded the alarm over collapsing "English bee" populations and the threat toads posed to the future of pollination (Hewitt 1956). Today they range over an eighth of the country, and in the past eighty-five years their numbers have swelled from a hundred to hundreds of millions and. The toads are deemed responsible for multiple species extinctions, have been known to kill anything from crickets to crocodiles, and will also eat their own kind. Ecologists

Figure 36. Two of the first cane toads introduced to Australia at the Meringa Experimental Station in 1935 (Source: Queensland State Archives, Item ID ITM1140022)

documented state border crossings in 1978 (QLD/NSW), 1984 (QLD/NT), and 2009 (NT/WA) as well as regional migration to Papua New Guinea (1937) and the Torres Strait Islands (2012). And although these dates may not reflect the first actual crossings and arrivals, the very existence of such record-keeping attests to the intense and ongoing interest in scrutinizing (and delaying) the toad "invasion front." For decades, the cane toad has stood as a spectacular demonstration of the potentially enduring, cascading, and devastating consequences of the hubris of intervention, which is to say, an excessively "successful" disruption of the conventions that govern the web of life yet one that stands as an abject demonstration of "failed" human mastery of nature.

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The cane toad is a storied force of life, but it is no myth or metaphor. It is a croaking, leaping, poisonous example of what can happen when people set about "solving" for global nature. The toad therefore casts a long shadow over the very idea of a science of ecology on the one hand and recent counterpoint from the environmental humanities on the other. However, rarely do ecologists and conservation scientists seem to ask: how did their expectations of the toad become so convincing as to create a delusion? Why were their forebears so mistaken as to what beetles and toads and cane are capable of? Indeed, historical geographer Peter Griggs observes that, even Mungomery and his colleagues appeared to, at the crucial moment, suppress this possibility in 1935: "all the cautious testing characterizing the previous investigations into cane grub control methods was completely forgotten when it came to the cane toad" (2011, 535). One reason why the mistake appears not to register transhistorically is that the same investigative methods of biology, ecology, population geography, and so forth that motivated the toad's conscription as a biocontrol agent were then deployed, almost immediately, to solve the puzzle of its uncontrollable biology. The cane toad's introduction does not falsify the project of biological control as it occasions further uses for it. New research questions and new subdisciplines—like invasion biology—develop because of an underlying presupposition that the method is sound, after all the cane toad's advance deconceals new strands in the web of life to follow, and maybe tweak or break.[11]

I am gesturing towards the familiar Kuhnian cycle of scientific development and change (i.e., normal science producing anomalies that accumulate to the point of crisis and thereby precipitate revolution). One reason why an anomaly does not seem to present is that the entomologists are simply involved *with* so much as they are involved *in* their research object: cane scientist/farmer/beetle/toad/exporter/broker come together in a dynamic field of power. If there is a law to that field, a "nomos" from which to draw an "anomaly" as it were, it seems to be unto itself: "do not fail to learn how to control the beetle" means "do not fail to grow the crop" means "do not fail to lure the high yield out from where the beetles have been hiding it." In this sense, it may not be correct to refer to the cane toad as a "predator"—at least not in 1935. It was introduced as a "biological control agent" to eradicate an identified "pest," the cane beetle; it was the cane beetle's status as a "predator" that was a problem. Only later did the cane toad's predatory potential become so terribly captivating.

When the cane toad went rogue, it changed what entomologists expected the toad was capable of, but not what was expected of the cane industry nor the expectations (political, economic, epistemic, moral) of entomology's experimental "station." Put directly, Mungomery and the cane toads he transported were historical subjects cast together in an enduring convention

[11] I am trying to get at a quality, symptomatic of crisis science, wherein ostensible failure invites more of the same. Rather than "bad faith" action, what compels me is the idea that the concept of failure gets turned against itself, broken down, and makes an epistemic virtue of worldly irresponsibility. In addition to anthropologies of crisis (Hu 2018; Jain 2013; Masco 2017; Nguyen 2010; Roitman 2014), my thinking is inspired by J.L. Austin's discussion of mistakes and accidents, justifications and excuses (Austin 1956).

of settler natural history and global political economy that together prevented not (only) biological control but (also) the sugar cane industry from registering as mistaken, if not to say mistakes. From what perspective, in fact, is it possible to say the cane toad introduction failed in its aim of improving crop yield? After all, the inability of the cane toad to bring down numbers inadvertently encouraged stronger and ultimately effective chemical treatments for stamping out the beetle. The intervention was a success, albeit indirectly, in luring out another aspect of industrial experimentation and control, chemical not biological. In the absence of an alternative epistemic authority (i.e., paradigm, episteme, discourse, law), an absence ensured by pressures to perdure a natural and moral order committed to not recognizing itself as mistaken, the cane toad was, to borrow from a contemporary idiom, a calibration error not a kernel panic. And with the busyness of securing the cane crop pointing in a different direction anyway, the cane toad inherited the station of the beetle: a form of life to control for, no longer at the scale of the plantation but, precisely, beyond its perimeter. A new specialization arose to keep up with the cane toad's lack of control: "invasion biology."

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It is such looping effects, to borrow Ian Hacking's term (1998), that environmental humanities scholars follow by recombining history, literature, ethnography, and media studies to show how the lives of animals always exceed their biology. They teach us that words like "native," "invasive," "exotic," "domesticated," "pest," "livestock," or "vermin," for instance, do not just refer to what kind of thing some animal is but also what kinds of things people can or cannot do with it in a given time and place, and towards a given set of ends. These terms are historically contingent, dynamic and often mutually-reinforcing. Their uptake or contestation tracks disagreements in our lives with others (human and more-than-human), shifts in power dynamics, and styles of moral reasoning.[12] This literature documents how the cane toad has been treated as

Figure 37. This cane toad statue is rather conspicuously situated at the southern entrance to the town. It was originally constructed out of papier mâché as a float for the 1983 Sarina Sugar Festival, was later recast in fiber glass for permanent installation, has been stolen and reinstalled a number of times, and is now cemented on a plinth that recognizes a number of other local icons including various sportspeople. Following a naming competition in the late nineties, the statue was nicknamed "Buffy" in reference to *bufo marinus* and, likely, the popularity of television show *Buffy the Vampire Slayer*. These moves, it might be said, are so many ways of domesticating, through symbolization, the ongoing vampiric predation of the cane toad upon the Australian landscape if not the sugar industry (Source: Damien Bright).

[12] It is possible to imagine of a critical bestiary that would track the diverse creaturely forces at work in the making of postcolonial Australia, with entries including the dingo (Rose 2011), the merino sheep (Franklin 2007), the rabbit (Lines 1991), the thylacine (Freeman 2010), and the penguin (Dooren 2011).

an enemy in something akin to a forever war against unruly nature, with combat tactics ranging from propaganda campaigns, informal community militia, appeals to the security state apparatus, and alcohol-fueled four-wheel drive "musters" (Robin 2017; Trigger et al. 2008). Rear-guard actions to reclaim and reappraise the animal persist. Some of the more esoteric such efforts are captured in the documentary *Cane Toads: An Unnatural History* (Lewis and Miall 1989). Here we meet ordinary people for whom the cane toad's seemingly limitless resourcefulness invites an almost mystical appreciation. If you follow the federal highway that lines the Queensland coastline, for instance, you will pass through the town of Sarina where the Plane Creek Sugar Mill has been churning out product since 1896 and local residents pooled their funds to erect an unusual sculpture: a giant bronze cane toad (Figure 37). In a more political spirit, meanwhile, the creature often serves in popular culture as a model of resistance, a notorious anti-hero on hand to contest the overreaches of state authority (Figure 38). Neither of these sets of recuperations—the first for extreme violence and the second for ordinary veneration—is "rational" in the narrow sense of the term and leave me wondering at the historical forces inadvertently unleashed, irrespective its status as a failed conservation experiment.

Many environmental humanities scholars powerfully connect the spectacular failure of the cane toad as a biocontrol agent to the ongoing violence of industrial farming. Here, for instance, are the concluding lines to an article on "pestiferousness" as a driver of entitlement in Australian agriculture: "responding differently to pests is also about learning to inhabit landscapes differently: about questioning the sense of entitlement that asks others to do all the work of fitting in with pre-given farming approaches. And so, it is about asking how farming might be done in more connected ways, as something other than a (failed) project of mastery" (O'Gorman and van Dooren 2017, 83). I certainly share the authors' interests in so-called "pests"

Figure 38. Satirical magazine *The Cane Toad Times* (1977-1979, 1983-1990) was an important vehicle of the counterculture movement and combined social commentary, irreverent journalism, poetry, and original artwork. It took up the cane toad as a proxy for the ordinary Queenslander, sometimes whimsically but often to expose everyday injustices under the conservative rule of premier Joh Bjelke-Peterson. This illustration depicts "The Perfectly Unemployed Person" and transposes the generalized disdain of the cane toad onto those stigmatized and demonized by the government of the day. (Illustration by Matt Mawson. Reprinted from "The Detached," by Dave Richards, 1978, *The Cane Toad Times*, 1(6), 2. Copyright (1978) Cane Toad Times Collectives 1977-1990.)

as more than a problem to control for. I am also moved by the non-utilitarian and non-settler ends to which cane toads are put, which open up new human-cane toad economies and intimacies. The crafting of clothing from cane toad hide is especially evocative in this regard (Robin 2017; Trigger et al. 2008). What strikes me is the final sentence in the above quote, however: "something other than a (failed) project of mastery." I believe that the authors parenthesize “failure” to remind readers that the horizon of mastery to which settler natural history points never arrives, always folds back on itself, and therefore should be set aside. Yes, and there might be another way of putting this too. As a horizon, mastery functions as a fantasy, and settler natural history and/or expansionist political economy does not so much abhor “failure” as it does find a way of putting it to work, albeit under different guises, in order to stay ahead of its own breakdown. “(Failure)” functions as a historically open-ended category onto which new projects of mastery can be grafted. Grafting expands the domain of mastery, whether biogeochemically as in the uptake of chemical treatments or morally as in the outgrowth of invasion biology.

The title of the article I am discussing is “The Promises of Pests,” in kinship with Donna Haraway’s (1992) important essay “The Promises of Monsters.”[13] The seam of their reasoning to which I relate yet which I am nevertheless picking at is this: what do we do with the pestilent and monstrous promise of the sugar cane operation itself?[14] It seems the cane toad recurs as a “never again” case for intervention not only as it shows how mistaken people can be in their expectations of what nature is capable of, but also for what people become unexpectedly capable of in turn. What seems to fail is not only human mastery of nature, but human self-mastery. The cane toad is less an example of what happens when intervention fails than when it backfires by triggering a chain reaction of negative effects that leave the original problem intact and generate entirely new ones to explain whose uncanny resemblance to the original problem—seemingly

[13] Here is O’Gorman and van Dooren’s (O’Gorman and van Dooren 2017, 87) explicit invocation which felicitously reproduces Haraway’s argument: “Paying attention to pests is one way of highlighting, and perhaps questioning, these [dualistic] modes of ordering and inhabiting the world. In this way, as Haraway argues, monstrous figures are good to ‘think with’ both because they unsettle assumptions and because in doing so they point toward other possibilities for life. The term monster, she reminds us, shares a common root with ‘demonstrate’: ‘monsters signify’ (Haraway 1992).”

[14] In a recent essay, Lorraine Daston (2019) explains monstrosity is a typical disorder of “specific nature,” that presents as the departure from reproductive normativity—grafting is one example she gives.

uncontrollable biology to control for—seems to further reel in, *in that moment*, the existing way of knowing, acting, and feeling about global nature. If I can mix metaphors by raising the specter of another well-known Australian "pest": curioser and curioser, down the rabbit hole I go and, as I do, the more delusional the 1930s vision of well-ordered nature appears.[15] There is something inordinate to the cane toad: the closer you look, the more there is to say, the less certain your conclusions, the more definitive the toad's escape. The cane toad casts the shadow of a doubt not only over how to know what to do with nature "out there" but also how to know what to do with ourselves—self-understanding. This might explain why the example recurs in relation to Reef intervention today, as journalists and scientists reassure themselves and their audience that history won't repeat itself. At the same time, what defines the Reef is inordinateness, uncontrollability, unknowability. If a hundred and one toads could remake an island in less than a dozen years, what kinds of (dis)alterations does reef-wide interventionism promise? How does the imaginary of intervention offset or channel, harness or hedge the uncertainty of its real-world effects?

[15] This remark may require further development. My sense is that the ongoing negative effects of intervention in the present confirm the sense that there was something "troubled" about the reasoning at the time. This can introduce a strain. If this reasoning was once possible, what guarantee is there that I won't fall for it again? One response is to hindcast the decision, to insist that "I don't think like that anymore" or, better yet, "I have never thought like that." This runs the risk of turning history into a "mummy" (Nietzsche via Hacking), which is tenuous for many reasons: the recentness of the past, the preceding and succeeding interventions, etc. Which makes the cane toad as the scapegoat "delusional intervention" all the more appealing. Yet the animal itself is consistent in its behavior over time, which makes for its own form of historical continuity, hence an additional sense of delusionment. Much of my thinking here is in conversation with Cavell's discussion of the "natural and conventional" in *The Claim of Reason* where he locates some of the force of incommensurability in self-knowledge (e.g., "Who is crazy? I do not say no one is, but must somebody be, when people's reactions are at variance with ours? … If I say 'they are crazy' or 'incomprehensible' then that is not a fact but my fate for them. I have gone as far as my imagination, magnanimity, or anxiety will allow; or as my honor, or my standing cares and commitments, can accommodate" (Cavell 1979, 117–18)).

2. Part Two: Robotic Environments

2.1. The Task is the Tether

In late 2004, Matthew Dunbabin and two colleagues from Australia's Commonwealth Scientific and Industrial Research Organisation (the Organisation) introduced an automated underwater vehicle to answer the following question: how do you collect local observations throughout the entire 344,400km^2 domain of the Reef, let alone the nearly 10,000,000km^2 that constitute Australia's Economic Exclusion Zone (Figure 39)? The warrant they gave for data collection indexes an established need among marine authorities, a horizon of expectation if you will: "monitoring is considered an essential task in understanding how long [The Reef] will remain in

Figure 39. Australia's marine jurisdiction the third largest in the world. Its size owes to territorial waters accruing from 12,000 surrounding islands and submarine continental shelf, and its perimeter remains contested. (Source: Commonwealth of Australia (Geoscience Australia), CC 4.0)

its current ‘pristine’ state” (Dunbabin, Corke, and Buskey 2004, 7). Mark, for now, the temporal connection of a timeless informatic task (“essential”) made timely via a specific ecological aspiration (“understanding how long”). Eight years later, in a comprehensive survey article co-authored with another colleague in 2012, Dunbabin situated his work within the emerging domain of “environmental robotics.” This field combines mechanical and computer engineering to promise “efficient and precise measurement of environmental processes at unprecedented scales that will push the frontiers of robotic and natural sciences” (Dunbabin and Marques 2012, 25). Efficiency, precision, and scale—these are the properties environmental robotics works up as the means and ends of scientific inquiry in the face of radical uncertainty.

The authors’ survey details an informatic division of labor across environmental domains among instruments calibrated to autonomous geospatial (i.e., satellites), regional (i.e., ocean buoys and weather stations) and local (i.e., user-operated devices) operations. It is the last of these Dunbabin wants to push, through the design of low-cost, lightweight, and even disposable autonomous vehicles able to “collect spatially dense information in real time from natural environments (because) traditional sensor networks only provide fixed monitoring points without the means to adapt to changes in the surrounding environment” (Dunbabin and Marques 2012, 23). Gone is the reference to “pristine” nature—and if that preconception already seemed surprising for the 2004 article, that is suggestive of both Dunbabin’s status as an outsider to coral reef studies (cf. chapter one) and his internalization of the long-standing picture of the Reef as the “world’s best managed reef.” Instead, Dunbabin and Marques note that robots proved themselves in oceans, deserts, outer space and nuclear power plants, “domains” inhospitable to prolonged human habitation and settlement, which contemporary anthropologists refer to as “the extreme” (Valentine, Olson, and Battaglia 2012). The reasoning seems to be: if it is not obvious how people go on in a world becoming unknowable, robots can show us the way, for they traverse the untraversable and inhabit the uninhabitable. Generalized unpredictability drives research and provides the warrant for saturating any given "domain" with a sensor array that can adapt to complete its "task."[16]

For decades, marine research directed submarines and torpedo-style vehicles for localized search and retrieval as well as long-range sensing operations. These machines' navigation methods are ill-adapted to the shallow and "unstructured" landscape of the Reef, however, and their price tag is prohibitive for the kind of mass production needed to make robot sensing "pervasive" and "persistent." Dunbabin's group used the first constraint to overcome the second. Acoustic sensing (e.g., sonar) produces topographical maps for navigating marine contexts where sight is limited or unreliable, yet at considerable expense. In shallow reef waters at the local scale—say, when diving during the daytime—visibility is not a problem. What if robots could just navigate by sight?

The "task" against which Dunbabin matched his robot was none other than the protocols the Institute used then and now for visual surveys along linear transacts. Via a technique known as the "manta tow," trained SCUBA divers make field observations of the reefscape directly beneath them while tethered to a support vessel that maintains a constant speed and heading. The method was developed in the early 1980s to conduct underwater transacts, describe the species composition of reef flats, and identify "visually dominant organisms"; very early on, this field method was used to track the geographic occurrence and produce population counts of crown-of-

[16] This conception of environment as extreme—*is this to say unconventional?*—might account for why current roboticists seem to bracket or simply bypass questions about what computer cognition is to human cognition. Put differently: in the extreme, thought may no longer be where the action is, because action goes before thought. For a compelling investigation of an earlier period of information science when this question was more pressing and open-ended, see (Pickering 2011).

Figure 40. Diver conducting a visual survey using the manta tow technique. First devised in 1985, the manta tow allowed divers to conduct longer and more numerous surveys, using standardized data collection protocols that aided training. The main problem, early reports suggest, was how readily this ease of vision distracted divers, as they became mesmerized by the reefscape unfolding below them. (Source: Australian Institute of Marine Science, CC 4.0)

thorns starfish, as it still is today (Figure 40). Mark that, albeit with human eyes, the Institute had been working for thirty years to meet the "essential" need for reef monitoring and surveillance that Dunbabin and his team identify in their initial research. In order to have a robot perform the same operation without the need for a ship's tether or human diver, Dunbabin's group devised a self-contained sensing "loop" wherein visual inputs feed updates to motion controls. In automation engineering, this process is referred to as "cutting the human out of the loop."[17] After the robot is placed in the water, its stereoscopic camera begins taking images of the reef beneath

[17] The expression connotes a decision-making process for which human judgment is no longer necessary. The term "loop" seemed to gain usage in computer linguistics and mathematics from the 1960s but has roots in symbolic logic. A loop is a calculative action (e.g., sorting elements in a series, summing prime numbers) that repeats until a condition or command terminates the process (e.g., no more elements to sort, sum would exceed a set ceiling). The name for this particular point of arrival, when executing a command no longer produces a different outcome, is known as a "loop invariant." One of the crucial steps in programming a loop to complete an action is learning to translate an ending into a "loop invariant." By reducing underwater survey to data collection along a transact with a set start and end point, it can be formalized as a limited sequence of loops.

it. The images are stored on an onboard computer. Software processes these images to detect topographic variation through texture mapping. Altimeters and odometers adjust for height and speed accordingly. The loop repeats to guide the robot along a fixed path to its destination. The result is a "vision-based guidance system," by which photographic images function as initial output and secondary input; one action, vision, becomes a means for another, navigation. The prototype performed successfully in pool tests and later ocean-based trials. The team achieved its goal of producing a low-cost, light weight, self-maneuvering robot that dynamically responded to its domain without a support vessel or trained operator. The tether was gone, at least in physical form: *the task itself became the tether.*

Such dynamic motion is reminiscent of Grey Walter's cybernetic "tortoise" built in 1953. In his study of informatic interaction, Pickering (2011) contrasts the "performative" quality of cybernetic mechanisms with first-generation artificial intelligence. Where the latter get from A to B by making representations of the world, the former get around in a world irreducible to representation through feedback interactions. Dunbabin's robot combines aspects of both modes. The possibility of such combination challenges Pickering's central claim, namely that cybernetic "performativity" models can re-enchant humankind with worldly unpredictability by modelling how to let go of a pretension to mastery. Because unknowability, for "environmental robotics," is a historical outcome of human world-making and not, say, a trove of metaphysical wonderment, non-mastery becomes a technical rather than a philosophical affair. In other words, the sensing abilities of "environmental robotics" augment the representational powers of imagined end users to enable them, on a task-by-task basis, to claim radical unknowability as the grounds for a particular kind of action—indirect, at a distance, with a calibrated sensing array able to lure in the parameters needed to execute a pre-ordained set of commands.[18]

Yet from the start, Dunbabin's group was looking beyond any one task. Their ultimate goal, they stated, was "to develop an autonomous systems 'capability' which can be scaled appropriately to achieve a variety of unspecified tasks." What additional tasks or actions can be based on underwater vision? A lot hangs on the word "appropriately." As security studies scholars note, the growth of remote sensing is especially conducive to extending the "domain" of biopolitics. After all, the history of robotics and computing has been the history of modern warfare under a different aspect (Braverman and Johnson 2020). It is easy to imagine, for instance, how Australia's amoral yet apparently legal immigration deterrence regime, the so-called Pacific Solution, would use a "capability" such as this. For now, however, I would like to stay with Dunbabin's group and continue to track intervention as an achievement in discerning and breaking open convention, which is not necessarily isolated from such concerns. They close by hinting at one possibility: "biomass identification and tracking" (Dunbabin, Corke, and Buskey 2004, 2106). I am inclined to put this in plainer language, to say that what they mean is something like "finding starfish." Yet in doing so I am forcing a desire for specificity that is not, in fact, apparent in their language. What their words reflect is a craving for generality, to borrow an expression of Wittgenstein's, germane to the technoscientific aspiration to produce "solutions that scale"—whither?

[18] Mindful of what comes next—namely, the application of this way of knowing to a form of interventionist "climate action" and so some variation on the so-called new conservation sciences or ecomodernism—we can see how the planetary is at work here: a relationship to historical time and physical environment as near-chaotic. This appears closer to Latour's (2015) charge that ecomodernism (of which Reef intervention is one variety) has a "uchronic" and not simply "anachronistic" sense of history (cf. (Hamilton 2016)). One of the things this chapter is tracking is how that "uchronicity" may, itself, be antecedent to our current moment in the practices of Reef science.

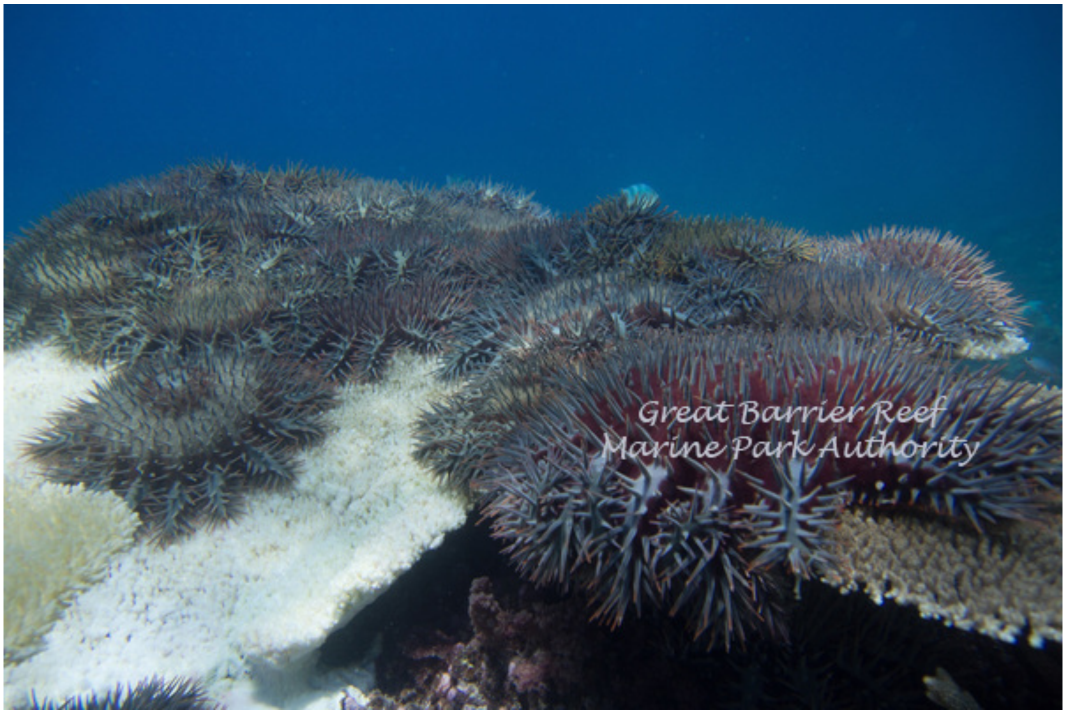

Figure 41. A group of crown-of-thorns starfish feeding on a reef flat, the characteristic feeding “scar” is visible in the foreground center and left. Although rarely seen or collected until the 1950s, molecular analyses suggest the starfish evolved some 3.65 million years ago (Source: D. Schultz, Great Barrier Reef Marine Park Authority, CC 4.0).

2.2. The Crown-of-Thorns Starfish, Again

Dunbabin’s surveillance target is none other than the crown-of-thorns starfish (Figure 41). In chapter one, I mention that cyclical “outbreaks” of this starfish were one of the driving forces behind the consolidation of globalized coral science. It is time to say more. The crown-of-thorns starfish is one of the few endemic predators of reef-building corals. Like a lot of starfish—and indeed like coral polyps themselves—it is mostly stomach. It feeds by moving over the reef flat, extruding its stomach, and digesting the coral beneath it. The average adult is twenty centimeters in diameter and can grow to up to eighty centimeters, reaches reproductive maturity after two to three years and can produce up to sixty-five million larvae per season. Since the late 1950s, every ten to fifteen years, they have appeared in massive concentrations (multiple hundreds or even thousands of animals per hectare) and decimated reefs in the Indo-Pacific (Figure 42). This

Figure 42. The crown-of-starfish is found throughout the waters of the Pacific and Indian oceans. Speculation is that the starfish evolved in the waters of the so-called Coral Triangle above Indonesia and then spread by traveling from reef to reef (Image reprinted from "The Faustian Traits of the Crown-of-Thorns Starfish," by Charles Birkeland, 1989, American Scientist, 77 (March-April), 156. Copyright (1989) by Sigma Xi, The Scientific Research Honor Society.)

leads to protracted phases of "recovery." It takes time for surviving coral colonies to heal and they may be unable to ward off disease or reproduce as usual in their distressed state. It takes time for the reefscape to grow back, whether by surviving colonies who might extend their footprint through asexual or sexual reproduction, or by incoming larvae from colonies, which, if nearby, the advancing crown-of-thorns likely hit as well. But this loss of coral cover, of course, disperses communities of grazing fish and invertebrates and the extended web of marine life that otherwise convenes upon an undamaged reef, which in turn scrambles fishing, tourism, research, coastal breakwaters, and so on. Seemingly out of nowhere, crown-of-thorns starfish outbreaks became an existential threat to reefs from the 1960s and remain so today.

Although identified in the 18th century, few specimens existed in museum collections before the 1960s and local reports from Pacific Islands suggest it was an irregular visitor. Although an echinoderm and so related to other radial invertebrates like starfish and brittlestars, the two known species of crown-of-thorns are considered to be evolutionarily isolated. As this chapter tracks shifting ideas about what the crown-of-thorns starfish is to scientists, managers, and publics and what ideas of motivated action ensue, I will neither use the Linnean name of *Acanthaster* nor under the management convention of "COTS." Besides, the "crown-of-thorns" namesake deserves comment. On the one hand, it is a descriptive shorthand for the tangle of spikes that cover the creature's spherical body and twenty-one radiating limbs. On the other, it is a poetic allusion drawn from the Christian tradition to the degrading sentence the creature imposes on reefs and their adjoining communities. In the lead-up to the Jesus' crucifixion, his captors placed a woven crown of thorns upon his head to inflict physical pain and mock his claim to authority. This pain is to be understood as a form of "agony," which is to say a singular, conscious experience of suffering with corresponding moral significance. The symbol, and its contested existence as a relic, has since been reclaimed in Christian mythology as a weapon of righteousness. The name then, refers both to what the creature *is*, by way of some distinguishing characteristic, and to what the creature *does*, by way of some historico-moral interpretation. The divergence between these two meanings is captured in the question that guided decades of research and policy: have crown-of-thorns starfish populations always waxed and waned in what amounts to a recently observed but otherwise "natural" cyclical phenomenon or are these population spikes historically novel and an "unnatural" response to human influence in need of redress? This question brought together a wide range of interests during a period of global social change and became the basis for authoritative claims to know coral reefs as ecologies comprised of living populations available to management (Sapp 1999).

*

For the longest time, these different theories of natural and anthropogenic causation "competed" due to a perceived lack of knowledge. Some scientists insisted that the rates of growth and reproduction predispose the starfish to massive population fluctuations, which only became apparent due to the post-war boom in marine tourism. Others emphasized the role of terrestrial run-off from agriculture and the overfishing of natural predators, such as the highly collected Giant Triton who. There was considerable interest in the question, not least of which on the Reef where a nascent tourism industry feared the worst. Consider this representative description that ran in a 1966 edition of *The Canberra Times*, the daily newspaper from the nation's capital:

> "Scientists know little about the creature. What they do know is that its favorite food is coral. … Because of this, the Great Barrier Reef, with all its miles of coral, is a gourmet's paradise for the crown of thorns. Acanthaster planci appears to have discovered this fact only recently. Up to 18 months ago, this greedy starfish was seen only rarely on the reef, so much so that the odd specimens caught were usually sold as tourist curios. In the last 18 months, however, thousands of the creatures have swarmed in to gnaw at the reef's living coral. The starfish invasion was first noticed near Green Island, off Cairns, where the creatures began to dine on coral that tourists regularly gape at through glass-bottomed boats." (*Canberra Times* 1966)

The emphasis on epistemic unknowns and of a struggle between whose appetite counts—the "greedy" starfish "gourmet" or the "gaping" (but paying) tourists—would persist and generate tensions between coral science and onshore industry. As coral scientists began to investigate, the "outbreak" problem dramatically jumped scale from the imagined duel between starfish and tourist for the same spot at the Reef buffet. Reports of thousands upon thousands of starfish, over hundreds of miles of reef, prompted cataclysmic predictions of collapse. Quickly, scientists found their findings challenged by anxious tourism operators and local authorities and the call for "further research" became an epistemic and political imperative.

Before long, other industries became ensnared in the conflict. Among the anthropogenic explanations for the starfish "outbreaks" were large-scale land clearing, pesticides, fertilizers, and the development of monocultures. The explanations were deeply unpalatable to onshore agricultural interests, not least of which "the peanut farmer from Kingaroy," Queensland's charismatic and ultimately corrupt state Premier Joh Bjelke-Peterson who made his fortune after the Second World War repurposing military materiel and running a commercial mechanized land-clearing business. Crown-of-thorns starfish larvae may not have survived in large numbers until increased levels of nitrogen and phosphorous washing out to Reef waters provided the necessary food. It is also possible that predators of these same larvae—less charismatic and collectible than the Giant Triton and perhaps small enough to have remained hidden from view entirely—had perished in the post-war years due to chemical poisoning through bioaccumulation.[19] There is likely no way of reconstructing just why the crown of thorns starfish has become the problem it is today.

And yet, at the time, the starfish threat was singular enough in its presentation—a voracious and novel biological predator—that knowing what to do about it appeared to fall under the remit of scientific authority. This was not the case for all threats to the Reef. As discussed in the introduction, it was in the late 1960s that the "Save the Barrier Reef" campaign got underway to prevent offshore oil and prospecting on the Reef (another of Bjelke-Peterson's commercial interests). One news report draws a stark line between the two threats: "Control of the Crown of Thorns must be entrusted to the reef biologists. But can control of eager oil-rich companies be entrusted to the Queensland government?" (*Noosa News* 1969). The language of "control" is telling as is the distribution of responsibility. Even though the starfish was a largely unknown entity to the biological practices of the time, even though the state and federal governments were about to institutionalize the Reef and marine science as novel research objects, still the crown of

[19] Pesticide poisoning works its way up the proverbial food chain through bioaccumulation, meaning that billions of starfish larvae may have feasted on contaminated phytoplankton before delivering a lethal dose to some historic predator who, over time, would not bother their descendants. Given the connectivity in the global oceans, the circulation of pesticides through bioaccumulation would have occurred at the planetary scale.

thorns starfish was placed under the description of a pest to be—somehow and with better knowledge—controlled.

*

What I am trying to draw attention to is how the very idea of the Reef's unknowability, its status as an epistemic resource, has been both a promise and problem for scientific authority. Here, and briefly, is another way of appreciating this. In a contribution to *The Ecology of Pests*, a 1981 volume published by the CSIRO, Donald Potts introduced the idea of crown-of-thorns starfish outbreaks to get away from the "emotionally charged" language of population explosions, infestations, plagues, and invasions. A Canberra-based snail biologist, the editors expressly reached out to Potts because he was at a remove from the institutional politics of tropical marine science and would provide a measured view. Potts saw terms like infestation as distracting and confusing to the extent it placed learned inquiry on an overly emotional footing. Twenty five years of ongoing dispute *about* whether and how starfish predate upon the Reef had led those involved to develop an impassioned commitment that turned them against one another to the point that "scientists and laymen found it increasingly difficult to recognize reliable factual information" (Potts 1981, 55). Yet the volume itself was an unusual occasion for making an appeal to dispassionate judgment, as it promised a comparative study of "pests," a group of organisms which the editors acknowledged are only deemed as such by virtue of a particular social convention, namely a perceived conflict with human interests and needs. Potts ultimately hedged on whether crown of thorns starfish are pests or not—"no" in the context of the global oceans, "maybe" in the context of local reefs. This meant that the neutralizing "outbreak" concept he introduced did not so much resolve tensions over what kind of response large numbers of starfish called for as it did establish a new unknown to resolve. In coining the language of “outbreak,” Potts thought to steady his colleagues’ excess of passion by providing a common epistemic object, but they only set upon that object with renewed vigor.

Terms such as “infestation” and “plague” are impassioned, to be sure, yet they are not without purpose. They locate the crown of thorns starfish—as so many other pests—as both a departure from natural and moral order that, indeed, exposes them to intervention. In her recent essay *Against Nature*, historian and philosopher of science Lorraine Daston argues that in the North Atlantic tradition dis/orders of nature serve to mediate dis/orders of morality. She offers three such orders: specific natures, local natures, and universal natural law. The first of these refers to what seemingly stable natural entities, available to classification in one way or another, whether in the idiom of Aristotelian inner principles or the medieval Great Chain of Being or the contemporary idiom of DNA (or, soon enough, mRNA). Daston argues that although the normativity of specific nature is historically open to contestation and with good reason—through grafting or selective breeding or in defiance of biological race—there is nevertheless a grammatical persistence of the concept over time. The canonical example of a disorder in specific nature is “generation gone awry: monsters that transgress species boundaries or, especially in the Christian tradition, forms of sexuality that do not aim at reproduction, including homosexuality” (Daston 2019, 11). The monstrosity of the crown of thorns starfish—like other perceived pests—lies in its hyperfecundity, its unexpected and surging excess which suggests that “something’s not right.” This is rarely, Daston suggests, a question asked *of* nature but rather one of moral subjects *through* nature.

Potts’ and his editor’s epistemic intervention sought to recast the linguistic conventions around how to refer to the loathed starfish and so pave the way to a possible consensus ecological view. What they may have misunderstood is that the problem of language reflected a frustration in excess of the protocols of scientific inquiry, the particulars of scientific personality, and even the politicization of results and funding. What glued all of this together was the unrelenting resistance of the crown of thorns to knowing control. Each recasting of the crown of thorns starfish problem deconcealed new aspects of the reef ecosystem, new ways of sounding its secrets, new thresholds of ecotoxicity, and new fights with regulators and industry over how to calibrate the Reef. Yet the starfish persists.[20]

Consider the contemporary depiction of crown of thorns starfish outbreaks in the planning documents of conservation managers: a disease curve that plots population peaks and troughs over time, akin to the successive "waves" of human viral infection and containment (Figure 43). This visualization gives, at last, a standard model of crown-of-thorns starfish behavior as a generalized threat to global reefs, useful irrespective of the specific tallies logged in statistical tables that document local variations in starfish counts and culls. What this visualization also shows is a mimetic uptake of the iconic "thorns" of the starfish now transposed as population "spikes" over time. The visualization represents the object of study, but in a way that also projects a degree of regularity—a normativity—to what once appeared monstrous: the sudden reproductive excess of a voracious reef devourer. The "why" of starfish plagues as possible indicators of a disorder in human-ocean relations that riveted publics and confounded

[20] To be clear, this vigor was productive as it suggested a new avenue of inquiry. Much like with cane toad "invasion biology," research object and research project co-evolved. One 1990 paper, for instance, cites four thresholds for assessing an "outbreak," each with their own corresponding data collection techniques, declaring: "it is now clear that a 'starfish outbreak' is a highly variable phenomenon" (Reichelt, Bradbury, and Moran 1990, 47). Marine scientists kept up with the variability of their object by varying their own research methods, in particular by finding ways of incorporating field-based data into general ecological models. The abovementioned article appeared in the journal *Mathematical and Computer Modelling*, a placement that marks a tension within ecological science over whether or not encounters between biophysical entities in the world conform to calculable information processes. In sum, the unpredictability of crown-of-thorns starfish outbreak detection and management extended the epistemic scope and remit of Australian marine science. This bears out in the three authors' own subsequent professional trajectories: Moran wrote the textbook on the manta-tow technique, Reichelt led the Authority from 2007 to 2018, and Bradbury now teaches global cybersecurity threat detection and strategy at the Australian National University in the federal capital of Canberra.

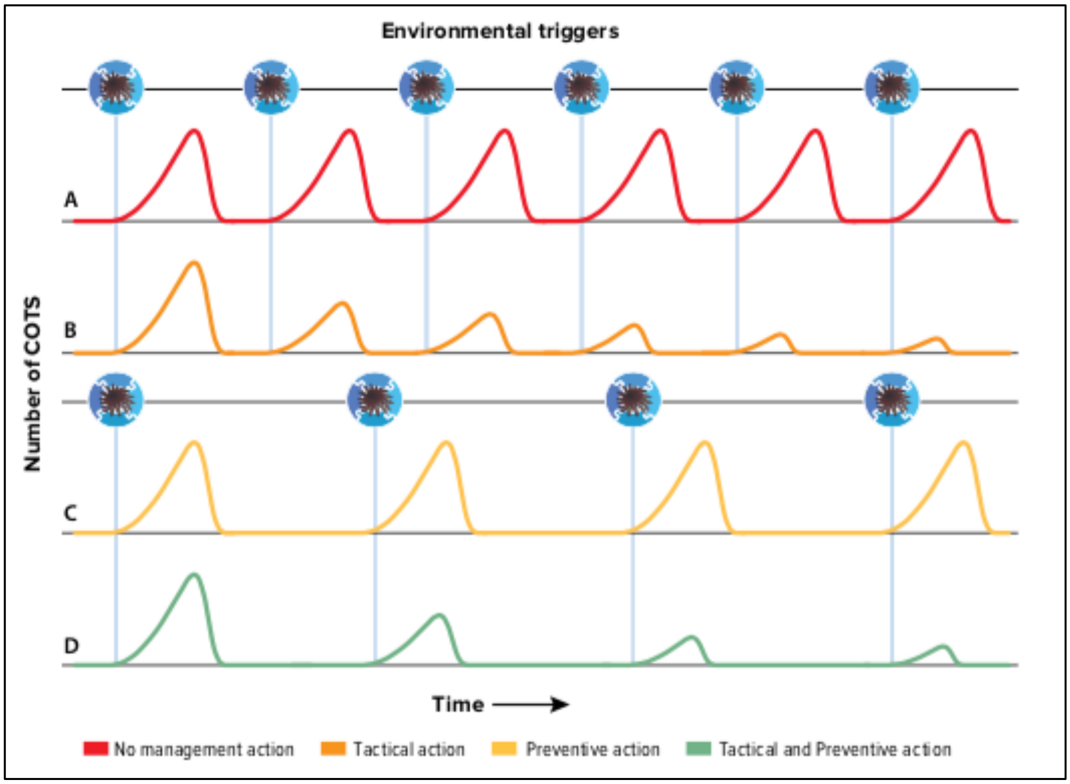

Figure 43. Comparison of the likely outcomes different outbreak management strategies. No action (A) shows persistent population spikes, as if to analogize the persistence of starfish thorns; prevention and intervention (D) shows a progressive elimination of spikes, as if to analogize the overcoming of starfish biology. (Source: Great Barrier Reef Marine Park Authority)

biology has given way to the "how" of outbreaks as a timeless reality to be systematically dispersed.

Today, contemporary reef scientists have stabilized the question of whether "nature" or "people" caused the monstrous surge in crown of thorns starfish by embracing a "multi-causal" management strategy that aims to stabilize this moral panic. Central to this achievement was the development of systematic field studies using techniques such as the "manta-tow" described earlier. Since the 1990s, passive data collection and monitoring has acquired further significance with the gradual warming and acidification of the oceans. No longer "mindless" labor, it is now the very feedstock of complex models and simulations. The shift in status of the crown-of-thorns from agonizing monster to predictable outbreak along with the increasingly "essential" need for pervasive and persistent data lay the groundwork for Dunbabin's robot.

2.3. How to Catch a Starfish

At the heart of Dunbabin's robot is a "capability" to put computer vision to use in the name of as yet unspecified actions. Navigation was the first of these, starfish surveillance the second. In taking on this new task, the robot earned a name: Starbug (Figure 44). It is an evocative moniker that implies creaturely fellowship between the robot and its target, connotes outer space and espionage for which the marine milieu has been a constant cipher, and rouses visions of technology for mass society and the public good—whether in the form of the Volkswagen Beetle or "bug," or the media cultures of science fiction and video gaming. There is nothing random about this spread of meanings. From an otherwise open-ended and as yet undetermined "capability," they help narrow down the range of expectations that the robot can meet.

Government divers regularly took photographs during Reef surveys. One Institute researcher provided Dunbabin with eighty digital images of crown-of-thorns starfish in various poses and settings, as well as some additional "control" images with no starfish at all. Dunbabin's team then converted these images into high-contrast texture maps, and calibrated existing pattern recognition techniques to create an algorithm that would look for the distinctive long and spiky "thorns" of the starfish and dismiss the rounder branches of the staghorn corals on which the starfish feed. The algorithm achieved a 65 per cent success rate, remarkable for a prototype but unlikely to warrant mass production and the launch of a robot fleet. This was in 2005 (Clement, Dunbabin, and Wyeth 2005). Over the next ten years, Dunbabin worked on various other dimensions of the "efficiency, precision, scale" trinity he came to outline in his

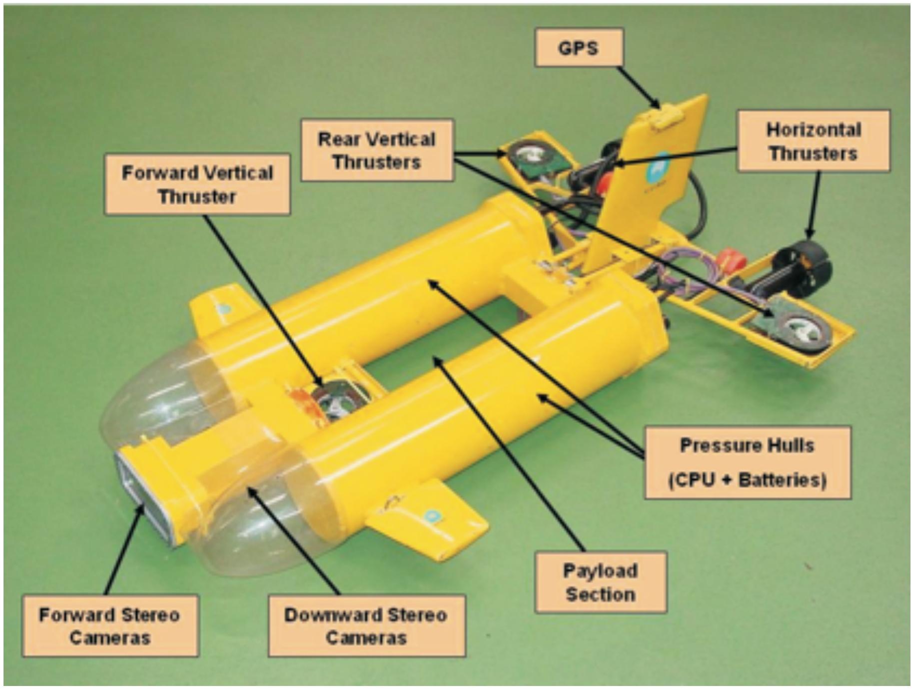

Figure 44. Starbug, 2005 version. The autonomous underwater vehicle combines a vision-guided navigation system with a range of dimensional movement controls to prioritize maneuverability in the shallow reef waters. The robot was designed for open-ended use, hence the "payload section" at the middle. (Image reprinted from "Experiments with Cooperative Robotics," by Matthew Dunbabin, Peter Corke, Iuliu Vasilescu, and Daniela Rus, The International Journal of Robotics Research 28, 6, 2009, 820. Copyright (2009) by Matthew Dunbabin)

2012 paper. These included underwater docking stations for discharging data and recharging batteries, wireless fleet communication to coordinate navigational maneuvers, and chemical sensing to multiply data acquisition targets. In 2015, he returned to the starfish project with renewed enthusiasm and a third task in mind: killing starfish.

Dunbabin had left CSIRO and joined Queensland University of Technology's Institute for Future Environments. With his new colleagues and students, he "trained" a new visual identification algorithm by applying machine-learning techniques to 3,000 images culled from YouTube videos that scientific and recreational divers had uploaded. Next was a simulated test "dive." The group programmed a robotic arm to guide a camera up and over a series of life-size "posters" of single square meter sections of reef and use the algorithm to identify starfish in the process. Again, the Institute provided the high-resolution imagery. The work took accuracy from 65 to 99.4 per cent. The final step was to equip the robot with an articulated arm tipped with a retractable syringe and program the fatal blow. When the robot positively identified a starfish, it dropped down to a fixed altitude above its target, extended the arm and delivered a lethal injection of bile salts. Over six months, the team alternated between open-water identification trials and laboratory injection simulations using 3D-printed starfish. They attained a 99.9 per cent accuracy rate, and the robot refused to inject the decoys.

Lethal injections for starfish, really? Yes. In 2005 when Dunbabin began training Starbug to identify starfish, he always knew that killing them would be a logical end point. When we spoke in 2016, he told me that even though he was an engineer, he still wanted to do his bit for the environment. He felt spurred to act when he learned of newly outbreaking crown-of-thorns starfish. He had in mind the beach clean-up, a form of participatory direct action in ecosystem restoration that involves taking objects discarded in a given landscape and sorting them for waste management or recycling. Voluntarist care corrects for generalized carelessness by isolating discrete objects such as plastic lids, snack wrappers, toothbrushes, sheet metal, rope and fishing nets, which visibly mar a landscape's appearance and invisibly interfere with its functions, making waterways toxic to human and animal life. The notion that crown-of-thorns starfish are something to "clean up," then, presumes a projection of the Reef as valuable in terms of its aesthetic integrity and organic abundance, to be defended at all costs.[21]

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[21] While clean-ups are far from unique to Australia, the activity is a go-to model of civic environmental action, as evidenced by its inclusion in the "Celebrate the Reef" program mentioned earlier. Indeed, Australian publics have been enlisted to clean-ups from an early age since the late eighties, when an annual "Clean Up Australia Day" was included in bicentenary celebrations of 1989, the same national anniversary that paid for the aquarium now known as ReefHQ. Its original slogans—"Keep Australia Beautiful" and "Do The Right Thing"—persist and pervade everyday life through ubiquitous signage outside inner city office buildings at suburban skateparks by highway rest-stops or on open beachfronts. Clean-ups allow for a scalar jump from the local to the ecological, as the cigarette butt exists as a discrete physical object you can grasp in your hand the better to sense and feel up to responding to the ramifying effects of carcinogenic contamination in human bodies and more than human landscapes. The ability to

In 2005, Dunbabin did not know about the long history of outbreaks and their study, and the manner in which each fresh outbreak cycle had led researchers and publics to proliferate questions and answers that further qualified the problem yet left it open to resolution. As discussed above, clearer insights into starfish biology, growth and development, nutrition, mobility, predation, genetics, and so on, did not diminish but amplify the threat of outbreaks to science and society and uphold the status and reputation of the crown-of-thorns starfish as the very incarnation of an environmental problem. Although Dunbabin came to learn this history in the course of his work, it was an initial degree of indifference towards the details that got him started.

> "They were a bit hesitant even back then. They weren't quite sure that it was full outbreak. They've seen these cycles before, and they thought that there's fossilized records to say there've been outbreaks in the past, but now with the work of [the Institute], [Glenn] De'ath and those guys, it's now conclusive that it's full outbreak, that it's bigger than everything before."

Note how Dunbabin jumps between three different moments. The slippages highlight subtle but important shifts in how researchers understand outbreaks and what, as a result, they expect to be able to do about them. First, the "even back then" of 2005, when the high variability of outbreaks meant the Institute's researchers still hesitated to make definitive assessments about the full scale of the problem. Second, the "now with the work of [the Institute], [Glenn] De'ath and those guys," where Dunbabin references a widely circulated 2012 reanalysis of historical survey data that demonstrated that regardless of variability between outbreaks their frequency and intensity is increasing over time—"the world's most extensive time series data on reef condition" (De'ath et al. 2012, 17995). Third, the "now conclusive that it's full outbreak" of 2016, when present day reports of another outbreak do not invite equivocation over the nature or scale of the problem but

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clean something up, then, implies exercising some power or influence over forces presumed noxious and presumed to exceed the control of any one individual.

instead an imperative to intervene in its occurrence. Put simply, Dunbabin reasons that if outbreak cycles are increasing and intensifying, then every new outbreak is "bigger than everything before." Variable or not, all outbreaks are "full outbreaks," and any and all means are welcome to hasten the starfish's end. Among other things, this characterization of the crown-of-thorns starfish problem encourages new entrants whose interests and methods do not necessarily aim at describing the creature's life cycle so much as figuring out how best to end it. Enter bile salts.

2.4. Out, Damned Outbreak

It is not easy to kill starfish, and especially not the crown-of-thorns starfish.[22] Their spikes are strong, sharp, and their venom induces acute pain on contact and prolonged nausea and vomiting. They are remarkably resistant to blunt trauma; they regenerate lost tentacles and even clone themselves if cut apart. Past control methods include hooking or floating starfish to the surface with compressed air and injecting various chemical cocktails. Early chemical solutions relied on copper and ammonia which are toxic to marine life generally, while later more targeted solutions required dozens of injections across the starfish's body lest it regenerate. It is as if each individual starfish contains a multitude of potential others within. For the longest time, outbreak control was considered a lost cause. Here is a finding from a 1985 government report, after a meticulously review of control methods, counts, and costs in Australia, the U.S., and Japan: "Efforts to control *A. planci* appear to have been successful in killing impressive numbers of *A.*

[22] A 1939 publication from the U.S. Bureau of Fisheries lists a range of methods for "eradicating" another species of starfish from oyster reefs in Long Island Sound. Already, this included experiments with chemical cocktails. The author begins the section on control methods thus: "the eradication of starfish on oyster beds has been practiced ever since the cultivation of oysters began" (Galstoff and Loosanoff 1939, 120). The statement implies that, contrary to its conventional usage to refer to the complete destruction of some thing or another, the "eradication of starfish" is a timeless, open-ended, and infinitely renewed project.

planci, but usually unsuccessful in reducing the population to 'normal levels.' High density populations of *A. planci* eventually decline of their own accord and, during control programs, have simultaneously declined in nearby areas in which no control effort was made."(Queensland State Archives 1985, 12).

> It was the mechanism of this "natural" abatement, the curious way starfish numbers "decline of their own accord" that drove a group of Townsville-based researchers to devise a single-injection control method in 2011.

Jairo Rivera-Posada led the study, a veterinary medicine professor turned marine science PhD student. He and his colleagues reviewed historical studies of sick and dying crown-of-thorns starfish at the end of "outbreak" cycles, which noted the onset of infectious disease and a range of possible pathogens but did not go on to investigate them further. They narrowed this list down to a species of pathogenic bacteria called vibrios. Vibrios are well known for causing foodborne illnesses such as gastroenteritis, severe topical infections such as sepsis, and even cholera from water contamination. They can do other things than cause disease in their host organism. But when they reach large numbers, they engage a collective mechanism known as "quorum sensing" and begin to perform various harmful or "virulent" actions. In the starfish's case, this means eroding the strength, stiffness, and flexibility of its body walls, triggering lesions and compromising immune protection against other pathogenic bacteria. Quorum sensing can happen across hosts, which explains why the mere presence of a diseased crown-of-thorns starfish can produce a cascade of infections in seemingly healthy neighbors. Decomposition and scavenging are rapid in the marine milieu, especially on a reef teeming with omnivores big and small. It is not inconceivable that once a vibrio infection took off hundreds of thousands of starfish could simply "disappear" in a matter of days and weeks.

What the researchers aimed to do, then, was increase vibrio numbers to sufficient levels to trigger quorum sensing and induce "dysbiosis," an imbalance in gut bacterial communities.

Figure 45. Diver injecting crown-of-thorns starfish with bile salts. The diver uses a hook to hold and steady the animal, before injecting the solution into its body. The equipment used is repurposed from agricultural science, for either administering vaccines to cattle or spraying pesticides on crops. (Source: Great Barrier Reef Marine Park Authority, CC 4.0)

Put directly, to stop crown-of-thorns starfish outbreaks on reefs, Rivera-Posada et al. sought to put bacteria outbreaks *inside* starfish.[23] The means to do so, it turned out, was right in front of them: "vibrios are usually isolated and cultured in microbiology laboratories by the use of thiosulfate-citrate-bile-sucrose agar (TCBS), which is considered the primary plating medium

[23] Presumably, it would be possible to visualize this process with a minor adjustment to the same disease graphs mentioned earlier. By charting vibrio and crown-of-thorns starfish numbers together, a "spike" in bacterial numbers would correspond to a "flattening" of the starfish population.

universally used for the isolation of these bacteria" (Rivera-Posada et al. 2011, 86). The most promising "control" mechanism for crown-of-thorns starfish is not a novel contraption, synthetic chemical compound, or even a particular bacterium. It is the medium in which microbiology does business, standardized and mass-produced so as to produce "universally" consistent results. The delivery mechanism? Agricultural technology: pesticide guns or livestock vaccine equipment. The pathology assay becomes the solution, put the plating medium inside the animal (Figure 45).

The method was startlingly effective at killing starfish, although why exactly remained somewhat unclear. Rivera-Posada and his group pushed on to study the individual components of TCBS and determined that one even more widely available ingredient, bile salts, triggered disease outbreak as well.[24] Bile salts are a slaughterhouse by-product: bovine and ovine gall bladders are largely deemed waste organs in industrialized meat production, that is when not converted into laboratory-grade reagents. But bile salts remain a regulated compound, and in laboratory grade form are costly and under patent. So, the team pursued a final angle relating to one possible cause of death, osmotic shock due to rapid change in gut ph. Injections of household vinegar, an inexpensive and globally available acid, produced a slower death but the same result: generalized tissue necrosis and rapid decomposition.

Crown-of-thorns starfish were never well loved. Indeed, it is hard to describe just how relentlessly these creatures have been hunted. Among oft-cited statistics: in the decades prior to bile salts, 17 million starfish were culled in the Indo-Pacific, but the outbreaks kept coming; a

[24] In revising this chapter, I have corrected a parapraxis in this sentence, wherein I wrote "*wildly* available" rather than "*widely* available." This slip is suggestive, as I am trying to convey the manner in which intervention has some driving force behind it that exceeds its apparent "civilized" and "civilizing" qualities. For the one-shot injection to be desirable as a control mechanism, it needs to be available to any and all people exposed to and concerned with crown-of-thorns outbreaks. As such its ingredients need to exist in "the wild," which here means in the ubiquitous goods of consumer supply chains, just like plastics and other consumer pollutants eligible for "clean up."

single female starfish can produce sixty-five million eggs in a single year; indexed to the cost of vinegar, the price of a starfish life is now one cent; and, according to the Queensland Animal Care Act, they are not animals at all and are not subject to "ethics" considerations. In this sense, the intensification of the global campaign to destroy crown-of-thorns starfish builds upon an established understanding of what these animals are, do, and deserve. It is no longer limited, however, by the prior question of why crown of thorns starfish "break out" and what that might have to do with the expansion of human industry into the ocean world. As all outbreaks are now "full outbreaks," the only question worth asking of the crown-of-thorns starfish is how best to kill it and the most desirable method is the one most ready-at-hand.

TCBS, bile salts, and vinegar are deemed "safe" to introduce in a marine setting because they are organic compounds easily processed by reef processes, unlike, for instance chemical cocktails of yore.[25] Yet to describe them as "natural," as the scientific literature does, is not only to fail to mention their industrial origins in pathology, meat processing, and mass consumption. It is also to hitch the efficacy of "climate action" to global supply chains that are themselves integral to the planetary scale reach of forces that continue to drive earth distress. In many ways, there is nothing unusual about this: the researchers developing the one-shot lethal injection were, from the start, eager to develop a method that would be as accessible, inexpensive, and rapid as possible or, put differently, that could seamlessly integrate with the conventions of ordinary life for any community living in proximity with coral reefs. The conventionality this intervention seeks to break open is the cyclical and increasingly frequent coming together of crown of thorns starfish and reef building oceans—it aims to "flatten the curve." To be sure, this will "buy time"

[25] It would be worthwhile comparing this with the post-war period in which the widespread use of pesticides and insecticides in agriculture went hand in hand with a concerted campaign of domestic hygiene. In the language of one 1946 US advertisement, household "pests" such as mice, rats, houseflies, mosquitoes and so forth deserved "super ammunition for the continued battle of the home front" (Russell 2001, 168).

for coral reef recovery yet it will do so in a way that transforms the very processes of mass industrialization that are predating upon the planet integral to its saving. Intervention accelerates crown-of-thorns starfish "control" efforts with a view to doing something, anything, to relieve pressure on global reefs. In the process, not only does it make a bioweapon of a bioassay and a killer robot of an underwater camera, but it also weaves new bonds of intimacy between industrialized modernity and marine life and makes a virtue of the very forces that are bringing the global "environment" undone.

2.5. Between Convention and Intervention

In this first part of the chapter, I attempted to track the spirit of intervention—the questions it asks, methods it uses, and objects it takes interest in. By focusing on the cane toad, I show not only that Reef intervention takes authorization from established traditions of inquiry, even as it defines itself against the would-be shortcomings of prior regimes of knowing and doing, but also to open up the critical natural history of the Reef to its inland projection.

I noted earlier that part of what defines intervention is the refusal or flouting of convention. I have tracked different moments when this refusal takes the form of a reversal: treating underwater survey as a sensing loop, treating the reef flat as a texture map, or the "natural" conclusion of an outbreak as the "natural" starting point for outbreak control. In doing so, I do not mean to pit the ingenuity of Dunbabin or Rivera-Posada and their colleagues against, for instance, the activity of human and other-than-human co-workers on which they depend. Such reliance is a general condition of technical activity and may not be the most helpful way of distinguishing intervention from its precursor ways of knowing and doing. If the sciences of marine life have always used their research object, "environment," as a means to define the limits to human action, how does intervention make a virtue of environmental uncertainty, and how does it cope with the allegedly limitless possibilities for action this opens up?

Technically, Dunbabin's robots are, like so many other machines, proxies for modes of action carried out by human agents and so complete "tasks" that are, in no respects, unconventional: navigation, photography, pest control. The intervention does not consist in completing such individual tasks mechanically, but in promising ever greater "efficiency, precision, and scale" so as to allow social life to automatically update to a world of increasing unpredictability.[26] The intervention, in other words, amounts less to a new way of doing old things *in* an environment than it does producing a *new* idea environment in which to act, one saturated with intervention to anticipate human needs. The expression "environmental robotics" is misleading, or, more accurately perhaps, partial. The kind of expectations this field promises corresponds just as much to interacting with environmentally-oriented robots as they do to experiencing and acting in a robotically-oriented world.[27]

The push for a fleet of robots is not simply justified on the grounds of adding individual surveillance units to different sections of Australia's vast marine jurisdiction. It is justified on the

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[26] Automaticity is what technology promises, part of its magic, as Alfred Gell explained some decades ago: "practical technical procedures, however efficient, always do 'cost' something, not necessarily on money terms but in terms of missed opportunities to devote time, effort, and resources to alternative goals, or alternative methods of achieving the same goal. The defining feature of 'magic' as an ideal technology is that it is 'costless' in terms of the kind of drudgery, hazards, and investments which actual technical activity inevitably requires." (Gell 1988, 9)

[27] It would be worth pursuing this claim in relation to "precision agriculture," a domain in which environmental sensing has cut its teeth, and for which the description "robotic environment" might pass without comment. For now, I note a different connection between intervention and automation. I was struck to find an early presentation of Dunbabin's in the proceedings of an international conference on "Field and Service Robotics," alongside an opening plenary on "Container Port Automation." The speaker-author represented Patrick Terminals, a firm responsible for roughly half of all loading and unloading operations in Australia's ports. Port loading docks have long been a significant "domain" of political organizing in Australia, as a critical economic and geopolitical bottleneck. Indeed, a turning point in the 1970s "Save the Reef" campaign that led to the gazetting of the Great Barrier Reef Marine Park and its associated agencies, was the refusal by unionized stevedores to unload oil drilling and prospecting equipment en route from Japan. The point of this comparison would be to press upon the way that the appeal of intervention in some ways corresponds to the demise of a mode of collective action and organizing, which in some ways affirms the appeal to these earlier historical moments (especially the 1970s) in a melancholic mode.

grounds of “capability,” an increase in the intensity and reliability of the maneuvers, coverage, and collection that the fleet form will bestow upon any and all units. Yet imagining a “robotic Reef” need not mean killer robots swarming Australian waters. It may be enough to acknowledge that Dunbabin’s robot no longer belongs on the page or in the lab. It has outgrown its laboratory “testbed,” refuses to inject 3D printed crown-of-thorns starfish, and will now only act as it is supposed to (i.e., with greater efficiency) through further “training” in the open ocean. And so, outbreak “control” now means putting individual starfish to work towards their own death, concluded thanks to the reanimated gall bladders of once slaughtered livestock. The individual starfish, too, is given a new “task” (if not to say “capability”) thanks to intervention, namely working its kind to death. This points to another dimension of the incorporation of unpredictability in the name of a self-intervening Reef. The one-shot injection pursues “starfish disease” as an object of knowledge yet produces “diseased environments” as a field of action. It is by viewing marine life under such a description that Rivera-Posada’s team could “scale up” their findings from the lab to the abattoir to the domestic setting and so explore the maximal global expression of a new control “capability.”

Conceptually, there is also a risk in giving in to the allure of intervention as open-ended creativity. It downplays the contingency involved in establishing a new orientation towards the world. It takes work to unsettle conventions, and the appeal to some intervention as a “game changer” is part of that work. (On one level, the expression is banal and simply hypes a novel set of tools. On another, it is a recruitment device, as it suggests a level playing field, and the welcoming of new talents.) Where is this contingency and what does it do? I first encountered Dunbabin’s research in splashy press coverage that announced the arrival of a “starfish killer, terminator, murderbot.” These articles discussed the long struggle to bring down numbers of crown-of-thorns starfish, and the dangers of killer robots. And, indeed, in all of his public appearances, Dunbabin and his colleagues are at pains to reassure the public that this lethal capacity will remain, ultimately, in human hands. Here is one of them quoted in the final lines of an article in the *New Scientist*:

> "In Australia, we've had a few disasters introducing new species to kill pests—witness the cane toad problem. … The advantage of introducing robots is that we can easily turn them off once they've done their job. We're not going to end up with a plague of crown of thorns-killing robots" (Slezak 2016, 37).

The engineers reassure readers that the robot cannot be "hacked," which makes it easy to forget that part of the robot's appeal *is* hacking: breaking into starfish stomachs to lure out the vibrios lying within, repurposing industrial technologies for marine conservation, killing starfish to "save the Reef," making a coral science problem disappear and with it the questions coral science was asking of global society. The difference between the plague of toads and the swarm of robots is not that the robot is not capable of causing disaster but that it's capacity to do so remains in human hands. There is, as it were, a kill switch behind the killing arm. But when exactly will the robots' job be "done"? It may not be tethered to a boat in the way the Institute's divers are. Instead, its tethers are to the very industries causing crown-of-thorns outbreaks to begin with. Moreover, if the robot shares the cane toad's status as a biocontrol agent, as a "species," as a worker, then the Reef shares the sugar cane industry's status as a national industry committed to endless growth—at the very same moment of its exposure to terminality, of its historic unknowability, of its availability to "last resort" forms of conservation. How can this be?

Conclusion

Intervention is a mode of "climate action" that claims a radical break with histories of conservation is possible and so imagines a uchronic, timeless canvas upon which to work. All the while, it depends upon the conventionality of earth distress as a chronic and ongoing condition. The problem becomes a promise. The cane toad, the starfish terminator, Frankenstein corals. These disavowed monsters are not problems to solve for. They can't be. They refuse control because they are uncontrollable. And in that capacity they function as a mimetic technics as well, luring us into a confrontation with the monstrosity of their parentage: as creatures of our own making. The fact that "Frankenstein" now functions as a quasi-adjective is a testament to the novel's enduring success at capturing the anxiety associated with scientific ingenuity. Yet this timelessness, perversely, obscures the historicity of practices of knowing, acting, and feeling upon which such ingenuity depends—the conventionality it opens up, refashions, rewrites. Mary Shelley may have been visionary, but she was a woman of her time, and in 1818 the problem and promise of galvanism—i.e., the possible reanimation of the dead with electricity—was a live debate, so to speak, in medical circles and likely known to her reading public. The question of what an intervention is, when it is horror and why, is not an eternal one.

In following the lure of Reef intervention—through its ever-proliferating projects, the cane toad, the agony become trauma of crown of thorns starfish outbreaks, COTSBot and its agricultural pharmakon—I have attempted to bring focus to some of the historical particulars without which this mode of knowing could not go on. It is not so much a return to life that Reef intervention promises as it is an ever deeper saturation of life with technology, perhaps limitlessly so. I tried to gesture towards this at the outset, with an exhausting enumeration of Reef interventions, whose sheer number suggest a combination of desperation and limitlessness to the "life support" project.

Dunbabin's robot has gone through five name changes: first a nameless prototype, then Starbug in 2005, then COTSBot in 2015 (Figure 46), then RangerBot in 2016 (Figure 47). The

Figure 46. COTSBot, 2015 version. The robot transitions from an ostensibly scientific instrument to something closer to an industrial prototype. It enters into a cycle of technological hype in which design aesthetics play a crucial role and are emphasized in media coverage—hence the conventions of product photography in this image in new technology monthly *Wired*. (Image reprinted from “The Great Barrier Reef’s Best Hope is a Killer Robot,” by Ian Frisch, *Wired*, April 14, 2016. Copyright (2016) by Mathew Dunbabin)

penultimate name change corresponded to a “People’s Choice Award,” organized by not-for-profit the Great Barrier Reef Foundation, complete with professional press campaign and a $750,000 grant from Google Australia. The final name change corresponds to the first stage of industrial production and a makeover courtesy of global industrial design studio DesignWorks. The killing capability is no longer front and center, because RangerBot may or may not be put to work killing crown-of-thorns starfish. The “capability” has after all, proven itself and the aim of environmental robotics is not to satisfy specific epistemic ends but function as a pervasive and persistent “platform,” to use the idiom of technology. Indeed, the latest uses of RangerBot have been to perform the seeming opposite of the act of killing. Rebranded as LarvalBot in 2019, Dunbabin and his team have deployed them to disperse coral larvae on the Reef during the annual spawning season. Meanwhile, funders have organized competitions in Queensland high schools to name individual robots launched on The Reef. These acts of campaigning and public recruitment are not anodyne. Since the embrace of intervention by the Institute and Authority, the federal government has delegated considerable authority to industry for identifying, funding, and supporting coral reef research. These are authorizing gestures that establish intervention as the conventional way of seeing and knowing marine life. To do so, they offer up the possibility of a new Reef to replace the old one.

Remember Ross and MJ, the two green turtles returned to the Reef in October 2015? A campaign manager at WWF explained to me what market research said about why green turtles are so good to recruit with: cute, forward-facing eyes, home, food, family. I wonder what makes RangerBot so good to recruit with today and what kind of home we are making for ourselves.

Figure 47. RangerBot, 2019 version. This latest iteration does not highlight the retractable arm used to kill crown-of-thorns starfish, as this is now just one among a range of the robot's capabilities. (Another capability includes the power not to take but to give life. A variation known as LarvalBot collects and redistributes coral gametes during annual mass spawning in the name of assisted fertilization.) The new name and look bring the robot into closer proximity with the consumer drone or performance racing vehicle. The "002" insignia invites multiple interpretations: serialized production, sporting numbering, and perhaps even the drama of espionage. Viewed in this way, earth distress is less an uncontrollable force of our own making than an opponent to best in competition. (Source: Matthew Dunbabin and DesignWorks)

CHAPTER FIVE: CLIMATE TANTRUM

The previous chapter demonstrated that scientific knowledge of coral reefs is now attempting to embrace the metaphysical uncertainty of its object in ways that make an epistemic virtue of the ongoing effects of earth distress. As earth distress puts a question mark over the very concept of environment, a widening array of knowledge actors are seizing upon the appeal of experimentation to stabilize their own expertise as salvage artists. Under this regime of experimentality, any and all efforts to maintain the Great Barrier Reef are worth putting to the test. This regime of knowing and doing does not so much attempt to alleviate earth distress as it does incorporate it into the knowledge production process at every level so as to establish a new frontier of human action, that of permanent intervention. By recruiting publics to their efforts, experimenters simultaneously sate a desire that something, anything, is "being done" to care for coral reefs while pre-empting alternative ethical and political responses to distressed oceans.

One of this dissertation's through-lines is the status of Australia's Great Barrier Reef as a medium for expert and non-expert expressions of something like longing (wonder, curiosity, desire, fear, resentment, mourning, etc.) under conditions of planetary diminishment. I have been attempting to show how the mass mediated terminality of this form of life emboldens epistemic projects construed, broadly speaking, as games of call and response with wounded nature whose outcomes continually push back the limits of what forms of care are deemed thinkable, plausible, and desirable (see also Farman 2022). The present chapter examines another aspect of the shifting conditions of knowing and acting on earth distress, namely, the relationship between disaster and normativity, fear and control, inaction and certainty. It examines how efforts, notably by the contemporary Australian environmental movement, to place the historical present under a description of generalized disastrousness (a condition of ongoing harm) encounter resistance from technocratic actors whose authority presumes a description of disaster as localized environmental disturbance (a condition of eventful harm). It asks: When is a disaster is not a disaster? What does getting through another extreme weather event mean when the only given is that it will be unlike any that went before? These questions are one way of feeling out tensions over whether earth distress arises as a problem for moral and political reasoning.

I argue the following: that earth distress unsettles the conventions of disaster normativity foundational to technopolitical authority in the present and, as such, exposes the seams of moral and non-moral reasoning, political and anti-political action. The ongoingness and planetarity of earth distress defies conventional understandings of disaster as a localized and bounded event. At the same time, earth distress is disaster-in-the-making, and so rouses political and moral instability. This instability invites but exceeds the authority of disaster expertise (scientists, lawyers, political representatives) committed to understanding disaster as an event-system. The possibility, even inevitability, of such challenges continuing into the future explains increasingly reactionary responses from authorities as they attempt to police public reasoning about earth distress. By examining how the ongoingness of the Reef in the historical present does and does not arise as a disaster, this chapter offers another way of conceptualizing coral encounter in the 21st century: knowing as bewildering.

To develop this argument, I proceed as follows. First, I take up the case of a cyclone that crossed a highly populated section of the Great Barrier Reef in March of 2017 to explain the relationship between disaster and normativity (Section I). I then explain how earth distress as an ongoing process unsettles disaster normativity, which is legible in expressions of moral and psychological lawlessness in response to extreme weather (Section II). I go on to show how Australian state and federal governments attempt to contain this lawlessness through the stabilizing power of "disaster management" yet fall short. This is brought out most strongly through a reading of a major legal case in response to a coal spill into the Reef Basin during the cyclone (Section III). I close by showing how federal political discourse shuts down political appeals to disastrousness and reasserts the narrow rationality of disaster normativity. This involves anti-moral and anti-political gestures that redescribe attempts to take earth distress seriously as the grounds for political reasoning as nothing short of delusional, which is to say a recruitment to lawlessness (Section IV). Before this, however, a few words on disaster.

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Disaster is not an innocent concept. What this means is that how I experience and respond to disaster, how I bring this concept to life in use has effects that can harm as well as heal. It is perhaps precisely because disaster, crisis, and intervention readily appeal to my capacity to anticipate, endure and alleviate suffering, my own as well as others, that the question arises: how do such concepts become available to use and abuse? And yet, to begin with, disaster is not an obviously first-person responsibility or, even, a human one. In fact, is it not a mistake to describe disaster as a concept rather than an event? "Crises and catastrophes are kinds of events that seem to demand, as if authored from outside human agency, an ethical response," observes Elizabeth Povinelli in a text that asks, inter alia, why it so difficult to imagine suffering as a place from which to live and write belonging today (2011, 14). A signal reason she gives for that difficulty is the practical and conceptual habits of late liberal modernity that routinely foreclose non-normative ways of living with others by aggregating suffering as disaster, a social event to be tensed, managed, and stabilized from afar. Such foreclosures are, also, studied (and studiable) responses to harm even though they perpetuate it and diminish its ethical and political potential: disaster and response coil around one another as the concept does the event.

This chapter both is and is not a study of disaster. This is because it asks how and why the question of disaster arises in relation to earth distress astride the Reef, and what ramifications this has for public reasoning about environmental harm and responsibility. To recall, one of the reasons I refer to "earth distress" in this manuscript is to try and suspend (for me as much as for you) the ways that "climate change" seems to turn the problem of planetary diminishment into an abstraction, an externalizable knowledge object, which makes it difficult to acknowledge human intimacy with its causes, effects, and affects. Consider, for instance, the expression "action on climate change" that, with nothing more than a preposition, asserts a form of action that is always at a distance. One way in which many climate action/change advocates enact the same interruption I take interest in, however, is by either directly or indirectly appealing to the concept of disaster so as to locate climate action/change within the here and now. This chapter is an examination of the appeal, effects, and charge of this move. I begin with the case of a natural disaster, the 2017 crossing of Cyclone Debbie, and follow some versions of an appeal to earth distress as disaster in order to understand the pressure thereby placed on existing disaster normativities. The writing is, in a sense, an attempt to create the space in which this pressure can expand, and this in two directions: First, to appreciate the narrow scope for political and moral reasoning that description of disaster as system-event encourages; Second, to appreciate the defensive countermaneuvers that any attack upon such descriptions provoke from technocratic authorities, which amount, often, to so many attempts to contain the political and ethical potential of disastrousness as a mere delusion, or, if you will, a disaster.

Disaster casts a long shadow. It is difficult if not impossible to disentangle event from aftermath. Working through the 1984 explosion of the Union Carbide chemical plant in Bhopal, Kim Fortun underscores the double binds which arise for advocates as the competing demands of disaster sponsor competing versions of political change, as well as competing avenues of critique and competing ethical desires (Fortun 2001). In the fallout of the 1986 Chernobyl Nuclear Disaster, Adriana Petryna discerns interlocking regimes of scientific knowing, bureaucratic disciplining, and political messaging. This cascade of experiments further compromises the embodied, psychic, and social immunities of radiated citizens (Petryna 2002). More recently, the surface-level "invisibility" of the BP Deepwater Horizon oil spill of 2010, David Bond shows, became an opportunity for science to produce "environment" as a documented, sampled, and monitored baseline condition of life fit for regulation (Bond 2013). I follow texts such as these to understand disaster as a constitutively tense and experimental opportunity for power to settle into new places in the would-be aftermath.

Disaster as a concept has a history. Just as disasters are historical events from which authorities fashion games of truth and power that catch and shape the afterlives of historical subjects, so too ideas about disaster are not stable over time. What this means is that the exercise of knowing authority in response to disaster draws on historically specific and specifiable repertoires. "Disaster management" or "disaster science" is a relatively recent yet globally distributed way of responding to world-altering events. Historian Deborah Coen (2018) locates the field's origins within efforts by the post-war US state to adapt emerging theories of closed-system cybernetics to control behavior in times of "extreme national and international stress," for which the burgeoning nuclear program provided the ideal staging post for conditioning individual and collective stress-responses. As anthropologist Joseph Masco (2006; 2014; 2020) has extensively documented, the high stakes, long lived, and mass mediated nature of this psychopolitical project refashioned the social contract between the United States and its citizens around perceptions and temporalities of imminent catastrophic danger to everyday life and the nation state. This has stabilized individual and communal understandings of how to sense danger and security with and from others in apocalyptic, nationalist, and eventful terms both within and beyond the United States. One signal result is that it is especially difficult to grapple with earth distress as a gradually, globally, and unevenly distributed force of destruction. That said, the vast majority of disaster managers working today operate without any personal or political affiliation with the US military-industrial complex. In deploying a hermeneutics of the near-collision to stabilize technocratic authorities far and wide beset by imminent threat, they draw upon conceptual resources proper to yet also in excess of the US nuclear security state, such as the science of ecology (Evans and Reid 2015) and post-war liberal political theory (Hu 2018). Such literature has honed my sensitivity to the way disaster responses are always conditioning of and conditioned by a tangle of epistemic, psychosocial, and political concepts.

Finally, let me circle back to Elizabeth Povinelli's reading of disaster as a resource within late liberal modernity. Povinelli motivates the qualifying "late" as follows: "[By "late liberalism"] I mean the shape that liberal governmentality has taken as it responds to a series of legitimacy crises in the wake of anticolonial, new social movements, and new Islamic movements. But in a broader sense late liberalism is a belated response to the challenge of social difference and the alternative social worlds and projects potentially sheltered there" (2011, 25). I draw attention to this definition for the way it figures "late liberalism" (in and beyond 21st century Australia) as a form of life responding to crisis *as it falls into crisis*, arriving to disaster late enough to run the recovery operation and dis/miss its own responsibility for the onset. The scope of the present chapter is narrower than Povinelli's study and is not, at this stage, a focused study of liberal reasoning. Nonetheless and from a different anthropological vantage, it is an attempt to catch the insecurities and frustrations on view within technomodernity as disaster redoubles upon itself to narrow or foreclose the possibilities for taking disastrousness as the grounds, however destabilizing, for public reasoning. The chapter might therefore resolve in a study of liberal reasoning that adopts an evenly hovering attention towards its object the better to track the psychopolitical tensions at play as disaster comes undone.

1. The Lazy Cyclone and the Tense Wait

In the early afternoon of Tuesday March 28, 2017, Tropical Cyclone Debbie made landfall on Australia's Whitsunday Coast, an epicenter of the Great Barrier Reef tourism industry. Wind gusts of 160mph broke state records as they pelted Hamilton Island. The cyclone's core then hovered over the resort towns of Airlie Beach and Proserpine, where the local rain gauge neared twelve inches until, in the early hours of Wednesday morning, it broke. A little further south, the Laguna Quays tidal station logged an eight-and-a-half-foot storm surge, which exceeded the previous highest astronomical tide by three feet. The storm's slow crossing earned it a nickname, "the lazy cyclone," an insult that dis/missed the particularly concentrated destruction soon to come. Over the next forty-eight hours, cyclone Debbie arced inland before returning to the Pacific Ocean just shy of the state capital of Brisbane, some seven hundred miles south of landfall. Unprecedented riverine and flash flooding coursed through the region's catchments in the days that followed.[1] What kind of happening was this?

Cyclones have long seamed the fabric of life in Australia's tropics, where it can sometimes feel like the danger they bring is less total collapse than a distressing but surmountable test. Such is how I encountered "cyclone season" in the course of annual safety

[1] As is typical for very big storms, Cyclone Debbie was extensively chronicled by domestic, international, and social media (e.g., Bec and Becken 2021; Caldwell 2017; Ritchie-Tyo 2017; J. Williams 2017). It was the subject of numerous government reports (e.g., Australian Government Bureau of Meteorology 2018; Australian Institute for Disaster Resilience n.d.).

inductions at the Institute in Townsville, required of all long-term visitors. Cyclones had their time, place, and corresponding training protocols just as they do in ordinary life. Such is why residents know to ready for landfall by securing property, rallying with neighbors to dispose sandbags around public infrastructure, packing essentials in case of evacuation, or keeping an eye and ear out for emergency communications. The enfolding of cyclones and their observation within cultural history is another way in which the tumult of their event can appear remarkably ordinary after the fact. Consider the frequently asked question of why, the world over, cyclones, also known as hurricanes and typhoons, are given the names of people. The answer usually points back to the idiosyncratic and somewhat imperious practice of 19th century colonial meteorologist Clement Wragge who, from his Queensland weather station and via a newsletter, named weather formations after the gods he read about, the women he imagined fancying and the politicians he reproved (Spicer 2016). But the practice achieved mainstream appeal after American novelist George R. Stewart published the 1941 novel *Storm* whose protagonist oscillates between an unnamed "junior meteorologist" and the cyclone itself. Possessed with "fatherly feeling," the one christens the other "Maria" in the course of observation—a God trick to which the reader is a party as the storm disperses a plague of locusts, lifts a drought, causes a flood, and disrupts national infrastructure. The novel's runaway success, and its popularity among enlisted US Navy weathermen, is credited with inspiring the naming convention still in service, albeit gender neutral and multilingual since the 1970s.[2]

[2] Meteorologists have long argued that giving cyclones short, recognizable names eases communication among global weather services and with the general public (see Smith 1990). From the 1940s, the global convention was to use more-or-less typical European women's names. The practice had sentimental aspirations at times, as when US Navy weathermen gave storms the names of their wives and girlfriends. But because a storm earns notoriety from its destructiveness, the practice dispensed gendered indignity and drew public protest. It stuck, however, until the 1970s when a number of regional meteorological associations pressed the issue. When it was clear the convention of exclusively feminized naming was untenable, one politician, Australian science minister William Harrison, took the moral high ground during a 1975 session of parliament and announced: "I think that both sexes should bear the odium of the devastation caused by cyclones." That odium is, sometimes, especially burdensome. The names of

Becoming familiar with cyclones is no matter of simple enjoyment; learning the techniques of mind and body germane to their regular encounter does not dispense with fear, even terror. To suggest otherwise would not only overlook the many creative uses of negative anticipation, it would also be obscene. Disasters, natural, technical, or naturaltechnical, are a collective trauma, the effects of which break unevenly and amplify prevailing vulnerabilities in the short and long-term (Hoffman and Oliver-Smith 2002). In the case of global ocean modelling, moreover, the sensory arrays and epistemic assumptions that guide detection skew heavily towards the Northern hemisphere, which builds translation errors into the very act of forecasting and therefore disaster exposure (Helmreich 2014). Moreover, cyclone encounters can be written from multiple angles, creating opportunities for acts of historical silencing and moral confusion. In early 2016, for instance, Cyclone Winston crossed into the Reef basin and brought down temperatures enough to spare vast tracts of coral from heat shock and bleaching in what some scientists referred to as an act of "rescue." Days earlier, however, it had been the strongest cyclone to make landfall in Fiji's history, killing forty-four people and destroying the homes of over 130,000 people.

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As historical subjects, cyclones are one and many, singular and recurrent, eventful and cyclical. Their seasonality makes them available, however partially, to epistemic scrutiny, retrospective narrativization, and habits of anticipation. Familiarity can sponsor something like confidence, which is to say the expectation of getting through it, for better and for worse.[3] What this draws

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cyclones that occasion extensive loss of life become taboo, withdrawn from subsequent use. Maria, the name of Stewart's fictional cyclone from 1941, was retired in 2017 after Hurricane Maria became the deadliest Atlantic storm this century, devastating Dominica, Saint Croix, Puerto Rico and the Caribbean.

[3] As Sianne Ngai explains, there is a conspicuous publicity to confidence, it can function as a circulating currency of trustworthiness without that trust ever being felt with certainty: "The world of [*The Confidence Man*'s] story *runs on a feeling that no one actually feels.* More specifically, the world is run by a feeling (confidence, trust) that no one in the novel can verify or publicly prove he possesses, *even* with aid of tokens (money, vouchers, receipts) that are

into view is a distinctively split form of anticipation: the tense wait. There is what to do before the cyclone comes and what to do after it is gone. There is pre-cyclone reasoning and post-cyclone reasoning, both of which are tensed in relation to the "not yet happening" of the eventfulness of the cyclone itself. In both instances, the thinking and the actions to which such thinking corresponds are disaster-bound, future-oriented, and mutually-informing. Writing of another disaster form, earthquakes and the fear they occasion, historian Deborah Coen speaks to this anticipatory habituation as follows: "Nineteenth-century seismology effectively distinguished between a background fear of *earthquakes*, and a situational fear *in an earthquake*, such that the former partly determined the latter" (2018, 126). The tensing I am trying to catch is slightly different from Coen's in that it presumes an afterwards. The presumption of such an afterwards is one of the ways that disaster acquires an eventfulness that can dis/miss more "durative" forms of catastrophe.[4]

There is, in ordinary language, a shorthand for these two anticipatory forms: preparation and recovery.[5] I prepare a meal for serving, a speech for delivering, a form for filing, a wound for dressing, or a body for burying. I prepare myself or another for going through some ordeal, like receiving bad news, speaking in public, meeting the parents, etc. Conversely, I can recover my composure, my health, my dignity, my position in society as well as my house, my investment, my losses. "To prepare" extends the domain of application of "to pare," i.e., cutting, peeling or trimming a fabric, fruit, or bush and so readying it for use. "To recover" harkens back

essentially abstractions of that unfelt 'confidence,' and whose values presuppose and depend on it" (2005, 69, emphasis in original).

[4] To the blinding effects of eventfulness, here is Povinelli: "Whether aggregated into a project or remaining in the diffused background of everyday life, these quasi-events rarely appear to be catastrophic in the ordinary sense of the word. They are not, for instance, the kind of event that riveted the United States in the wake of Hurricane Katrina. The engine is not the ceiling of the New Orleans Superdome. It is not a modernist wonder—the largest fixed-dome stadium in the world—whose fragility in the face of a natural event transformed a catastrophe into a sublime event and intensified an ethical demand that even a president couldn't simply fly over" (Povinelli 2011, 133).

[5] As elsewhere in this chapter, I mark these terms with a slash to emphasize their interdependency.

to the now obsolete use of "to cover" as another verb for "to get." This sense of recovery as the successful return of something once got and now lost explains its established use within healing and legal practices, as in tort law when one party sues another to get something back (and get back at someone else while they're at it). Why the semantic detour? First, it is a way of appreciating why preparation and recovery might coil around one another when another cyclone looms. Cyclones bring danger, trauma, loss, which I can work to prepare *for* and recover *from*, although distinguishing between the two is no straightforward matter.[6] Second, it shows how ordinary and capacious these two concepts are, and so how ready-at-hand they are when we find ourselves trying to imagine (and trying not to imagine) what a coming disaster requires of us. Thirdly, when taken together, the disorienting interdependency and ready availability of these concepts helps us to appreciate why technopolitical expertise might organize itself around putting some order into, even trying to monopolize, the techniques and norms of "preparedness and recovery."

"Disaster management." This field's very name, if not its existence, asserts, a unity that sublimates the tension of waiting upon which it works by parsing its tense, separating the before and after, and thereby stabilizing the eventfulness of disaster. Perhaps, more accurately, rather than sublimating preparation/recovery, it offers a substitute: disaster/management. [7] Disaster

[6] I can appreciate that getting ready for something, getting through it, and getting over it are connected, but that does not mean that it is clear to me when or how they will connect.

[7] As opposed to "preparation," "readiness" and "preparedness" are terms of military science. They were transposed to disaster management after World War II and the subject they designated dramatically expanded accordingly (from, e.g., military personnel and materiel to, e.g., national transportation grids, city utilities, emergency administrative measures, sense of civic duty) (See Collier and Lakoff 2021). To rephrase my remarks from the introduction, disaster science can be traced to a historical period when the possibility of a secular eschaton, apocalypse by design in the form of mutually assured nuclear destruction, inspired an understanding of political power and technoscientific action as, potentially, capable of bringing history itself to an end. There would be more to be said about the genealogy of disaster management, its relationship to cybernetics, shock as dis/regulating, and recovery as an entitlement to recuperate losses. I will hold off for now though, lest my attention begin to hover unevenly.

management binds a disordering force (disaster) to an ordering one (management), which announces the production and enforcement of norms, call this "disaster normalcy." And yet, as I have been suggesting, while there may be a body of expertise scaffolded upon habituation to preparation/recovery, it has no monopoly thereon. The ordinary force of these concepts exceeds the authority of experts and institutions even as they draw upon it. An example, by now familiar, can be found in the chaos born of the will to know the nosology of COVID-19 during the ongoing global pandemic. Authorities official and unofficial, certified and self-appointed endlessly produce and dispute measures of preparation and recovery in what has become a defining feature of the churn of communal life amidst the pandemic's cascading waves.[8] But there are countless less dramatic versions of this confusion over whether something decisive is about to or has already happened, as when I join a group waiting at the bus stop until it swells to the point where one of us realizes that the last bus has already gone.

Cyclones, pandemics, wars, revolutions, holidays, pilgrimages, world cups, bus trips… These are examples, more or less terrifying and more or less ritualized, of norms in action and therefore under pressure. Durkheim's famous coinage "collective effervescence" refers to the dis/orienting psychopolitical energy unleashed in such moments, when the lifting of standing norms creates an opening, at once alluring and repulsive, for re/creating the ties that bind. [9] To

[8] Anthropologist Carlo Caduff, who spent a decade studying pandemic preparedness before the outbreak of COVID-19, underscores how paradoxical this turn of events might appear: "What this pandemic shows is a lack of preparedness. This will come as a surprise, given the billions of dollars, euros, and pounds that were spent over the last 15 years on pandemic preparedness, including experience with past epidemics and pandemics such as Ebola and swine flu. How can it be that hospitals ran out of N95 masks in week one? Where did all the billions spent on preparedness go? … Fifteen years of pandemic preparedness seem to have evaporated into thin air in this pandemic" (Caduff 2020, 479). COVID-19 and cyclones may seem a world away, but Caduff's question encouraged me to see the problem of "disaster normalcy" in new light. As with all disasters, there are other questions for anthropology that COVID-19 raises, i.e., the power asymmetries and historical injustices that preparedness/recovery exacerbates (cf. Manderson, Burke, and Wahlberg 2021).
[9] For a précis on the pyschophysics of collective effervescence and the broader grammar of mass affect, see Mazzarella (2017).

rephrase then, disaster normalcy is born impatient and deflects scrutiny by shifting from preparedness to recovery when its norms tremble, as all norms must. Disaster management is possessed, so to speak, by the will to prepare for recovery. What this means is that its allure may lie less in the power it *brings back* when disaster strikes than the powerlessness it appears to *take away*, namely, the bewilderment of getting lost between onset and aftermath, in extremis and beyond normalcy, knowing not what to do.

2. The Climate Tantrum and the Angry Summer

One hallmark of a distressed earth is the rising frequency of increasingly intense tropical cyclones: As sea surface temperatures increase, so does the supply of warm, moist air that, literally, fuels tropical cyclones; rising sea levels enable greater storm surges; cyclones retain greater force at landfall owing to the progressive degradation of natural breakwaters—such as coral reefs.[10] What happens when disaster's norms begin to tremble? When preparedness (knowing what to do to prepare *for* disaster) and recovery (knowing what to do to recover *from* disaster) are not just split, but increasingly difficult to distinguish? When disaster defies management? The litany of broken records that Cyclone Debbie left in its wake is a disaster of disaster normativity.

As moral technologies and distinctly human creations, norms are inherently unstable and require constant shoring up. Indeed, this volatility, this insecurity within the norm, is one reason

[10] Tropical cyclones, also referred to as hurricanes and typhoons, are rainstorms driven by strong rotating winds around a low-pressure center. They form when prevailing atmospheric conditions combine with large areas of warm surface air. Typically, this happens at sea, especially in the tropics. A low-pressure area can rapidly drop when it forms over an area of warm, moist air. The warm, moist air rises to fill the low-pressure area, drawing more warm, moist air in, which drops the pressure further. The cycle continues; the air pulled in accelerates; the result is cyclonic winds in their distinctive vortex shape. The low-pressure center becomes the eye of the cyclone and the moisture in the air drawn in forms dense, expanding rain clouds (Cheal et al. 2017; Knutson et al. 2010; 2019; Kossin et al. 2020; Murakami et al. 2017).

that extraordinary violence can be done in their name (Foucault 2003; Butler 1995). Pride is way of passing comment on normativity and shame is a technique of normalization. The expectation of recovering from a cyclone can foster anticipatory actions that swell with pride. Anticipation splits and tension sets in: prepare to wait or await recovery? Even settling on an answer can feel like an achievement worth broadcasting: in the grip of crisis, your anxiety is never yours alone, your busyness is everyone's business. But because such actions come before landfall, because they come before the reality of disaster hitting, because they seem to resolve the tense wait of split anticipation—and seeming is enough—they can appear misguided and so invite shame. "Just look at them, too busy focusing on tomorrow to plan for the day ahead!"[11]

Here is an ordinary example of pride in powerlessness. In the town of Bowen on the eve of Cyclone Debbie's crossing, Graham Wilson sought to reassure his neighbors (and surely himself) of the recovery to come. When no one was watching, he grabbed two cans of spray-paint and scrawled a triumphalist taunt on the fence surrounding his home: "CYCLONE DEBBIE BRING IT ON" (Figure 48). The idea of dispelling the town's anxiety in this way, he told reporters, came to him in the dead of the night: "Let's break the ice and put a little humor into this." Perhaps the humor lay in turning domestic decorum on its head, or in making a sporting contest of the coming storm, or in relaying a vain desire to scream into the wind. It seems, also, to be an act of settler magical thinking that sacrifices the polite authority of Wilson's white picket fence the better to broadcast its, his power. Two days later, with Bowen largely spared, he changed the message: "Cyclone Debbie: 0 Final Score Bowen: 1." What was a toss-up became a binary outcome, the contest settled.

[11] A familiar version of this is the outrage directed towards anyone seen refusing to evacuate, which dismisses the fact that each and every person will have different reasons for staying somewhere including, for many, wanting to leave but having no way to get going or nowhere to arrive (Gemenne 2010).

Figure 48. Graham Wilson turned his fence into a banner in the days before Cyclone Debbie made landfall, broadcasting his sense of (in)security in the prospect of getting over the storm. (Source: "Cyclone Debbie – Bring it On," *The Age & Sydney Morning Herald*, March 16, 2017, https://youtu.be/B8ot8gD6kX8)

The humor was a distraction. Cyclone Debbie prompted tens of thousands of residents to evacuate, hundreds of thousands more experienced power outages, four hundred schools shut down, and major transportation links were severed, including the federal highway, regional airports, rail lines and seaports. Fourteen people died. The storm disturbed over a quarter of the coral cover of the Great Barrier Reef, which was still reeling from the 2015-16 mass bleaching event. A government monitoring team found near total destruction on many of the reefs they surveyed. The team's leader, Angus Thompson, told reporters that some reefs would take a decade to recover (McLeish 2017; Thompson et al. 2017). By transposing a spatial disturbance in historical time, that projection makes the setback to coral growth and reef formation feel tractable: what the storm destroyed in days, corals will grow back over ten years. The labor and patience involved seem almost epic.[12] At the same time, the force of this transposition presumes Cyclone Debbie is an event isolated in historical time rather than one extreme in a sequence of extremes to come. It presumes to know what corals have to do to recover *as if* corals did not also have to prepare for another cyclone. The point is, while the report is grave and even devastating, it heeds the terms of disaster normalcy. But, if you consider that all decades to come will know storms that strain the powers of human survey and coral integrity, then the foreseeable future itself becomes disastrous. The force of Thompson's transposition, perhaps even the report itself, gives way and something like confusion sets in: What can I work towards that won't get constantly swept away? What can corals wait for that won't be endlessly withheld?

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Over the years, climate scientists have often distinguished climatology and meteorology as two related but distinct fields of inquiry. Broadly speaking, the one explains atmospheric interactions across deep time at the whole earth scale, the canonical expression of which is the generalized multivariate climate scenario, whereas the other explains, often with extreme precision, the physical principles by which particular climate conditions beget particular weather formations (Edwards 2009). Put differently, the weather is climate brought down to earth. Accordingly, proponents and detractors of the claim that earth distress is happening and therefore warrants a historical reset of global society appeal to variations in the weather as supporting evidence in their long-running dispute. One example is an annual weather report released at the height of Cyclone Debbie's onslaught by leading Australian climate science non-profit, the Climate

[12] "Any kind of narrative, including the ubiquitous modes of myth and folktale, will develop the arts of storytelling. What determines that storytelling leads in the direction of the epic is the emergence of a certain idea, the idea of heroic action" (Hainsworth 1991, 10).

Council.[13] It coins an expression for this new disaster-prone present, the "Angry Summer" (Steffen et al. 2017). The report highlights why the general condition of earth distress gave rise to the particular weather events that marked the past year. From the projective perspective of climate science what that means is that next year the weather will get worse, more extreme, i.e., angrier and angrier.[14]

The emotion loaded onto the expression "angry summer" may come across as unscientific, yet only if we take a narrow view of science and scientists as dispassionate about their objects.[15] But there is more to say. Anger recalls the ascription of moral significance to the order of nature, as discussed in the previous chapter with reference to historian and philosopher of science Lorraine Daston's *Against Nature* (2019), a précis on North Atlantic traditions of popular and learned natural/moral history. To recall, Daston distinguishes three orders of nature

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[13] In 2011, the Australian federal government, then led by the progressive Labor party who had returned to power promising to implement a strong climate action policy after twelve years in opposition, formed an official independent advisory body called the Climate Commission. The commission was led by conservationist and media commentator Tim Flannery, with other members drawn from climate science, engineering, conservation biology, and business. After the 2013 federal election, the conservative Liberal party returned to power and disbanded the commission, directing the Bureau of Meteorology to provide climate change advice instead. Public outrage ensued and the Climate Council re-launched thanks to a crowdsourcing campaign. Its "team of experts" expanded from six to twenty members, adding practitioners credentialed in normative dispensations of economics, law, political science, and public health.

[14] The organization released a report titled "The Angriest Summer" to refer to the summer of 2018/19, which noted that previous Angry Summers include 2012/13, 2013/14 and 2015/16. It referred to the summer of 2019/20 as "The Crisis Summer." The Climate Council (and the reporters that relay their findings) are quick to use expressions like "extremes are the new normal," a version the expression anthropologists of crisis locate within the repertoire of disaster management (cf. Masco 2014; Collier and Lakoff 2021). One point of convergence among these actors is their commitment not only to the functioning of liberal institutions but to systems thinking as a way of planning for exogenic disturbance (aka "shock" or "stress") as a heuristic that might destabilize the research subject but not the researchers themselves.

[15] I made the point at the outset of this dissertation that the move to reclaim the emotional life of scientists, for better and for worse, from the normative picture of science as mechanically objective has been foundational to the history and philosophy of science (Feyerabend 2010; Fleck 2008; Kuhn 2012; Haraway 1989; Harding 1995; Stengers 2010; Traweek 1992). It was thanks to feminist science and technology scholars, however, that I first came into this understanding. The way epistemic authority is persistently predicated upon normative exclusions may be why I remain convinced that the moral and political struggle over the emotional stakes of knowledge/power persists no matter the obviousness of the statement that science is not monolithic nor are scientists dispassionate. Besides, social scientists are not immune from the narrow understanding of objectivity either. In the second edition of an anthology of anthropological studies of natural disaster, the editors defended their original title against criticisms of irrational projection. That title? *The Angry Earth* (Oliver-Smith, Hoffman, and Hoffman 2019).

and their corresponding natural/moral imaginaries: specific natures and taxonomy/monstrosity; local natures and balance/disequilibria; universal natural laws and uniformity/anomaly. Daston speculates that people produce and enforce their own moral norms by drawing on the order of nature because, on the one hand, it is something outside of us and therefore available to interactive mediation and, on the other, its variations are more durable, so to speak, than our own. Daston situates fires, floods, earthquakes and cyclones as typical expressions of local disorder, namely, dramatic and even devastating yet ultimately transient interruptions to the surrounding landscape. They can yet need not be understood as evidence of malevolence. Because this imputation of intended harm, even of revenge, is a moral escalation that does not arise without cause, namely, an intimation of "human complicity in the disaster, even if no one deliberately willed the devastation" (Daston 2019, 20). Because of this, (natural) disorder invites a (moral) reckoning, whose success coincides with a return to equilibrium, to an untroubled landscape. Within the pages of "Angry Summer 2016/17," there is such a charge of complicity.

For the Climate Council, summer is not merely extreme, i.e., dangerous in a nonmoral sense, it is extremely angry. The cause of this state of affairs is a continued global reliance on fossil fuels and the Australian government's own "failing" climate policy (Steffen et al. 2017, 11). When viewed as a discernible disequilibrium in the energy market, earth distress becomes a local disorder with global dimensions. This form of explanation reflects the report's authors' affiliation with Earth Systems Science. Indeed, it is following a passing reference to this very disciplinary formation that Daston anticipates the possibility that local (dis)orders of nature could scale to the whole earth.[16] Earth Systems Science describes the planet as a hypercomplex system

[16] Daston cites atmospheric chemist James Lovelock and author of the Gaia hypothesis: "Even proponents of the Gaia hypothesis, which envisions the Earth as a living organism, quickly admit that it is not 'alive in any sentient way, or even alive like an animal or bacterium.' Rather, vengeful nature is a self-regulating system, like a thermostat or the governor of a Watt steam engine." (Daston 2019, 19–20) By recalling Gaia theory's grounds in closed-

operating within a set of boundaries or thresholds that could, under sufficient pressure, cede to devastating shocks and so dramatically change state. Despite finding that a number of these boundaries have, in fact, already been exceeded, many Earth Systems Scientists continue, in a sense, to appeal to publics and political actors in the register of disaster preparation.[17] And yet, there are implications in the Climate Council's report that strain this grammar of global systems and local stressors.

An angry summer is not reducible to the set of extreme weather events that draw it into view but is *its own kind of natural entity*. By entity I do not mean a creature such as a platypus or a lichen or a coral or a woman named Gaia or Debbie—which would throw us back on specific nature, Daston's first regime of natural/moral disturbance. No, the anger in question courses through seasonality itself, whose combination of internal variation and sequenced constancy ground metaphysical categories such as time, cause and change (Durkheim 1995). Under this description, the problem shifts orders in the other direction: it is not (only) a local disequilibrium projected on the whole earth scale but rather (also) a generalized disturbance within what Daston calls "universal natural law," which is to say within ideas of what is possible and impossible, permissible and impermissible. In the North Atlantic tradition of which Daston writes, "the order of natural laws became a secular metaphysics during the Enlightenment, despite its origins in the theology of a completely free divine will that imposed—and in principle also occasionally revoked—its dictates on the entire universe" (2019, 31). The norms of nature, in other words,

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systems cybernetics, Lovelock via Daston is cautioning against imputing a more metaphysically open-ended idea of nature to the theory, which caution, incidentally, is intended for critics and enthusiasts alike.

[17] The lead author on the "Angry Summer" reports is Will Steffen, a member of the original group and a noted climate scientist. Through published research and institution-building, Steffen has made major contributions to the field of Earth Systems Science and the launch of the Anthropocene concept. The Anthropocene's contestability is well established and addressed elsewhere in this dissertation. Earth Systems Science, however, has received precious little critical scrutiny despite being the description of planetary change upon which the Anthropocene concept is scaffolded. While this chapter gestures towards such scrutiny, by connecting Earth Systems Science to the psychotechnics of disaster management, it is not a full critique. For an inquiry of this order, see Hu (2022).

may be becoming as unstable as our own, which raises a question: if the concept of the law falls into question, what are the grounds for moral reasoning?[18] The Climate Council report coincided with Cyclone Debbie, which formed at the tail-end of the typical "cyclone season." The fact that the timing of the report's release meant it did not include the cyclone is not (only) a case study gone begging but (also) further evidence that it is now predictably unpredictable whether the historical present calls for preparation or recovery.

This same perspective can be cast on another report of summer anger, when Graham Wilson de/faced his home. Speaking to reporters, Wilson rests one arm casually on the fence.[19] The wind shakes the palm trees behind him, muffles the microphone's pick-up, and whips around the Australian flag hoisted in the backyard. "There's a lot of anxiety in town," he says, his tone calm, genial, confident verging on condescending:

> "People are concerned. People haven't been through a cyclone this size before. Anybody over sixty has, our last cyclone that was this big was in '58, ahh 1958. So, I just, at 2 o'clock this morning got out of bed and thought 'let's break the ice and put a bit of humor into this.' It's a tough little town. It'll actually get better for it in the long run, it won't hurt the town."

These are familiar deflationary gestures: an appeal to prior weather events so as to normalize the present extremity and stabilize "cyclone season"; an appeal to the wisdom of age, place and the prepossession that comes with, literally, being weaned on the extreme; an appeal to the virtue of trauma as the engine of triumph. The camera turns the corner where the "icebreaker" carries onto another stretch of fence. With casual misogyny, the words reach for and batten down another

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[18] Again, it is worth underlining that Daston appreciates this possibility: "Natural orders are, in effect, more orderly than human orders, which may offer a clue as to why natural orders are invoked to buttress human orders and not vice versa. *In an age of genetic engineering and anthropogenic climate change this imbalance of power may be shifting in the opposite direction*" (Daston 2019, 69, emphasis mine). To the best of my knowledge, she has not pursued this line of inquiry further. It does, however, seem worth noting that power is what's at stake in the struggle over whether dis/ordered nature or engineering grounds normativity.

[19] The short interview with Wilson can be found on YouTube (The Age & Sydney Morning Herald 2017). The images of Wilson's fence if not his explanation circulated through global wire services, extending the small town "icebreaker" to audiences as far afield as New York City (Reuters 2017).

norm: “Bowen is not a pussy town. Do your best you got.”[20] He then lists the steps he has taken to prepare (showing the camera he’s already anticipated that form of anticipation) before heaping praise on his neighbors for doing the same. But then, what starts off as pride turns to bewilderment. “I have not seen this town so prepared, with people buying fuel, people buying food, which I’ve never seen in cyclones as, as, so more, ahh, full on, before.” In trying to bring his sentence to a close, his composure wavers and words fail him. This is what Freud calls a slip or a parapraxis, a mistaken action that arises in moments of everyday disaster as a subject acts out what they cannot not do. It is the shadow of a doubt that flickers as Wilson realizes that his “tough little town” is preparing in a way that suggests that maybe, just maybe, there is nothing normal about Cyclone Debbie. The man spray-painting his fence with fighting words is not (only) compelling moral community with his neighbors but (also) going to pieces, losing it at night to keep it together in the morning, betting the house on recovery because preparation is a losing game. It’s a joke and a tantrum and a joke about tantrums that meets the possibility of a lawless world with enraged frustration instead of sorrow.[21]

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[20] Philosopher Kate Manne argues that a “naïve conception” of misogyny as hatred of women in a generic sense makes it hard to subject the social lives and afterlives of misogyny to political scrutiny, because it narrowly presumes that particular expressions of misogyny point back to an underlying psychological aversion to women. Manne’s “ameliorative conception” defines misogyny (particularly in US, Canadian, and Australian white middle-class contexts) as a formation that invokes and works to uphold norms of feminine subordination and masculine dominance. Manne’s definition allows for an appreciation of misogyny as a disastrously de/stabilizing force under conditions of perceived wounded masculinity: “In view of some women’s social roles in a patriarchal culture as men’s attentive, loving subordinates, this suggests one obvious possibility to consider. A woman’s perceived resistance to or violation of the norms and expectations that govern these social roles would naturally tend to provoke just these kinds of reactions. What could be a more natural basis for hostility and aggression than defection from the role of an attentive, loving subordinate? This could be expected to leave some of the characteristic beneficiaries of gender (viz., men) feeling both usurped and neglected. And, emotionally speaking, this combination could be disastrous” (Manne 2017, 49–50).

[21] I am thinking with Adam Phillips’ (2013) essay on tantrums and their uses. Among other things, this text introduced me to the notion of “converting trauma into triumph,” which Phillips borrows (critically) from psychoanalyst Robert Stoller. In brief, Phillips redescribes the tantrum as “the magical act of a desperate person” whose frustration swells before an object they have not but cannot but want, which risks tipping over into destructive rage. The characters in this drama are parent and child, whose roles oscillate whenever the one responds to the other’s frustration in kind. I am trying to show that these same dynamics work over the dyads of resident and town, man and nature, Graham and Debbie.

3. Spilt Coal and the Engineered Miracle

Months after Cyclone Debbie's crossing, the Queensland government reported damages of over AUD$3.5 billion, which, at time of writing and compared with Cyclone Yasi in 2011, makes it the second costliest storm in the state's history. The bill was split three ways between residential and commercial losses recorded in insurance claims (AUD$1.7 billion), crop damages (AUD$1billion), and lost coal export revenues (AUD$1.5 billion). Twenty-two mines stopped production due to broken supply lines.[22] The damages bill is a perverse expression of a common refrain among ordinary Queenslanders and the government agencies who speak in their name, which is that extreme weather leaves a powerful sense of togetherness in its wake. On paper, the tourism, agriculture, and coal industries are fellow economic victims with a shared stake in recovery whereas, in reality, their day-to-day activities put them at odds with one another. You do not take a trip to Queensland to mine coal or plant the next harvest. You do not mine coal without draining water from arable farmland. You do not tend to the agricultural hinterland without ignoring visitors to the booming coastal vacationland.[23] Adding to these tensions, however, is the fact that these same three industries often stand accused of harming the Reef and by extension the planet, making earth distress worse and therefore intensifying the next cyclone.

[22] The figures for this damage assessment can be found in government reports (Office of the Inspector-General Emergency Management 2017), insurance industry assessments (PERILS 2018), and economic analysis (Lenzen et al. 2019). In the classic move of renewal through disaster, all texts acknowledge the cyclone's devastation while using it as a heuristic opportunity. Indeed, the insurance industry plays a pivotal role in disaster normativity. Today, it does not simply consume climate data but is increasingly producing and distributing it.

[23] The purpose of drawing these distinctions is to appreciate the stark tensions that divide the region and which, every day, people negotiate in some kind of way. The fact that there are many subject positions that work across this divide (e.g., fly-in-fly-out mine workers who work ten days on/four days off; backpackers on working holiday visas who pick fruit to tour the Reef or, as is often the case, who work in the tourism industry in exchange for room & board; farmers who transform their properties into eco-resorts) does not resolve this tension as a political problem. It does, however, allow political actors to invoke cross-industry entrepreneurialism. Thanks to such craven redescriptions of any expression of need as a problem of moral psychology, the politics of redistribution disappear, and capital consolidates its contradictions.

The damages bill stabilizes such tensions, as the demands of recovery transform relations among people into relations among repayments.

My point is not that recovery is easy and cost-free. I am simply trying to slow down and catch a shift in perspective that happens when the premium placed upon orderly recovery obscures the disorderly politics that disastrousness brings to the fore. The Queensland Inspector-General's "Cyclone Debbie Review" puts this on display, detailing the "lessons for delivering value and confidence through trust and empowerment" that the storm deposited. It is, so to speak, textbook disaster management in which one cyclone becomes a retrospective heuristic to better prepare for the next. The weather system tests the disaster management system but vindicates it too. The word "system" occurs 224 times in the 140-page report. It is often capitalized with reference to disaster management, although not systematically. Here is an example of that convention and the self-regulating logic of disaster management: "Building and maintaining community confidence and participation in the System, as public value changes over time is difficult. … As such, those operating within the disaster management system also need to accommodate changes in community expectations and community needs" (Office of the Inspector-General Emergency Management 2017, 37). Disaster management is immortal, if you will, ever-learning and ever-changing and ever-accommodating. Intensifying weather extremes are reducible to community "values" and "expectations," which the System takes in as inputs so as to stabilize the output experience of recovery. The interchangeability of event and response create a normalizing loop so committed to turning trauma into triumph that it even takes the cyclone's distinctive vortex shape as inspiration for its graphic identity (Figure 49). The report fashions an icon of the storm, its likeness flattened, smoothed, and fixed into a template for future action that defies its historically recent and action-defying inhuman power.

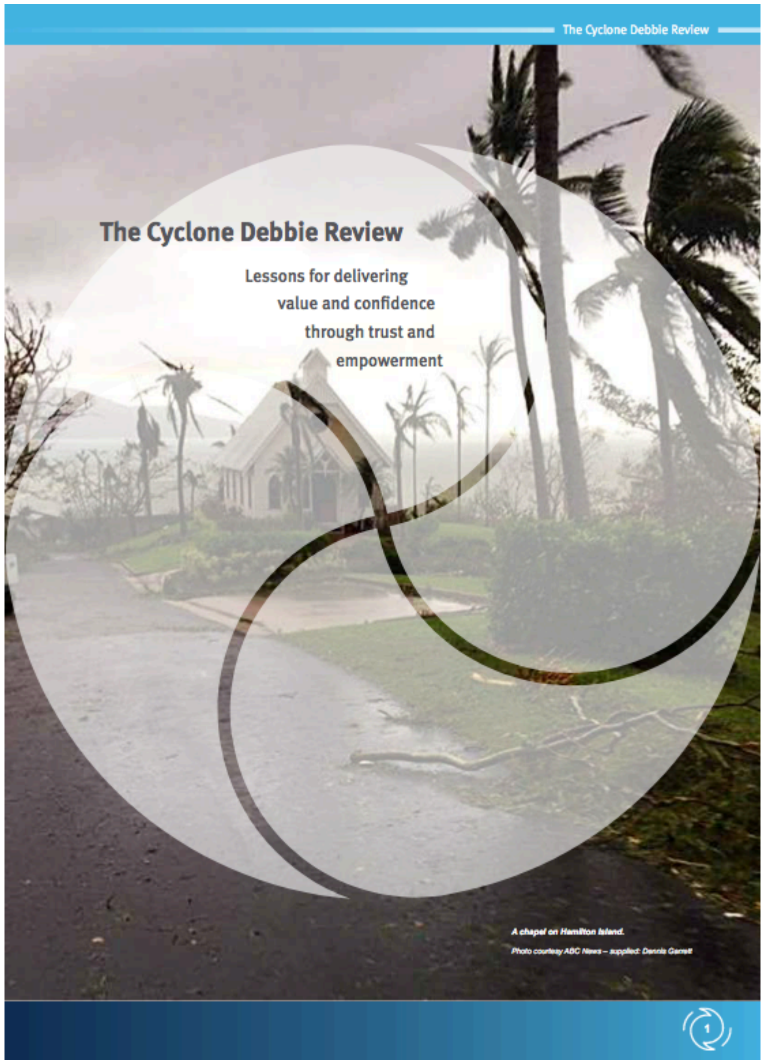

Figure 49. The cyclone form is transformed into an icon, suggesting an ability to if not prevent its effects than at least direct and control their application. (Source: Office of the Inspector-General Emergency Management, Queensland Government, CC 4.0)

After Cyclone Debbie the state government issued a fabulously defensive report, so what? Let's recall: first, expert authority has no monopoly on the tense wait before disaster, on the desire know how to distinguish preparation from recovery; second, earth distress is not (only) a local disorder of nature in need of equilibrating but (also) a disorder of universal nature where metaphysical anomalies secular or otherwise, chance, and lawlessness become possible, for better and for worse. With this in mind, I am suggesting that in trying to reassure constituents (and surely itself) that Queensland will not only keep getting back to normal but get better at it, the state government is trying to close the book on disaster ongoingness, which forces a narrow understanding of the trouble not only with nature but also moral and political reasoning, and, thereby, leaves its own authority exposed. To try and put the oscillation directly: as storms intensify, the stakes of preparation/recovery go up, so does the scope for solidarity and, at the same time, complicity. Moral confusion risks lapsing into lawlessness, yet an appeal to the law on the basis of disaster normalcy is overly narrow, historically regressive; no amount of graphic design can contain disastrousness tout court. A much-publicized legal battle in Cyclone Debbie's aftermath offers one example of a struggle over the force of the law under conditions of disaster normalcy. It involved a notorious port, ambivalently perpetrator and victim of climatic harm, and became a significant moment in the so-called "war of coral against coal."

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As landfall approached on March 27, the operators of the country's northernmost deep-water port grew worried. Located at Abbot Point just north of Bowen, the port is a remote, access-restricted facility dedicated to shipping coal. It lay within the cyclone's path. The operators knew that heavy rain could inundate its storage facilities and spill coal dust into the Great Barrier Reef basin and the Caley Valley Wetlands, a protected area directly adjacent to the site. They rushed to register a so-called Temporary Emissions License with the state government. This instrument would authorize, due to conditions unforeseen at the time of initial permitting, the discharge of water contaminated with higher concentrations of suspended solids (i.e., coal dust) than under normal operating conditions (i.e., 100 mg/L up from 30 mg/L).[24] The operators' fear proved

[24] "Coal dust" (also known as "coal fines") is a by-product of mining, handling, transporting, and processing coal. It is, in essence, a powdered form of coal that produced by friction, hence its ubiquity in the production process. Coal dust is a well-known industrial hazard, especially in its airborne form as the agent responsible both for chronic human injury and fatality ("black lung") and mine collapses and explosions (in sufficient quantities, coal dust

Figure 50. The satellite image obtained by Mackay Conservation Group shows the familiar form of environmental catastrophe, the fossil fuel slick (Source: Queensland Department of Natural Resources)

warranted. Satellite imagery captured in the days following showed a massive slick of coal-saturated water oozing from the port facilities into the wetlands (Figure 50). One water sample the operators took on March 30, the last day the temporary authorization was in effect, showed that water with 806 mg/L of suspended solids was leeching into The Reef basin (Robertson 2017; Slezak 2018).

Cyclones overwhelm the spatial barriers afforded by reefs, coastlines, riverbanks, rooftops, drywall, and containment facilities, and dramatically disclose the dynamic material conditions of settlement astride the sea. For a short window, as coal dust ebbed into the Pacific Ocean, this fact was visible as a disturbance in the landscape. It allowed conservationists a rare opportunity to bypass commercial restrictions on access and image-making to demonstrate the

becomes a volatilized explosive). The Australian Institute of Marine Science studied the contaminating effects of coal dust on reef organisms, which prompted a direction from the state government that Adani dump dredge spoil from the Abbot Point port expansion on land at not at sea.

vulnerability of the status quo to change. The Mackay Conservation Group, a small but proactive organization based in the region, procured the suggestive satellite images, which prompted larger national organizations to quickly commission drone and helicopter footage (Figure 51). This action formed part of a longstanding and loosely coordinated pressure campaign to halt the mining, burning, and selling of coal. To call this a push for "energy transition" would be too narrow. The point of the campaign is not just for Australia to do its part in balancing the planet's carbon budget (i.e., the why of Earth Systems Science) but to force Australia to publicly reckon with its history as a global resource depot (i.e., the why of transnational environmentalism). Abbot Point is a chapter in that history's making.

In 2011, India's third largest multinational conglomerate, the Adani Group, obtained an exclusive 99-year lease as sole operator of the Abbot Point port. Gautam Adani, the company founder and chair, told reporters at the time that "Abbot Point is our contribution to India's global ambitions" (Nicholson 2011). The port was a key piece of an infrastructure puzzle the

Figure 51. An image taken by helicopter some ten days later shows the persistent visual signature of industrial pollution (Source: Dean Sewell/Oculi, CC 2.0)

company needed to solve in order to develop the Carmichael Mine, then imagined as Australia's biggest coalmine with a footprint of 173 square miles and a projected yield of sixty megatons per year over sixty years. These volumes would raise Australia's coal exports by a third and require airport, rail, and port expansions that would encourage competing mining ventures in the largely unexploited Galilee Basin, estimated to hold over ten Carmichael Mines' worth of coal. Adani would recuperate costs from the infrastructure build by assessing charges and handling fees on the assets under its control, particularly the Abbot Point port.[25] In the years since, many of Adani's plans have been downgraded or simply axed, in part owing to a loosely coordinated and decade-long "Stop Adani" campaign. The organizing goal is to set a counterprecedent, namely, to pressure state and federal governments along with banking and logistics firms to distance themselves from the Carmichael Mine and thereby establish that fossil fuel development is politically, economically, and environmentally toxic.[26] The Abbot Point port was central to these efforts, as organizers continuously used it to show where coal kills coral, when reward turns to risk, and why action to "Stop Adani" is action to "Save The Reef" (Figure 52, Figure 53, Figure 54).

In response to public concern at the dramatic sight of coal pooling at the edge of The Reef in the aftermath of Cyclone Debbie, the Queensland state government ran a series of investigations into the Abbot Point port operations. Ultimately, it initiated legal proceedings. At issue was whether the spill constituted environmental harm as defined by the Temporary

[25] In 2020, four coal companies took legal action against Adani for charging A$255 million in excess of their annual user agreements. The court issued a A$106 million fine. Adani is considering its options for appeal (Ludlow 2020).
[26] See, for example: (Environmental Defenders Office n.d.; Goodell 2019; Holmes 2017; Ship Technology 2016)

Figure 52. A protest action organized in December 2016 in Townsville, on the occasion of the visit of company CEO Gautam Adani (Source: Natasha Mulhall, Stop Adani, CC 2.0)

Emissions License thresholds and whether the port operators were aware of this.[27] The assessment report into contamination of the wetlands found measures within authorized thresholds although emphasized an absence of reliable baseline measurements and variability at different testing locations. “Any impacts from the stormwater discharge,” the authors noted “were mitigated by the large amount of water flowing naturally through the wetland” (Queensland Department of Environment and Science 2017, i). The purifying water they are referring to—it took me a couple of passes to get this—is the very inundation the cyclone brought, which occasioned the overflow of coal dust and the need for the higher contamination thresholds to begin with. From the perspective of the aftermath, the cyclone did not (only) bring

[27] The most serious charge of wilful non-compliance was considered in 2018 and could have led to a fine of up to A$3.6 million. The case was only opened following the public release of emails exchanged during the cyclone between Adani and the Queensland. The Mackay Conservation Group obtained this correspondence through the Freedom of Information Act (FOIA). It took a year to approve the FOIA request because the Adani Group initiated legal proceedings argued the documents were commercially sensitive (Horn 2018).

Figure 53. An underwater "banner drop" staged by participants in a national day of action organized by the Australian branch of 350.org (Source: 350.org Australia, CC 2.0)

previously unforeseen environmental qua legal risk but (also) a previously unforeseen chance to insure against it; it turns out the wetland did not need judicial protection because it had climatic protection. The very boundaries the cyclone dissolved in practice resurface as the cyclone asserts a future anterior power of self-regulation. The state quietly closed the case in 2019. It is not clear why the company’s Reef basin reading of 806 mg/L was insufficient evidence to prosecute. It is possible that the Temporary Emissions License is simply impossible to enforce precisely because it applies in the moment of disaster when the law refuses to be found. Readings taken afterwards will be modulated by the passage of time and the moral imaginary of recovery that takes an absence of evidence to announce the return to nor mal. The cyclone ate my homework/My homework at the cyclone. No matter. The case that is no longer a case turns the disaster into an

Figure 54. A painting displayed in a community action organized in a park in Melbourne, roughly 1800 miles from Abbot Point (Source: John Englart, CC 2.0).

event that was a non-event. It is a picture of the lawlessness of disastrousness, in which the cyclone is made to shift aspects between engineering catastrophe and engineered miracle.

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Cyclone Debbie dramatically demonstrates the present damage that comes with living under conditions of earth distress. It also allowed conservation actors to seize upon the Abbot Point spill as an attack on the Reef to implicate the coal industry in fast and slow forms of violence. Yet in response, the Adani Group positioned itself as an infrastructure operator exposed as any other to disaster qua unforeseen circumstances.[28] With this, public pressure to challenge the port

[28] Disaster and pollution simpliciter draw environment into focus as a problem of knowledge and out of focus as a problem of political accountability. Responding to pollution is thus an occasion for actors in positions of epistemic authority to use would-be knowledge gaps to exercise power and rationalize environmental harm, often with lasting effects (Bond 2013; 2018; Bright 2016; Fortun 2001; Liboiron 2021).

operators' cyclone preparedness resolved with a decision about environmental harm given from the perspective of recovery. The slip—that it was Cyclone Debbie who did the preparing all along—deescalates any appeal to broader political and moral reasoning, stabilizes the equivalence of environmental law and the laws of nature, and dispels the shadow of lawlessness that earth distress casts over both.

The court proceedings indicate that disaster normativity in the form of the pollution threshold is all but incapable of tensing, sensing and acknowledging intimacy between coal and coral as a historical reality. This intimacy obtains not only as direct instances of local contact in the moment of the disaster, but in the myriad diffuse, invisible, and indirect forms of contact that limn the disastrousness of planetary scale combustion. The decision-non-decision ends with a promissory note to measure better next time: Adani agreed to install an AUD$100,000 real-time monitoring system at the discharge point of its coal storage ponds (Decena 2019). It is another expression of disaster normalcy as heuristic, although it does suggest an appetite to catch the direct and local version of disaster intimacy. Meanwhile, an online FAQ appending the state government timeline of its investigation emphasizes that images of the spill—which drove the backlash and still feature on the Adani Group's Wikipedia page—provide no reliable evidence of environmental harm. Here is the disclaimer:

> "Q: Why did the satellite imagery appear to show the wetland full of coal fines?
> A: It is difficult to draw conclusions as to the cause of the colour variation depicted in the imagery of the Caley Valley Wetland following Tropical Cyclone Debbie, due to the high variability of the wetland system and the imagery itself. The appearance of water bodies in remotely sensed imagery can be affected by several factors, including the depth and clarity of the water, the angle of the sun and the sensor when the image is captured. No conclusions regarding the condition of the wetland could be determined from this imagery and inspection of the site was required" (Queensland Department of Environment and Science 2017).

It is possible to read this note as a closing argument on the Abbot Point case, a thinly veiled expression of frustration on the part of the Queensland government, which was repeatedly and publicly pressured into taking legal action against a powerful multinational, and yet ended up unable to prove what everyone said they could see. There is a certain irony to the statement: because images can deceive, they are reliable grounds for convening an inspection. At the same time, what modulated the presence of coal dust was not the limitations of static, satellite imagery at grappling with the motion of light on water but the power of dynamic, torrential rain to disperse contaminants into the ocean. The frequently asked question about a frequently circulated image is not, really, a general question about the evidentiary status of photography before the law. Rather, it is a specific question about the self-evidently porous boundary between storage pond and wetland. From this perspective, the government's statement is less ironic than it is canny, a statement of the obvious that distracts from the persistence of immeasurable contamination. Is this gaslighting?

As Stanley Cavell contends, the genius of *Gaslight*, George Cukor's 1944 film to which we owe the expression, is not that it *points* to the psychology of manipulation by deception but that it *shows* us how, why, and that it works. From the minute the audience sits down, the lights dim, and the projector starts rolling, the viewer already knows, in their soul, so to speak, the reality of Paula/Bergman's situation—because they are experiencing a version of it themselves. Photography causes us, Cavell writes, "to see things that are absent: it makes things present to us to which we are not present. Hence I call film a moving image of skepticism. In viewing the film, we know ourselves to be in Paula's condition of victimization, in need of ratification, if so far without her bad luck—as if to be human is to be subject to the madness of skepticism." (Cavell 1996, 69). To be caught unawares, for Cavell, is not the same thing as to meet reality with skepticism awaiting vindication. The one acknowledges that my saying "I do not know" is no disaster, no act of self-denial, even though it may feel that way. The other insists on a threshold of shared certainty that, precisely because it flickers on approach, can, in the meantime, further entrench my skepticism. Of course images can deceive us. It is part of the modern condition that we encounter so much of reality through a screen obliquely. But that need not make them unreliable go-betweens for reasoning through the difficulties of reality—unless, that is, we adhere to a narrow, scientistic understanding of rationality as absolute certainty obtained in abstraction from the human condition (cf. Crary 2007; 2016). Cavell refuses such an understanding of rationality by waging that we might too. Why? Because he, the philosopher, plays at the armchair film critic only to show us that you, the reader, were always already an armchair film critic. Together, writer and reader let go of a craving for authority, re-enact the redescription of *Gaslight* as a film about film that is really about the shadow of doubt that hovers over our communal existence but need not deny its (e)motion, and, in the process, we rehearse a dialogue in self-understanding: Paula/Paula, film/audience, cinema/philosophy, author/reader, I/you.

So, once more, what makes the government's answer to the public's imagined question canny? It distracts from addressing a disagreement on the meaning of a particular image with an abstraction about images in general we can all agree with. We receive a lesson in what we already know about manipulation by deception, but no insight about how to go on with what we cannot unsee: the difficulty of a reality in which coal dust does not just evaporate into thin air but bleeds, immeasurably and ineluctably, out of the frame and onto the Reef.

Am I getting carried away? A cautionary note on imagery might be just that, a call for caution. At the same time, and once more, if you consider that all decades to come will know storms that strain the powers of chemical assay and reef integrity, then a call for caution is also a precaution against a broader politics of disastrousness. It is a defensive maneuver against a politics of environment that takes the Reef itself as its point of departure and arrival. In *Gaslight*, Gregory did not manipulate Paula at random or out of sheer malice; he preyed on her knack for imaginative projection as a trained artist, he craved the jewels she had inherited, and he abused of her desire for intimacy. The case against the Abbot Point Port was but one moment in the campaign to "Stop Adani" and "Save the Reef," whose organizers' claim to foster moral and political reasoning exceeds the bounds of environmental law. The government disclaimer can be read as a response to the movement and not just the case. By policing environmental harm as a crossed threshold in need of "ground truthing" by technical expertise, the politics of disaster can be reduced to optics and vice versa. On this basis, any appeal to authority that challenges the narrow rationality of disaster normativity can be pre-empted as a disaster of its own in the form of a partisan recruitment to lawlessness and delusion.

4. "I Think the Senator Needs a Lot More Than a Hanky."

On the eve of Cyclone Debbie's landfall, Adam Bandt, the lone Green Party representative in the lower chamber of Australia's federal parliament, released a statement on the country's appetite for coal. "The more coal we burn, the more intense extreme weather events like Cyclone Debbie will be. People will suffer," he warned. Government enthusiasm for coal was serving, he said, "to prop up a declining industry that's threatening our way of life." Joshua Frydenberg, the minister for the environment and energy and a rising star in the ruling conservative government, quickly countered: "The Greens are using Cyclone Debbie to score cheap political points at a time when lives and livelihoods are at risk. These claims are as unconscionable as they are hysterical. The Greens should be ashamed of themselves." He added that energy analysts predicted decades of reliance on coal and technology improvements that would lower emissions from combustion. "We shouldn't," he insisted, "be ruling out energy sources based on extreme ideology" (Bourke 2017). To make the case that coal combustion is morally bankrupt and exponentially harmful, Bandt established a continuity between the oncoming cyclone and the one coming after that. Frydenberg, conversely, stated that the only moral lesson a cyclone yields is what will be owed to the lives and industries in harm's way today. To suggest otherwise, to take a broader view of time, place and "our way of life" is amoral, delusional and extremist.

It is possible to explain this exchange, along with the resolution-nonresolution of the coal spill, as evidence of the state's regulatory capture owing to established financial and electoral interests in extractive industries among political parties and elites. Such investigations are vital for discerning complicities between the regulators and the regulated, which license turning nature into stuff as a matter of civic necessity. I am trying, however, to find a way of writing through this tangle that does not require taking at face value, so to speak, the authority of economic rationality that such criticism often presumes to discredit. I am trying, in fact, to understand how the very threat that earth distress presents to the normativity of economic rationality might rouse a sense of lawlessness that is stabilized by other, non-economic or non-rational means.

How the Carmichael Mine is taken up as a case, what it is deemed a *case of*, matters to the lessons it can yield and the norms it appeals to.[29] A recent article by historian of science Iain McCalman offers a compelling synthesis of how to make the case for using the mine as the foundation for environmental organizing without breaking from economic rationality. One line of reasoning he develops underscores the mine's threat from the perspective of planetary climate

[29] "To ask the question of what makes something a case, and nor merely a gestural instance, illustration, or example, is to query the adequacy of an object to bear the weight of an explanation worthy of attending to and taking a lesson from; the case is actuarial. It raises questions of precedent and futurity, of canons of contextualization, or narrative elucidation. This is what's disciplinary about the normativity of caseness" (Berlant 2007, 666).

science. With reference to promised export yields, he cites analysis from the Australian Marine Conservation Society to the effect that, when burnt, coal from the Carmichael Mine will yield "120 million tonnes of CO_2 per annum into the atmosphere, an amount greater than the annual emissions of over one hundred individual countries" (McCalman 2017, 10). The move, as geographers Connor Jolley and Lauren Rickards observe, is characteristic of a campaigning tactic whereby "the impact of the Adani mine is of global significance and extends beyond Australia's territorial confines, folding a remote site in western Queensland into planetary systems of climate and politics" (2020, 17). Yet the monumentality of these figures does not, strictly speaking, contradict the "opportunity," however perverse, that the mine represents within present-day global energy markets. In another line of argument, McCalman points out that the political refrain that extractive industries are drivers of "jobs and growth" is pure perception management directed at marginal electorates. It simply does not stack up against the Adani Group's own statements nor the prospect of industry automation, he underlines before adding, "against this, too, we also need to weight the potential loss of some 64,000 jobs in the tourist industry if the Reef was to perish" (10). As sounds as these arguments are, they seem to presume that "market forces" *should* make political sense, that, if divorced from craven short-term electoral interests or devoted to the cause of climate action, markets *can* stabilize political norms.[30]

This can be understood by highlighting one of the basic assumptions of market orthodoxy: under the model of perfect competition, economic actors maximize their utility

[30] Market Forces is the name of a major Australian climate non-profit often called upon to point out the misrepresentation of the economics of major development projects. To be clear, both this group and McCalman are nothing if not savvy critics of the double standards and outright complicities that bind state and corporate actors to climate inaction. McCalman also views the climate and economic case as just one among many reasons for questioning extractivism and defending the Reef, and it is far from the most important to him. I take up his paper precisely because it is a strong example of how stable, in the midst of ongoing disastrousness, the idea of a stabilizing climate/market system can be.

(broadly construed) by engaging in acts of exchange that, when taken together against the general background constant of the market, establish an equilibrium of outcomes. "All things being equal" is an expression that captures the notion of a dynamic equilibrium achieved against a general background constant. And one of economic theory's cannier moves, over the years, has been to willingly revise and update what counts as "all," "things," "being," and "equal" in order to bring model and reality into more perfect alignment without questioning whether they might, in fact, pull in wildly different directions (MacKenzie, Muniesa, and Siu 2007). A sense of this orthodoxy can help appreciate the appeal of placing earth distress under a market description in the hopes of influencing the behavior of political and corporate elites. You might call this holding technopolitical authorities to their own professed standards, or, calling out their hypocrisy, or, using their professed pride in economic rationality to shame them into taking responsibility for their bad action. Consider, though, how similar the language game of politics under a market description is to disaster under the description of systems theory in posing a problem of natural/moral dis/order as one of an identifiable, localized, disequilibrium. Does the problem of earth distress not show us that, decidedly, if there is one assumption we cannot take for granted it's that all things can ever be equal again?

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In a recent paper, political theorist Melissa Lane (2018) offers one way of appreciating the willful confusion of political and economic rationality under conditions of earth distress via a criticism of the so-called "problem of negligibility." This hypothetical imagines a situation in which my decision to do some helpful action A has a "negligible" or "imperceptible" effect in altering about some harmful collective outcome O, hence the general form of the problem: "why act when one's actions cannot make a meaningful difference?" The argument from negligibility often arises in debates over the difficulty of "scaling up" climate action, whether through so-called ethical consumerism or corporate divestment campaigns or national emissions reduction targets. It is a constant within discussions of the Carmichael Mine and the Stop Adani campaign more generally, where boosters explain that if corporations like the Adani Group do not get their coal from the Galilee Basin then it will simply find it elsewhere, thus making no difference to global carbon budgets and undermining Australia's economic advantage and political reputation on the global stage. As Lane explains, the problem of negligibility gains its force from, on the one hand, taking up the normative assumptions of rational-choice theory and consequentialist reasoning more generally, namely, that the point of any action, its why, is best evaluated in terms of its future effects and, at the same time, subordinating these theories of political action to market logics.

To cast another perspective on the Bandt-Frydenberg exchange and disaster normativity, I would like to emphasize two points from Lane's argument. The first is that "the problem of negligibility" places historical action under the description of the market model of perfect competition, which is to say an abstract understanding of life with others as the pursuit of a dynamic equilibrium against a general background constant. While theoretical, this background constant is held steady thanks to forward contracts on coal exports, or industry analysts projecting future demand, or geological surveys of billions of coal "awaiting" production in the Galilee Basin. Regardless of the fact that economic theory could further nuance this basic market model, Lane argues that to even entertain the analogy is dangerous because it denies the importance of uncertainty, interaction, and identity formation as the historically concrete conditions under which people act as they do and so set the fundamental conditions for politics.

> "A theory which assumes that it can hold the general outcome of others' efforts constant relative to a given equilibrium point is fundamentally apolitical

> insofar as it fails to grasp the possibility of [sudden shifts in behavior]. To treat the overall outcome of human interactions as a static given, against which one must assess the negligibility of one's actions, is a form of rationality that takes no account of ruptures that mark our political history, and indeed, that mark many other aspects of our lives (such as style, dress and demeanor) as well" (Lane 2018, 167)

Here is the second point of Lane's I wish to emphasize: what is distinctive about the "problem of negligibility" is not that it allows individual agents to discursively absolve themselves of doing environmental harm in the name of greater economic good. This would read negligibility as a version of the so-called "dirty hands problem," wherein the disaster of earth distress today is the price to pay for the beneficent effects of global markets that will see us through the recovery tomorrow. It seems to me that it is this version of the problem that many arguments against the Carmichael Mine posit, by retaining the premises of economic rationality yet drawing far less beneficent conclusions than those at which its boosters arrive. What Lane instead contends is that negligibility allows individual agents *to conceptualize a way of acting that lacks any substantive efficacy of its own* because decided, resolved, by the inexorable laws of the market. Lane's reading follows a question about why it is that so many powerful people seem drawn to the problem of negligibility to deflect from action that might alleviate earth distress. Power, Lane says, brings responsibility; by conceiving the problem of earth distress under the description of market rationality, I can cling to a fantasy that I am only responsible for the actions whose consequences I have some say in. The result is a way of rationalizing my own powerlessness as someone's else's problem: "It is especially (if not only) in the grip of the twentieth-century market model of perfect competition that we have come to conclude too readily that our hands are necessarily dirty—at the price of conceding that they are impotent" (179). Lane concludes her paper by calling for a broader conception of climate action that appeals to other traditions of moral and political reasoning to embrace powerlessness as acceptable grounds for action, whether it brings positive or negative consequences. My more limited interest, however, is in understanding how powerlessness is put into circulation as earth distress places pressure upon the narrow rationality of disaster normativity and provokes defensive maneuvers to sustain its hold.

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Recall that Bandt indicted the government for "propping up a declining industry and threatening our way of life" to which Frydenberg responded that "we shouldn't be ruling out energy sources based on extreme ideology." Frydenberg's counter is insincere in offering a version of the partisan moralism he decries, yet at the same time it appears to respond to the substance of Bandt's economic argument by rebutting climate predictions with market predictions and so fabulating an ideological battle between realism and radicalism. And yet, Frydenberg's response is also excessive for the moral escalation it invites. In playing at picking up Bandt's gauntlet, he throws a bigger one down. He calls in reinforcements from normativities less obviously unsettled by the disaster at hand, namely, economic norms ("industry experts"), gender norms ("hysterical") and national security norms ("extreme ideology"). What, decidedly, does not seem to disturb Frydenberg is the ramping up of his own invective, the thinly veiled threat to, as he might put it, "lives and livelihoods" that his words of enraged frustration carry. It is, as it were, shameless.

The same disturbance repeated itself on the floor of the Senate the next day. Greens' senator Peter Whish-Wilson read Professor Terry Hughes "and then we wept" tweet (discussed in chapter one) into the official parliamentary record. He then asked his question. Did Simon Birmingham, the minister for education and training, agree with Hughes that "it is not too late to save the Reef if we leave coal in the ground"? "Do I agree that Senator Whish-Wilson needs a hanky?" Birmingham responded, "I think Senator Whish-Wilson needs a lot more than a hanky. Senator Whish-Wilson needs a reality check on a whole range of fronts" (Commonwealth of Australia 2017). Again, we see a charge of delusion, an appeal to hypermasculinity, and this time an overt threat of violence—from the minister for education and training, no less. One final example of such inflammatory political speech bears mentioning. A month earlier, in February 2017, then treasurer and later prime minister Scott Morrison took a softball question from one of his backbench colleagues on economic performance during "Question Time," the ritual public exchange of questions and answers from members of parliament to the government that happens every day that parliament is in session. Morrison flouted the rules against using props when answering questions by surreptitiously withdrawing a lump of coal from behind the file in his hand and brandishing it at the representatives sitting on the opposition benches in front of him:

> "This is coal. Don't be afraid! Don't be scared! It's coal. It was dug up by men and women who work in the electorate of those who sit opposite. … It's coal that has ensured for over a hundred years that Australia has enjoyed an energy competitive advantage that has delivered prosperity to Australian businesses and has ensured that Australian industry has been able to remain competitive on a global market. Mr. Speaker, those opposite have an ideological, pathological fear of coal. There's no word for coalophobia officially, Mr. Speaker, but that's the malady that afflicts those opposite. But it's that malady, Mr. Speaker, that is afflicting the jobs in the towns, and the industries, and indeed in this country because of their pathological, ideological opposition to coal being an important part of our sustainable and more certain energy future."

It is a truism in Australian politics that the rhetorical exchanges between politicians—especially within the walls of parliament—are indecorous, barbed, and rarely plain-speaking. It is also standard for Australian politicians to burnish their credentials by denigrating women and marginalized others.[31] It would be possible to interpret the pattern of feigned outrage and cruel

[31] In 2012, then prime minister Julia Gillard delivered the so-called "misogyny speech" during one session of Question Time, in which she accused the then opposition leader Tony Abbott of sexism and misogyny, prompting international coverage and revisions to Australian dictionaries. In recent years, a number of high-profile scandals have engulfed parliament and led to a series of defamation and sexual harassment lawsuits, as well as, albeit

mockery on view in Morrison's parliamentary ode to coal as a feature of the moral psychology selected for and amplified in Australia's parliamentary system, which pundits often explain (away) with reference to socialization through student politics. But this would be to adopt and endorse the very rationalizing gesture of reducing political problems to problems of personal responsibility. What seems striking, here, is the juvenile yet no less forceful pattern of hyperbolic intimidation and humiliation on the part of political authorities asked to exercise their authority in ways they do not know how to.

Morrison is acting out—defying parliamentary procedure—and showing that he understands the needs, hopes, and dreams of the nation to be intimately bound up with the lump of coal in his hands. The charge of pathology, of a contagious malady called "coalophobia" that will grip the country in a death spiral, turns any substantive discussion of how to align meaning and value in difficult times into a seditious recruitment to disorderliness. Morrison's fearless fearmongering, agree with us or else, fabulates a psychopolitical tipping point beyond which Australia will not recognize itself.

But these are not just idle threats. In recent years, state and federal politicians have taken public aim at "green lawfare," a portmanteau that equates legal action with insurrection, in a bid to narrow the scope for environmental litigation of the kind described earlier. At the same time, governments have legislated new chokepoints for the expression of political dissent, which include: restrictions on public assembly; additional mandatory reporting requirements for local NGOs; limits on transnational organizations running campaigns on so-called "national" political issues; reduced whistleblower protections for federal employees; the extension of counter-

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belatedly, a formal inquiry into the cultural of intimidation, bullying and sexual harassment within Parliament House. Most recently, on the eve of calling the federal election, current prime minister Scott Morrison was exposed as having achieved preselection to his electorate some twenty years ago thanks to a racist smear campaign against his opponent, a physician of Lebanese descent. Morrison disputed the accusation.

terrorism laws to acts of commercial trespass and industrial sabotage. These policy changes have their histories, rationales, and contestations that exceed the scope of the present paper. I point to them rather as an indication of a tendency from government to react to calls to write "climate action" into law by, instead, flexing their powers to remake the law itself. One of the consequences of these actions is a proliferation of non- and anti-government initiatives—such as a recent spate of infrastructure "blockades" organized in the heart of Sydney by locally and transnationally organized climate activists—which themselves invite unprecedented imposts of surveillance and enforcement in the name of defending "public order."

Postscript

On May 21, 2022, the Australian federal election took place. It decisively ended Scott Morrison's tenure as prime minister and with it over nine years of conservative government. The opposing Labor party obtained a narrow governing majority, but the most discussed electoral result was the success of a half dozen so-called "Teal" candidates who claimed typically "safe" Liberal party seats. All of these candidates campaigned for action on climate change, gender equality, and independent local representation in a centrist spirit (hence "Teal" as "not-Green"). Many received support from Climate 200, a crowd-funding platform developed by political donor and energy entrepreneur Simon Holmes à Court. The most high profile member of parliament ousted by the "Teal wave" was Joshua Frydenberg; pediatric neurologist Monique Ryan replaced the presumed successor to the prime ministership. Also significant was the election of three Green candidates, who joined Adam Bandt in the lower house of parliament to represent metropolitan electorates of Brisbane, the Queensland state capital. Many pundits expressed surprise at both results, often attributing the Greens' success to disastrous flooding that overwhelmed Brisbane as the lead up to the election. The Green Party, however, said the result was years in the making, the gradual effect of rolling outreach sustained beyond the event-time of any one disaster or election campaign. One candidate characterized this electioneering approach as akin to "social work," grounded in door-knocking and home visits to voters in need. The newly elected Labor government has promised to put an end to the "climate wars" and make up for a "lost decade" of climate action. So far, this looks like legislative action in the form of a stronger national emissions reduction target, the rejection of a major new coalmine application near Brisbane, and diplomatic outreach to near neighbors in the Pacific long frustrated by the former government's seeming indifference to rising sea levels.

It is possible to interpret the federal election result in the idiom of markets and systems as a "correction" for past excesses, the return of order after a period of disorder. And, to be sure, a palpable sense of change if not relief coursed through numerous public and social media channels in the days following. At the same time, and in the spirit of this chapter, such an interpretation risks assuming the clean-cut position of the aftermath, in which correction arises as the confirmation of a prior and now deconcealed instability. A "lost decade" is not so easily recovered from. It would be hasty to presume that what took place under three democratically elected conservative governments was not *a way*, however wanting or mistaken, of responding to earth distress. The material and psychopolitical effects of these years, then, will not be so easily dispensed with. The question of what to do with the powerlessness earth distress brings other than unleash it upon each other is, as it were, still open.

CONCLUSION

1. Thinking Acting Historically

In a notorious pamphlet, G.E.M. Anscombe (1956) criticizes the actions of her Oxford peers and superiors in supporting the conferral of an honorary degree upon Harry Truman, the wartime president of the United States. Truman committed murder by using nuclear weapons on Hiroshima and Nagasaki, she says, and the bestowal of public honors is not an appropriate response to murder. Anscombe's central claim is that whatever the effect the nuclear strikes had in bringing the war to an end, the decision itself amounted to murder. This is not simply because countless civilian lives were lost and destroyed as result, but because Truman's reasoning, his way of justifying the taking of these lives, was barbarous. Anscombe reasons that in pointing to Imperial Japan's refusal to accept unconditional surrender as the basis for using nuclear weapons, Truman embraced an unlimited objective in war. Hence, she concludes, it is not only a historical but also a moral error to honor Truman. Conferring the degree would be a senseless act in its own right, it would urge confusion about a foundational concept of moral reasoning: murder. The pamphlet not only previews Anscombe's writings on moral philosophy, intentional action, and consequentialism, it offers an example thereof. By engaging her peers in an eleventh-hour dialogue upon which she stakes her soul, she shows them another way of reasoning about action and consequence and conscientiousness.

"Climate change" is not a moral concept in the same way that murder is, and yet it has moral dimensions. Pesticides are not weapons in the same way that nuclear bombs are, and yet they sow planetary destruction. It is in order to emphasize the moral cline of "climate change" that alternatives such as "ecocide" or "capitalocene" or "the sixth mass extinction" have gained traction in public discourse. Yet as discursive interventions into an ongoing debate over how best to characterize the historical present, the proliferation of terms might be less a way out of the puzzlement over "what is to be done" than a further way into it. I offer "earth distress" up not to resolve but acknowledge that moral confusion over what actions are required of us in the historical present is a crucial dimension of our distressing historical reality. Interminable terminological debates are one place where the particular pressure of this confusion registers, or, I might say, where the action is—but it is only one. Technoplanetary reasoning and salvage are another.

The typical distinction of "climate change" from "climate action" is unhelpful. The former is often taken up as a bundled concept, at once epistemic, political and moral in import and the latter as a redemptive horizon of expectation. Hence, the insistence that only by surrendering to the truth of "climate change" as a description of the historical present will the path be cleared for decisive and reparative "climate action." My use of earth distress is an attempt to offer another way of orienting to coral crisis, earthbound endangerment, and action in the historical present. Its coinage results from my attempt to put some language on why, after years of fieldwork among coral reefs and the people attached to them in restless and relentless pursuit of "climate action," did I see such distress, so little redress, and still such a powerful will to redemption.

Technoplanetary reasoning and salvage orient to "climate change" as something to harness, however obliquely—to anticipate, accelerate, inhabit, polarize, occupy, and redirect. In placing the social worlds of these undertakings under the description of earth distress, I have tried to show that climate action is a way, to borrow from J.L. Austin, of "doing things with climate change" and this, in key respects, by learning how to channel its limitlessness.

By situating coral reefs, the Great Barrier Reef, and technoplanetary reasoning in historical context, I have shown that corals have long mediated human understandings of nature as a keeper of metaphysical truths. For example: the consolidation of the Reef as a national icon through the establishment of the Great Barrier Reef Marine Park Area and its responsible scientific and management authorities in the 1970s allowed Australia to project a degree of timeless sovereign authority over planetary nature, irrespective of past uses of the Reef as a resource frontier within a settler regime of natural history to which the country remains committed. In this respect, it is possible to appreciate the technonationalist undertones of large-scale projects under way to establish the Great Barrier Reef as a biogeochemical laboratory for technoplanetary salvage.

Developing an appetite for the natural history of coral reefs as something other than a repository of anecdote is more than just an exercise in historical appreciation. It is crucial for understanding the orientation of technoplanetary reasoning towards the historical present. It is only by insisting on drawing a line under past histories of human-nature relations that technoplanetary salvage can argue that the "geological agency of mankind" clears the way for redemptive action. By doing so, technoplanetary salvage dramatically expands the authority of science and technology today, and this in ways that urge indifference to the lessons to be learned from past mistakes, let alone the very real danger of repeating them. Yet even such urging cannot evacuate doubt, which persists (if only defensively) in the frequent comparisons of coral reef intervention to cane toad intervention. As visions of total "life support" for coral reefs become reality, their architects and brokers need not be entirely conscious of the dangers of pursuing such an unlimited objective to be mindful of the possibility that human-coral relations will never be the same.

In order to encourage a critical natural history of the present, wherein the boundary between nature and technics is repeatedly and compulsively transgressed, I have argued other ways of describing the relationship between knowing and acting. The aspiration of North Atlantic science to aperspectival objectivity was always just that, an aspiration. As technoplanetary reasoning avows non-indifference towards its object, and so embraces the virtue of endowing its research subjects with subjective power, a new approach is needed to catch the psychopolitics on display. If we begin from the assumption that knowing is a way of tensioning some kind of object-relation, then we can move to describe the psychopolitics of more-than-human encounters otherwise than in terms of guilt or innocence, pragmatism or romanticism. Hence, knowing as relating, absorbing, synthesis, luring, bewildering.

2. Unknow-ability

From the standpoint of psychoanalysis, there is nothing unexpected about knowing as something in excess of conscious intellection. Yet this is not how the North Atlantic tradition of scientific inquiry has historically understood its duty towards its research objects. It may be possible to argue that conservation science is an exception in this regard, yet even here the emphasis would remain on largely conscious expressions of emotionality such as care, love, and sacrifice. The starting point for technoplanetary reasoning as a movement is that the diagnosis of climate change authorizes a radical break with past traditions of objectivity as “morally wrong” because of the consequences owing not to too much but too little of the right kind of participation in the lives of more-than-human others. This allows technoplanetary reasoning to regard its own project as belated and so urge expedited and accelerated measures to expand its operations—

including the dismissal of environmental regulations, moratoria, or precautions as unnecessary barriers to disruption.

Many critical social scientific and humanities scholars have forcefully called for a greater appreciation of the obligate relations that bind human beings to earth others in historical time. Technoplanetary reasoning appreciates this only too well, and yet in "catching up" it misses the ethical lesson about human vulnerability in the name of stabilizing human authority. There is a pressing need for renewed attention to the non-innocence of the obligate relations between human and more-than-human beings, an explicitly critical multispecies ethnography.

Within the post-war tradition of coral reef studies, the unusual biogeochemistry of the coral holobiont was considered an epistemic barrier to be overcome. If only we understood more about what coral reefs are, then we would know who to be to them. Today, it is precisely because we know too much about coral reefs, the how and why of their finitude, that they place pressure upon our own self-understanding. This relationship of terminality, concrete as a matter of empirical science yet abstract as a matter of historical temporality, is pushing the representatives of planetary coral science to view previously unthinkable practices of salvage as not only reasonable but necessary undertakings. But is this a "bad thing"? Isn't doing something to alleviate earth distress better than nothing? This manuscript makes the case that these are not the right questions to ask.

The assertion of a decisive break with history might satisfy the desire to "do something" about earth distress, yet it also risks deflecting from the danger that technoplanetary salvage is both an "otherwise" way of knowing and acting and, in key respects with regards to the drivers of earth distress, more of the same. The Reef is an especially powerful medium for appreciating this slippage for the ways in which, historically as well as presently, it has mediated the importance to human and more-than-human flourishing not only of relationality but also of boundaries, obstacles, limits—barriers. The new science of salvage depends upon making the old science of conservation seem more obsolete than it is. Assisted evolution builds upon the theories, methods, and foundations of past research in order to take off. It leverages the Institute's local staff, global reputation, and exclusive access to the Reef today. It is only by being so thoroughly *inside* the politics of coral science that it can claim to *overturn* them. But technoplanetary salvage is not without consequences for human subjectivity, and this, crucially, is part of the point.

The idea that doing something is better than nothing is a way of, if only temporarily, lifting the distress that follows from acknowledging the powerlessness of the human condition before ongoing and accelerating planetary diminishment. Yet the opposition of "climate action" to "climate inaction" will always be overdrawn insofar as any historical action today contributes in some way shape or form to earth distress. In this sense, the action/inaction dichotomy is another way in which technoplanetary salvage asserts its "necessity" over against a more radical evaluation of the responsibility of technoplanetary reasoning in sustaining the historical drivers of earth distress.

I have argued that "super corals" are not a form of life that we find but one that we choose to produce because of what we have figured out to do with "ordinary" corals: stress them to death in the hope they will produce offspring that can survive. Fashioning a planetary pest control program from the very agroindustrial supply chains that may be responsible for spikes in crown-of-thorns starfish numbers is rather ingenious. Indeed, it might be so effective, too effective, at "solving" the crown-of-thorns starfish problem that it becomes difficult to appreciate what made this problem so pressing in the first place. Because automated pest control does not just put the crown-of-thorns starfish to work in reducing its own numbers, it also silences once deafening questions as to the excesses of industrialization. My reason for emphasizing the tensions that arise in the social worlds of technoplanetary reasoning—dread that courts opportunity, care that shades into callousness, relief that begets anxiety—is in no way a dismissal of the researchers, technicians, and volunteers as unstable. I too contributed to the work of trans-gen, assisted corals evolve, and so go extinct. Earth distress is not just distressing but destabilizing, even debilitating. How we acknowledge that matters.

I attempt to acknowledge the destabilizing powers of assisted evolution by redescribing it as, from a certain aspect, assisted extinction. That is one way of putting things. Here is another: what if “super corals” were “infra corals”? They are the infrastructure for holding together a new historical era of human-coral relations. They live with biogeochemical debility as an unstable form of life at an early and still speculative phase of technobiological evolution. They demonstrate the dramatic reversal of the ontological status of reef-building corals as a form of life that no longer provides “life support” to global nature but instead requires it from human beings. Could “infra corals” ever “take off”? It is language that might trouble the authority that technoplanetary reasoning claims by endlessly opening up the fabric of reality to extend the reach of human want and need. It might be a starting point, however, to consider whether we are asking the right things of technoscience and it of us.

There are of many alternatives to technoplanetary salvage: run for office; embrace the coequal status of non-modernist technoscience; refuse capitalism; blow up a pipeline. The question is, are any of these alternatives open to technoscience and the forces of state and industry that depend upon it? My concern in this manuscript is not with adjudicating solutions but taking seriously the presuppositions of technoplanetary reasoning about what more-than-human nature is good (enough) for and what is good (enough) for more-than-human nature. One of those presuppositions is that working on nature (i.e. "action on climate change") is more important than working upon ourselves. "As go the corals, so go the oceans, so goes the planet, so go our souls." Can the equation be reversed?

3. Towards Science Fiction

There is another way of stating my claim about technoplanetary reasoning as an avoidance of history and that is to emphasize its embrace of futurity. After all, it is a futurism, but of what kind? If technoplanetary salvage is in many ways regressive, a doubling down on human mastery over global nature not despite but because of the Anthropocene verdict of non-mastery, what horizon of expectation can this possibly open up? One possibility is quite simply: no horizon at all. Technoplanetary reasoning may be utterly fatalistic in its assessment of the historical present and understand the work of salvage as, yes, accelerating evolution but in no way partaking of it. It is in part by trying to describe this possibility as, itself, an historical attitude that I have tried to broaden our repertoire for understanding how to go on in these times when technoplanetary salvage is becoming an increasingly obligatory and powerful force to reckon with.

There is another way in which futurism presses upon technoplanetary reasoning and that is in the form of science fiction. I recall one day, early on during fieldwork, when I happened across a scale model of the Tardis, Dr Who's famous blue telephone box and dimension-defying time-travelling spacecraft. I had been accompanying the SeaSim manager as he gave a visiting journalist on a tour of the SeaSim Precinct. We had spent some time talking over assisted evolution and the trans-gen experiment setup, when we neared the end of our circuit by a series of large outdoor crown-of-thorns starfish holding tanks. The ersatz Tardis stood alongside.

Pointing to it, I exclaimed “Ha! Another time machine then?” Our guide smiled and explained that it was part of an annual open day where staff and researchers dress up to present the Institute’s work to the visiting public, but no, he didn’t see it as a time machine reference. He gestured to the crown-of-thorns starfish pasted on the side and said: “Aliens, see?” As I write these words and once more reenact a game of show-and-tell, I find myself tempted to montage these ostensibly conflicting interpretations. An image comes to mind: the biologist climbs aboard the Tardis and travels the universe in order to endlessly gather up strange new lifeforms to doctor them.

The contours of this image come to me from another time and another science fiction tragic. In his posthumously published “Lecture on Ethics,” Ludwig Wittgenstein elaborates on his theme by showing different aspects of what ethical reasoning might be, how we might acknowledge its pressure upon our ordinary experience. Here are two images he reaches for in quick succession:

> “I believe the best way of describing it is to say that when I have it I wonder at the existence of the world. I will mention another experience straight away which I also know and which others of you might be acquainted with: it is, what one might call, the experience of feeling absolutely safe.” (1965, 8)

In what follows, Wittgenstein attempts to distinguish ethical reasoning from scientific reasoning, and to do so reaches for another striking example: what might happen if, suddenly, one of the members of the assembled audience turned into a lion began to roar:

> “Now whenever we should have recovered from our surprise, what I would suggest would be to fetch a doctor and have the case scientifically investigated and if it were not for hurting him I would have him vivisected. And where would the miracle have got to? For it is clear that when we look at it in this way everything miraculous has disappeared; unless what we mean by this term is merely that a fact has not yet been explained by science. … This shows that it is absurd to say “Science has proved that there are no miracles.” The truth is that the scientific way of looking at a fact is not the way to look at it as a miracle.” (1965, 8–9)

With these words, I do not understand Wittgenstein to be subjecting scientists to merciless critique. I understand him to be saying that scientific reasoning, if only as it obtains at the time, in the early days of the so-called “Great Acceleration,” committed to “restricted rationality” and “asperspectival objectivity,” and so as it persists today, if only in minded residue, is apt to explain the world away rather than thrill to dwell within it. If technoplanetary reasoning is open to regarding the world otherwise, then perhaps the interpretive field of science fiction is one place where to meet it.

*

Let me close, then, by revisiting one science fiction example mentioned in earlier in this manuscript, namely, Philip K. Dick’s 1968 novel *Do Androids Dream of Electric Sheep*? To recap: the text imagines a dystopian future in the aftermath of a nuclear war, in which humans endure thanks, in part, to the labor of android workers on earth and in extraterrestrial colonies. These so-called “replicants” are conscripted to serve as miners, sex workers, janitors, secretaries, political assassins, and so on, until, that is, they reach the end of their pre-programmed lifespan and are no more. In a crucial aspect of the novel that remains gestural in Ridley Scott’s 1982 film adaptation *Blade Runner*, replicants are not only humanoid but also animaloid. The nuclear war wiped out most animal life and so there is a thriving trade in animal “replicants,” whose variable quality is measured in degrees of exoticism and verisimilitude which earn corresponding degrees of prestige and commercial value.

Replicants appear to saturate the division of labor in this fabulated world. Indeed, they may even work as “blade runners,” a law-enforcement unit formed to catch and kill any replicants who refuse to go terminal by, instead, going rogue and challenging the social order. The novel/film’s protagonist, Rick Deckard, is drawn from their ranks. This sets up the well-known plot twist or, more accurately, open ending: is Deckard himself a replicant? The twist is a twist, the ending is open, because there seems to be something obscene about the idea that Deckard would labor so tirelessly to kill "one of his own." This is especially so when the reader/viewer comes to understand that the dystopia is so distasteful, the forced labor regime so interminable, the need for revolution so pressing, that they extend their sympathy to the replicants as fellow creatures.

Over the past years, I have reader a number of authors invoke this novel/film in order to make sense of technoplanetary salvage and suggest that the same question of sympathy arises. Here is one version, drawn from the closing pages of a recent general audience monograph on the making of planetary engineering, *Under a White Sky* (2021). The book is wide-ranging and meticulous, the work of staff writer at *The New Yorker* and author of the acclaimed *The Sixth Extinction* (2014), Elizabeth Kolbert:

> "As one replicant in *Blade Runner* says to Harrison Ford, who may or may not be playing a replicant: "You think I'd be working in a place like this if I could afford a real snake?" It's in this context that interventions like assisted evolution and gene drives and digging millions of trenches to bury billions of trees have to be assessed. Geoengineering may be "entirely crazy and quite disconcerting," but if it could slow the melting of the Greenland ice sheet, or take some of "the pain and suffering away," or help prevent no-longer-fully-natural ecosystems from collapsing, doesn't it have to be considered?" (Kolbert 2021, 200)

Here is the question/non-question discussed earlier: "If not this, then what? We cannot afford to do nothing." But what, exactly, is the "context" Kolbert is pointing to, which context will help us see to this question in the right light? The rhetorical question that the replicant, Zhora, puts to Deckard is a joke: there are, in all likelihood, no "real" snakes anywhere anymore within the universe of the novel/film. At the same time, Zhora is trying to deceive Deckard and his police interrogation by maintaining her cover as a non-replicant burlesque performer. The snake both is and isn't as real as it gets, and so is the job. As a replicant for whom work is not a choice but an obligation, an assignation, it is a moment in which temporary intimacy with an ersatz animal covers up the cruelty of a world in which freedom is, at best, and for a time this may be good enough, a joke. Fraught with miscommunication and metacommentary on the futility of choice, how does such "context" help clear up the morality of technoplanetary salvage?

Let me approach this question of context from another angle. There is a confusion in the opening lines from this passage of Kolbert's: is it Harrison Ford the actor who is, possibly, mistaken about his humanity or the character that he is playing? I can expect that the author means to refer to Deckard and not Ford but the syntax suggests otherwise. This slippage offers another way into questioning "this context." Is it a dialogue from a 1982 Hollywood movie taken as a statement of fact about the historical present or, rather, a statement of fact that technoplanetary salvage cannot be understood with reference to any real existing historical reality?

With these two redescriptions of Kolbert's context in mind, let me begin again. *Do Androids Dream of Electric Sheep?/Blade Runner* may provide context for making sense of the infernal choice between technoplanetary salvage and the collapse of global nature. These works show us that the two phenomena are irremediably intertwined as expressions of large-scale historical forces that, in ordinary life, manifest in the human capacity for affection and aggression and their possible confusion. They show us that we might stop and wonder whether the best way to assess actions that seem "crazy" and "disconcerting" is in virtue of their consequences upon a speculative future or, instead, in virtue of what these distressing feelings might be telling us about the difficulty of outmaneuvering the historical reality before our eyes.

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