# PLASTIC LEGACIES

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## Pollution, Persistence, and Politics

*Edited by*

TRISIA FARRELLY, SY TAFFEL, AND IAN SHAW

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# Introduction

## Our Plastic Inheritance

*Trisia Farrelly, Sy Taffel, and Ian Shaw*

Plastics have revolutionized our lives. They have made possible things such as smartphones, modern cars, and LCD screens that depend on the light weight, high strength, and electrical and thermal insulation of plastics. They have enabled the production of disposable surgical equipment that ensures sterility, thereby minimizing inter-patient disease transfer. Countless lives have been saved, and the use of antibiotics has been reduced, as a result of lower levels of post-operative infection. Plastics allow the minimization of food contamination by harmful bacteria and reduce food-borne illnesses. With COVID-19, health or frontline workers and the vulnerable population rely on Personal Protective Equipment (PPE) made of plastic. On the face of it, plastics are good . . . .

Despite the wonderful advances that plastics have enabled, however, thousands of unnecessary uses have developed simply because plastics are cheap and disposable. Drink containers, bags, straws, cutlery, and other single-use disposable plastics bring few tangible benefits to the vast majority of people who use them for their convenience.[1] A lot of single-use PPE equipment ends up in the environment. This could be avoided if they were swapped for reusables for those not working on the frontline and for those not immune compromised. Many plastic items—including toys and other items meant for recreation, entertainment, or aesthetics—often last little longer than plastics specifically designated for single use. When plastics are deemed disposed of "responsibly," this often involves the export of "recyclable" material from higher-GDP to lower-GDP countries. Whether



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responsibly or irresponsibly managed, all plastics will eventually find their way into the biosphere.

Plastics are polymers: molecules composed of repeating monomer units strongly bonded together. The adjective *plastic* refers to the capacity of these malleable materials to be moulded and set. Historically, a range of natural malleable materials such as rubber, ivory, and amber were employed (Bensaude-Vincent 2013). However, by the late nineteenth century, the industrial demand for these pliable materials exceeded their supply. Subsequent to the invention of Bakelite in 1907, the first petrochemical-derived synthetic plastic, there has been a meteoric growth in the production of synthetic polymers, to the point that they are now synonymous with the word *plastic* itself; when other plastics are mentioned, they tend to be prefixed as natural or bioplastics. Although no synthetic polymers were produced prior to 1907, and less than half a million tonnes were produced annually by 1950, by 2016, global plastics production reached 335 million tonnes per annum (PlasticsEurope 2017). That figure is set to go higher with continued activity in the petrochemical sector. In 2015, the Ellen MacArthur Foundation estimated that by 2050 the world's oceans will contain more plastics by weight than fish (MacArthur, Waughray, and Stuchtey 2016). Then, in 2017, a report predicted a 33–36 percent increase in plastics production by 2025 and illustrated how the fossil fuel industry is driving that production, with no sign of slowing down (CIEL 2017). For example, Exxon Mobile and Shell Chemical have poured almost $200 billion into new "cracking" plants since 2010 to produce everyday consumer plastics in the United States.

There is virtually nowhere on Earth today that remains untouched by plastics. They are found in the Arctic Ocean (Obbard et al. 2014), 83 percent of global tap water samples, air, honey, beer, soil, and sea salt (Kosuth, Mason, and Wattenberg 2018). One hundred percent of animals tested at the bottom of the ten-kilometre-deep Mariana Trench, one of the most remote places on the planet, had ingested plastic (Jamieson et al. 2017).

Because of the chemical nature of plastics, bacteria and other living members of the biosphere cannot readily degrade them, so they persist in the environment. During their afterlife, they are buffeted and pulverized



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by the physical environment and broken down by marine fauna such as Antarctic krill (Dawson et al. 2018). These processes eventually lead to the formation of microplastics and nanoplastics small enough to penetrate cell membranes. Plastics fill the stomachs of animals when they are mistaken for food, making them feel full while providing no nutritional value and damaging their digestive tracts. Some of the monomers used to produce plastics, such as bisphenol A (BPA) and styrene, are toxicants, as are many of the plasticizers, colourants, flame retardants, and UV stabilizers added to those monomers. In marine and freshwater environments, plastics tend to adsorb (attract) persistent organic pollutants (POPs) such as pesticides and other toxic substances. When ingested, plastics leach these toxicants into tissues and organs, where they bioaccumulate. When these creatures are eaten by predators, such as larger fish, whales, or humans, these toxic substances biomagnify, meaning that they are found in higher concentrations further up the food chain (Rochman 2015). In short, they wreak havoc on ecological and biological systems. So, after a bit more consideration, perhaps plastics are not as good as we originally thought.

In a risk-benefit (i.e., bad versus good) setting, perhaps it is acceptable that a modicum of environmental harm might result from the plastics-driven improvements to surgical procedures, disaster relief equipment, and other necessities, but this is far removed from exposing organisms to health-related risks by using disposable plastic cups or bags. The logic of the above argument is clear, but trying to persuade a public and its leaders to get rid of unnecessary, yet economically cheap and convenient, products manufactured by large and powerful companies is no simple task. It is especially challenging when many of the harms associated with plastics are suffered not only by those located at sites of extraction and production but also by communities located far away from these sites.

If we are to wean ourselves off our cultural addiction to unnecessary and harmful plastics, then we will need powerful science communication about the harms that plastics cause. We will also need to engage politicians who can initiate policy and legislation to render our reliance on unnecessary and disposable plastics illegal and hold corporations accountable. “We” should also engage reflexively with who exactly is



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being signalled by the collective pronoun *we*. All too often it refers to privileged inhabitants of the developed world and involves universalizing their situation as *the* human condition, continuing a long tradition of bourgeois and colonialist discourse that functionally silences marginalized groups. As Chapters 3, 7, and 11 of this book emphasize in regard to Māori and Inuit groups, and to inhabitants of India and the Philippines, not everyone is affected equally by, or complicit in, producing the harms associated with plastics. For example, on average, the inhabitants of the United States, Germany, Kuwait, and New Zealand produce between thirty-three and seventy times more plastic waste than citizens of India or Sudan (Jambeck et al. 2015).

At the same time, however, the enduring dominance of a neoliberal ideology that fetishizes competitive individualism and quantitative competition within markets signals why there is still a need for collective nouns and pronouns. If the "we" is erased entirely, then all that is left is a collection of individuals, *homo economicus*, the atomized consumer-subject of neoliberalism (Brown 2015). A cultural politics of plastics therefore requires the formation of a sense of common ground and a "we," albeit one that does not seek to universalize and homogenize but recognizes difference and promotes the forms of purposive collective action necessary to address twenty-first-century socio-ecological crises (Gilbert 2014; Hardt and Negri 2017).

This book also forms a substantial critique of neoliberal approaches to tackling the crisis of plastics. Frequently, these are consumer-led approaches to ethical consumption that nominally seek to address the complex issues associated with plastics via individual, market-based interventions. As Chapters 4, 6, and 8 emphasize, such solutions fail fundamentally to recognize, let alone address, the scale of the issue. Additionally, acts of ethical consumption do not address issues of production, infrastructure, and industrial waste, all of which are significant problems that domestic consumption practices simply cannot scale up to address. A related neoliberal solution to ecological crises is seen in the promise of the utopian technological fix, which advocates that legislative solutions are unnecessary: the market will self-correct, and technological innovations such as The Ocean Cleanup (see Chapter 9), recycling, plastic-eating bacteria, and waste-to-energy incineration will "save the world" from


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ecological crises arising from industrial capitalism. In place of ethical consumerism and technological solutionism, the authors of this book advocate for various forms of collective political and legislative action and activism designed to mitigate, not resolve, issues in the use of plastics. Plastics cannot simply be erased from the planet; the question therefore becomes how best to live with them and reduce harms to human and non-human lives.

The complexities inherent in how plastics are produced, consumed, and discarded are never purely material, social, nor stable. As such, addressing the complex social and environmental issues associated with plastics requires an interdisciplinary focus that crosses the divisions among the natural and life sciences, social sciences, arts, and humanities. This book brings together contributions that lay out scientific positions set within a human context to explore some of the political ramifications associated with plastics. Nevertheless, social scientists, artists, and natural and life scientists speak very different languages. This can make comprehension, let alone conversation, across these academic domains difficult. As editors of this volume, we came to understand better the value and challenges of such interdisciplinary collaborations in the process of curating this material. This journey has meant that we are a little more fluent in each other's strange language, and most importantly we now better understand the breadth of issues related to the pollution, persistence, and politics of plastics. We hope that our readers, like us, will obtain a deeper understanding of the complex socio-ecological issues associated with plastics after they turn the final page of this book.

We also hope that our readers echo the interdisciplinary makeup of the contents of the book: academics and students working across the range of disciplines that comprise contemporary environmental studies (Castree, Hulme, and Proctor 2018) and environmental humanities (Rose et al. 2012). Additionally, we hope that this book appeals to activists and policy makers. Indeed, one of the key interventions that *Plastic Legacies* seeks to make is to consider how a broad range of academic perspectives can contribute to pragmatic attempts to engage with (if not contribute to finding solutions to) the multiple crises pertaining to the use of plastics.

In the remainder of this introduction, we present the three key themes that structure the book and comprise its subtitle: pollution, persistence,



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and politics. Broadly speaking, the first section, "Pollution," lays out the scientific basis for understanding the global plastics crisis and asks readers to question how and why we construe plastics as pollution. Because this section introduces the issues associated with plastics, some chapters are more descriptive than those in subsequent sections. The second section, "Persistence," considers how the material affordances of plastics require us to think across spatio-temporal scales that far exceed how social or environmental crises are typically framed. And the third section, "Politics," explores a range of strategies designed to intervene in the complex issues outlined in the first two sections.

## Pollution

Plastics are routinely referred to as pollution, but what does that really mean? Beyond a broad sense that plastics are problematic or damaging materials, how should we understand pollution as a category? What or who is harmed by these materials? In *Purity and Danger*, Mary Douglas (1966) referred to pollution as "matter out of place." Whether a person or thing is *in* or *out* of place is determined by cultural and political norms. By describing plastics as pollution, are we saying that there is no place for synthetic polymers in spite of the social benefits that certain plastics bring? It is useful to reiterate that not all plastics are alike, and not all plastics are good or bad, safe, or hazardous, in all circumstances all of the time. Different plastics break down and adsorb persistent organic pollutants more or less easily and are more or less buoyant, economically and culturally valuable, and recyclable. Paying attention to the specific materialities of plastics within specific contexts therefore becomes important. Nevertheless, as Max Liboiron (2016) points out, the toxicological science that labels plastics as "pollutants" and determines the safe limits of toxicants is made to appear apolitical. Yet risk assessments themselves are socially mediated and never apolitical. This does not mean that they are fabricated; rather, tools, technologies, techniques, funding bodies, institutional structures, economic power, and cultural norms all play parts in the co-production of scientific knowledge. All of them come together to the ultimate determination of whether a polymer is safe or hazardous, under which conditions, and at which stage in its life cycle.



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Traditionally, toxicology has been guided by the Paracelsus principle, which contends that the dose makes the poison (Myers and Hessler 2007). All substances can be poisonous. The concentration determines whether something acts as a toxicant. Below a certain threshold, substances are considered to be safe; above it, they are understood to be harmful. Indeed, substances such as water are completely necessary for human and non-human life, but above certain concentrations water intoxication—a potentially fatal condition—occurs. With regard to plastics, some monomers, plasticizers, and additives (e.g., phthalates) are endocrine disrupting chemicals (EDCs) that can leach from plastic packages and containers into food and beverages (Farrelly and Shaw 2017). EDCs interfere with the hormonal systems of humans and animals, causing a range of negative developmental, reproductive, neurological, and immune effects (Diamanti-Kandarakis et al. 2009; Shaw 2014). As noted in Chapter 12 of this volume, the determination of safe limits of EDCs is complex. EDCs are hazardous at low doses, and particularly at crucial periods, such as during fetal development and breastfeeding. The "low-dose theory" is one example of the politicization of plastics science. The theory is now commonly accepted by endocrinologists, yet it has been slow to be accepted, unsurprisingly, by the petrochemical and plastics industries—including the scientists that they fund and the politicians that they support.

As shown in Chapter 7 of this volume, the use of language and interpretation more broadly has significant implications for social and environmental responses. The word *litter* is a case in point. The word may be defined as "rubbish such as paper, cans, and bottles left lying in an open or public place" (Stevenson 2010). There are many documented cases in which the plastics industry and many states around the world have deployed the word in their public messaging to deflect the blame for plastics pollution onto individual consumers. New Zealand has seen a string of "anti-litter" campaigns since the government established the Anti-Litter Council in 1967. Examples of the slogans used for these campaigns include "Be a Tidy Kiwi" and "Do the Right Thing." In 2017, a $1.7 million "Litter Less, Recycle More" campaign was established by the New Zealand Packaging Forum (the New Zealand packaging industry). In the United States, the American Chemistry Council website is designed to convey the message that plastics are a problem only if those


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who use them are irresponsible or ignorant (Liboiron 2012). The Plastics Federation of South Africa adopted the US catchphrase—"Plastics Don't Litter, People Do!"—"illustrating the core strategy of individualizing the problem, confining it to the domain of consumption, and thus heading off questions about production and the structuring of markets" (Hallowes and Munnik 2008, 116). As Liboiron (2012, 206) emphasizes, "one of the major scalar fallacies in environmentalism . . . is that systemic environmental degradation is created, and can be combated, through individual consumer choice."

Why is this a fallacy? Because individual action cannot possibly scale up to the level of the current plastics pollution crisis. Particularly when acting individually, consumers have little power over the volume of virgin content in new plastic products, the kinds of unlabelled toxicants introduced into plastics production and recycling processes, the fast-increasing volumes of plastics produced each year, and the kinds of synthetic fabrics produced and traded around the world. Individual consumers also hold little power over the tire dust, flecks of plastic road paint, and microfibres that are unintentionally released to accumulate in the biosphere and that are not captured in waste management systems. The negative externalities of plastics are not the results of irresponsible consumer behaviour. They are not the results of littering or poor consumption choices. Plastics pollution is the result of a failing global plastics economy, one that does not account for negative socio-ecological externalities.

Some of the contributors to this volume apply the term "litter." In some places, this is because it denotes a different kind of materiality and human activity. "Litter" is also often used because it is the most familiar term (for the reasons noted above). However, wherever it is used in this book, the intention of the authors differs dramatically from that of plastics industry messaging. We, as editors, prefer the term "pollution" because it draws attention to the various forms that plastics can take. This term captures not just the pieces of discarded plastic that we can see, but also the tiny plastic fragments that leach toxicants, adsorb other pollutants, and interact with other materials and biological forms in often novel ways that produce unexpected results. We also think that the term "pollution" is more relevant to the content of this book since the term "pollutant" encapsulates not only the physical and visible form but also the chemical,



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gaseous, socio-political, and energetic qualities and potentials of plastics. "Pollution" also often implies a grander scale than "littering" (e.g., air, sound, or light pollution), and it is most likely to be attributed to an industrial source. However, mere use of the term "pollution" does not automatically imply industry responsibility in all cases. For example, in a media analysis of environmental pollution, Hook et al. (2017) found that the state blamed Japanese citizens rather than industry for unsuccessfully avoiding or mitigating the risks posed by "pollution."

Many contributors to this volume sit within science and technology studies (STS). STS reconciles the socio-political, technical, and scientific practices that underpin the physical and chemical considerations of plastics as pollution and concludes that no claim to scientific validity exists outside social and political debate. The contributions in this book emphasize plastics as sociocultural, political, and processual, detailing the instability and unpredictability of plastics as evidenced in their physical, socio-political, and chemical entanglements. This is a shift away from the ways in which plastics and other materials have been treated historically as stable, inert, and asocial objects. This also calls for attention to the specific material affordances of the plastics in question and their contextual relations. In other words, this calls for the kind of nuance and specificity often absent from homogenized claims regarding plastics as "bad" polluting actors frequently accompanied by equally problematic assertions that specific actions aimed at reducing the use of plastics are *the* solution.

The production, recycling, burning, burying, and otherwise discarding of plastics frequently involve social justice issues rarely exposed publicly. The Basel Convention working group first used the term "waste colonialism" in 1989. Then, in 1992, Jim Puckett of Greenpeace coined the term "toxic colonialism." These expressions are most commonly used to describe how more developed countries dump their hazardous wastes into less developed countries. For example, as illustrated in Chapter 3 of this volume, Indigenous communities are disproportionately exposed to the harms of plastics pollution. Meaningful responses to the plastics crisis require a specific focus on the liveliness of plastics and the ways that they become enrolled in a wide range of physical, chemical, and socio-political assemblages. One size does not fit all.



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Whether intentional or not, the negative impacts of plastics pollution can be felt immediately and travel thousands of kilometres away from the source. The externalization of environmental harms from affluent areas to poorer communities, states, and regions is frequently associated with neoliberal globalization. Neoliberal globalization is partly characterized by the minimization of investment costs (by not accounting for negative environmental and social externalities), individualizing responsibility for environmental health (thereby distracting attention from the major offenders like the multi-hundred-billion-dollar petrochemical industry), and the fetishization of economic growth.

The first section of this book introduces a range of concerns about plastics as "pollution" in terms of marine and human health (Chapters 1 and 2) before considering the unequal distributions of those harms (Chapter 3) and problematizing straightforward narratives of plastics as "pollution" (Chapter 4).

Chapter 1 is a collaboration between marine scientists Imogen Napper and Richard Thompson and psychologist Sabine Pahl. It provides an overview of the problems associated with marine plastics pollution. The authors also explore the motivational factors most likely to influence positive environmental behavioural change and emphasize that education and awareness-raising programs will continue to be fruitless without working concurrently to address the multiple systemic weaknesses in the global plastics economy. This requires an integrated, interdisciplinary, and intersectoral approach coupled with the recognition that marine plastics pollution is terrestrial in origin. This chapter is the first of many in this volume to reference the importance of scale when understanding and responding to plastics pollution. Among the scales noted here are quantities of litter, time scale, and national and global responses.

In Chapter 2, "Slow Violence: The Erosion of Plastic Marine Debris and of Human Health," Sasha Adkins invites readers to consider the increasing volumes and pathways of plastics and plastics-related toxicants entering human bodies. The chapter draws attention to the gradual and often invisible harms wrought on humans by every life stage of plastic products in addition to outlining the connections among plastics, fossil fuels, and climate change.



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Chapter 3, "How Seabirds and the Incorporation of Indigenous Science Illustrate the Legacies of Plastics Pollution," is a collaboration between marine biologists Stephanie Borrelle and Jennifer Provencher and environmental and Indigenous rights advocate Tina Ngata (of the Ngāti Porou Māori tribe). It explores how Indigenous peoples are disproportionately affected by marine plastics pollution because of their reliance on seabirds and other marine species for food. The authors present a strong case for the importance of culturally appropriate collaborations between Indigenous groups and researchers in deepening understandings of the lived experiences of marine pollution set in historical, geographical, and culturally specific contexts.

Chapter 4, the final chapter in this section, Sven Bergmann's "Dawn of the Plastisphere: An Experiment with Unpredictable Effects," explores the material politics of marine plastics pollution, examining how the category of microplastics is not merely descriptive; the term "microplastics" performatively affects how plastics pollution is understood and made visible. Bergmann also questions the notion of plastics as pollutants when plastics debris is considered a "plastisphere": the porous surfaces of marine plastics pollution, where a range of microbial life flourishes. The chapter troubles the false dichotomy of bad versus good that permeates plastics discourse by showing readers that plastics are not hazardous to all life; they can be home to unique microbial ecologies.

## Persistence

This section of the book directs the reader's attention to the intergenerational, deep-time, and multi-scale implications of the use of plastics. The material impacts of plastics over geological time scales are rarely contemplated within political discourse. The use of non-renewable forms of energy in the production of plastics emphasizes the links among plastics, the geopolitics of fossil fuel extraction, and anthropogenic climate change. Approximately 8 percent of all extracted oil is required to produce plastics (Hopewell, Dvorak, and Kosior 2009, 2115), and as noted earlier the global share of oil used to produce plastics will increase dramatically over the coming years. From the fossilized remains of organisms that lived millions of years ago, humans produce disposable items such as plastic coffee cups



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and bags used for just a few minutes, yet their geological presence will remain perceptible for millennia.

This resonates with concerns associated with the discourse of the Anthropocene, in which human actions are understood to have marked a new geological epoch. In the Anthropocene, planetary ecological conditions are forecast to be far less hospitable for humans and most other life forms. The impacts on the Earth system, which will be perceptible in the geological strata of the planet for millions of years, include changes to greenhouse gas concentrations (Crutzen 2002); perturbations in the nitrogen and phosphorus cycles; the presence of radionuclides from the use of nuclear weapons (Waters et al. 2015); a soaring rate of species extinction equalled only during the handful of mass extinction events in the planet's geological record; and the accumulation of immense quantities of non-biodegradable techno-fossils such as plastics (Taffel 2016).

The concept of the Anthropocene has been both enthusiastically adopted and heavily critiqued. Proponents contend that a new geological epoch that emphasizes recent human action as a dominant factor in ecological change can be a motivating factor in precipitating the kinds of radical socio-ecological change required to address multiple and entangled environmental crises, such as climate change, deforestation, reductions in biodiversity, and use of plastics (e.g., Lewis and Maslin 2018; Steffen, Crutzen, and McNeill 2007). Critics, in contrast, advocate that describing Anthropos—the human species—as the central figure of geological change repeats the mistake of universalizing diverse activities, declaring that "we" are all equally to blame for crises perpetuated primarily by particular groups of privileged people. This has led to the counterdiscourse of the Capitalocene, which argues that the economic and power relations associated with capitalism rather than humanity per se should be identified as the key actor associated with these changes (Bonneuil and Fressoz 2016; Moore 2015). A related line of critique addresses the anthropocentricism of the Anthropocene. The new materialist turn in the social sciences and humanities asserts that humans never act alone and that assemblages, or relational networks, include a multiplicity of species ( Haraway 2016; Tsing 2015; Van Dooren, Kirksey, and Münster 2016). Agency, traditionally the preserve of the rational human agent, is extended to matter of all varieties (Bennett 2009; Latour 2004) to propose that things are lively sites,



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always in the process of acting with other things. Through this aperture, the problem is not humans in general, but certain privileged groups of humans working in concert with computers, cars, coal, cows, and other entities.

Plastics are a useful case study for new materialist conceptions of distributed agency since they are designed materials that never remain within their temporal and spatial boundaries. References to the "end of life" of plastics (in terms of fate and management) are misleading; there is no end of life for polymer resins, synthetic fibres, monomers, and additives. While many contributors to this book mention the circular economy, as the book illustrates, plastics are notorious for their unintentional releases into the environment at every stage of their life cycles. It is, therefore, unlikely that a circular economy will ever be able to eliminate all of the negative externalities of the kinds of plastics currently produce, even if the volume of production could be dramatically reduced. Plastics act in and with the world in often indeterminate ways and with no end in sight as they become implicated in other things to create novel and often surprising ecologies. Plastics exemplify how matter is leaky, active, and transformative rather than static, placid, and inert. But what does this activity mean for human agency and for the ability of concerted collective political action to substantively reduce the harmful impacts of plastics? The chapters in this section of the book grapple with these questions about scale that speak to the politics of plastics-related assemblages and their materiality.

In Chapter 5, "Plastiglomerate: Plastics, Geology, and the New Materialism of the Anthropocene," Christina Gerhardt discusses the formation of "plastiglomerates": fused assemblages of plastic, rock, wood, and other materials. The chapter provides an overview of how plastics, the Anthropocene, and climate change are not separable phenomena but fundamentally entangled. Gerhardt explores the deep time of plastics, tracing their sources back to the fossil fuels whose combustion threatens to unleash catastrophic climate change on ecological systems as the twenty-first century unfolds. This chapter resonates with that of Borrelle, Provencher, and Ngata in arguing that many inhabitants of the South Pacific region have contributed little to climate change and the global plastics crisis, yet they are among the most affected by them. Consequently,


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Gerhardt argues, we need to reorganize power structures radically in order to ensure climate, economic, and ethnic justice.

The three subsequent chapters in this section build upon these themes by using focused case studies that extend the analyses of materiality, scale, and persistence that Gerhardt introduces. In Chapter 6, "Dressed in Plastic: The Persistence of Polyester Clothes," Elyse Stanes focuses on one of the intimate everyday uses of plastics that is easy to forget: its ubiquitous presence in our wardrobes. Drawing from fieldwork conducted in Sydney, Australia, Stanes outlines the material production of polyester and its association with fast fashion and contemporary cultures of consumption alongside new social and ontological relationships arising from the release of polyester microfibres when they are shed during machine washing. Because the smallest microfibres cannot be captured in washing machine or water treatment plant filters, they find their way into aquatic environments. Again, we see how plastics are not neatly bounded objects but participate in ongoing material flows, leading Stanes to describe them as "assembled materials in transition." These materials escape waste management systems and alter social and ecological systems across multiple spatial and temporal scales.

Tridibesh Dey and Mike Michael, in Chapter 7, "Caring for the Multiple Cares of Plastics," draw from Dey's experiences working as an engineer for an NGO in India. The chapter explores how plastics are entangled with activism, caste, class, masculinity, and religion. The authors discuss the materiality of plastic in terms of its ability to be shaped or moulded (its plasticity), and they argue that we need to be attentive to how we care for the socio-ecological impacts of plastics. Their work combines postcolonial theory with the ecological politics of new materialism toward a "plasticity of care" and raises further questions about the perceived moralities of plastics as inherently good or bad.

In Chapter 8, the final chapter in this section, Laura McLauchlan further explores how questions of care are complicated by the multiplicity of spatial and temporal scales at which plastics operate. Drawing from fieldwork on hedgehog conservation in Bristol, United Kingdom, McLauchlan focuses on how the ideology of neoliberalism, which propounds action to be the domain of individual consumers, masks the massively distributed assemblages that connect humans and non-humans. Such connectivity,



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however, does not guarantee positive outcomes for actors such as hedgehogs. Indeed, globalized consumer capitalism, in which consumer demand is manipulated through mass marketing, has created plastics-strewn urban environments hazardous to many forms of life, including hedgehogs. McLauchlan argues that the only way to create infrastructural changes that offer habitable environments for a wide variety of biotic actors is by focusing on collective systems of care and exploring how humans form assemblages with others.

## Politics

Addressing the pollution and persistence associated with plastics requires political engagement. The final section of the book foregrounds strategies and tactics that explicitly seek to intervene in the global plastics crisis, ranging from technological fixes, through activism and art, to international policy. Mediated representations such as photographs, artworks, and documentary films can have significant impacts on behavioural change and environmental activism. A notable example is Chris Jordan's photographs in his collection *Midway: Message from the Gyre* (Flannery 2009). Jordan's photographs are dominated by brightly coloured small plastic items lying in the bellies of decomposing birds. His images are regularly cited as inspiring individual and group action. One of the contributors to this book, Stephanie Borrelle, considers Jordan's work a catalyst for action: "When I saw Chris Jordan's photograph of a dead albatross with a pile of plastic pieces inside it for the first time . . . it led me to social action and directed my scientific career. I now spend my life trying to make a positive difference fighting plastic pollution—I am an average person" (cited in Morton 2018). A surge of documentaries on plastics pollution has also had a significant impact on public awareness of the crisis. In particular, the documentary series *Blue Planet II* (BBC 2017), featuring Sir David Attenborough, inspired the parent company, the British Broadcasting Corporation, to ban all single-use plastics by 2020 (Leary 2018). The series has also had a significant global impact on the public, galvanizing thousands to reject single-use plastics, to conduct online research on the harms of marine plastics pollution, and to engage in discussions on the topic in social media. The exposure afforded by *Blue Planet II* and


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the public support that it has generated have been key to the enactment of legislation such as bans on bags and certain other single-use plastics. Indeed, this newfound visibility of plastics as a global environmental crisis is one of the reasons that, as editors, we believe *Plastic Legacies* makes a timely contribution.

Alongside the growth in media representation and public concern have been increases in scientific and government interest in the environmental impacts of plastics. In 2015, the European Union funded €7.5 million for microplastics research. Marine plastics pollution was also highlighted as a priority at the G7 Leaders' Summit in June 2015 in Germany. The G7 Leaders' Declaration acknowledged the global risks posed by marine plastics pollution, particularly to marine and coastal life, ecosystems, and human health. The statement called for actions and solutions and stressed the need to address the sources and the removal of legacy pollution where possible, as well as education, research, and outreach (UNEP 2016). The 2030 Sustainable Development Goals offer a multilateral and integrated approach to global pollution, and most recently the United Nations Environmental Assembly coordinated member states to contribute to resolutions addressing global pollution. As several of the chapters here emphasize, for effective action to tackle the global plastics crisis, we must have effective international legislative frameworks.

The potentials and pitfalls of politics, communications, and the global plastics crisis form the theme of this final section of the book. In Chapter 9, "Communicative Capitalism, Technological Solutionism, and The Ocean Cleanup," Sy Taffel considers how plastics are integral to digital telecommunications technologies and simultaneously key tools for addressing the issues of plastics pollution. Taffel explores how digital technologies and plastics share a logic of convenient overconsumption that has deleterious environmental effects. This consumer-driven logic is connected to an ideology of technological solutionism in which digital innovations are touted as a panacea for the ecological impacts of consumer capitalism. Taffel uses The Ocean Cleanup as a case study to illustrate this logic. The Ocean Cleanup is a technology focused NGO that claims it will rid the oceans of plastic. Taffel argues that such projects detract from the messy but necessary process of politics. The Ocean Cleanup suggests fallaciously



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that "ideologically neutral" technology will resolve ecological crises, thereby allowing overconsumption to continue unabated.

In Chapter 10, Johanne Tarpgaard follows the work of Bruno Latour to examine how practice-based science might influence processes and pragmatics in the public domain with the potential for social and legislative change. Tarpgaard draws from ethnographic fieldwork to examine the practices of Danish NGO Plastic Change, one of the most influential organizations in Denmark in increasing public awareness of plastics pollution. She describes some of the ways in which Plastic Change combines witnessing, storying, and imagery that reify neoliberal logics and reinforce flawed scientific practices. However, she argues that the same flawed logics and practices might surprise us by contributing to the kinds of broader systemic shifts needed to respond powerfully to the global plastics crisis.

In Chapter 11, "Plastics Talk/Talking Plastics: The Communicative Power of Plasticity," Deirdre McKay and her colleagues outline insights gleaned from two action research projects conducted in the Philippines and United Kingdom. They explore how plastics communicate important messages about class, gender, and identity formation of the subaltern. The authors outline how global attempts to respond to plastics pollution often neglect the socio-cultural differences between social groups, the important messages that plastics "speak" to us about including gender and Indigenous politics, and the cultural subversion of global waste. The authors emphasize that we need to learn to be attentive to the messages that plastics communicate if we are to respond to plastics pollution in empowering and meaningful ways.

Chapter 12, the final chapter, from Trisia Farrelly, Ian Shaw, and John Holland, is entitled "Redressing the Faustian Bargains of Plastics Economies." The chapter outlines the need for a legally binding international treaty on plastics pollution based on the successes of the Montréal Protocol on chlorofluorocarbons (CFCs) and other ozone-depleting substances. The authors emphasize that such a global instrument must focus on prevention and the full life cycle of plastics from extraction to recovery of legacy plastics. The chapter foregrounds the hazardous, ambiguous, and unpredictable nature of plastics' physical, toxic, and biological entanglements and consequently argues that legislation should focus on preventing



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the most hazardous plastics and that this determination should be based on the precautionary principle.

This book brings together a broad range of thinkers and doers including social anthropologists, political ecologists, geographers, activists, and natural scientists to lay out the hard facts, set them in a human context, and explore political ramifications. We thought this was a logical and simple approach to addressing 'Plastic Legacies' until it became clear that we all speak very different languages. This led to a journey of understanding and learning that the editors of this volume simply did not expect. We are now much the wiser, have discarded our preconceptions, and even speak a little of each other's strange languages. Most importantly, we now better understand the breadth of issues relating to 'Pollution, Persistence, and Politics'. We hope that our readers will, like us, understand the issues better after they turn the final page of this book. We also hope those fighting to prevent plastic pollution ensure they conserve their energy for the long haul and remain persistent, and, very importantly, that the key messages conveyed here find their way to politicians.

## NOTE

1. Straws do provide significant benefits to certain groups of people with disabilities, and reusable straws made from metal, bamboo, paper, and glass present low-cost and less environmentally harmful alternatives to most consumers.

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PART I

# POLLUTION

I

# Marine Litter

## Are There Solutions to This Global Environmental Problem?

*Imogen E. Napper, Sabine Pahl, and Richard C. Thompson*

Modern lifestyles generate considerable quantities of waste on a daily basis. Marine litter (also called marine debris) is solid waste that has been discharged into the marine environment resulting from activities on land or at sea. Plastics represent a substantial fraction of the municipal waste stream as well as marine litter. Plastics are lightweight, inexpensive, durable, and versatile materials that bring many societal benefits, especially in health care, agriculture, transportation, construction, and packaging (PlasticsEurope 2016). Given the durability of plastics, they also have considerable persistence in the environment or a landfill. This is a growing issue; just a few decades ago much of our waste was composed of organic, degradable materials, yet in the past number of years we have produced more plastic items than in the entire century before.

There has been a substantial increase in plastics production, from 5 million tonnes globally in the 1950s to over 300 million tonnes today (Andrady and Neal 2009; PlasticsEurope 2015). The use of plastics varies among countries, and global production is likely to continue and even to increase substantially over the next few decades. Despite the durability



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of plastics, the main uses are in relatively short-lived applications such as packaging, which accounts for about 40 percent of all production. Although packaging plays an important role in protecting food, drink, and other items, and thus reduces damage and wastage of products, it has also led to a rapid accumulation of persistent plastics waste.

There is increasing awareness of the accumulation of litter in marine, freshwater, and terrestrial environments from a variety of sources (Eerkes-Medrano, Thompson, and Aldridge 2015). The importance of the sources varies considerably geographically, but on a global scale it is widely recognized that most litter in the marine environment comes from land-based actions such as general littering, dumping of waste and loss during waste collection, and inappropriately managed landfill sites. Litter from shipping and other maritime activities contributes a much smaller proportion ( Jambeck et al. 2015; Mehlhart and Blepp 2012).

It has been suggested that the accumulation and fragmentation of marine litter have led to one of the most ubiquitous and long-lasting recent changes to the surface of our planet (Barnes et al. 2009). This debris is widely seen in the environment, where it has accumulated at the sea surface (Law et al. 2010), on the shorelines of even the most remote islands (Barnes 2005), in the deep sea (Bergmann and Klages 2012; Woodall et al. 2014), and in Arctic sea ice (Obbard et al. 2014).

Globally, about 75 percent of all marine litter consists of various plastics, with other materials—such as glass, metal, and paper—contributing much smaller amounts. Even though the large majority of marine litter is plastics, the time scales for the degradation of plastic items are not known with certainty and will depend on the chemical nature of the material, the characteristics of the environment in which they persist, and the manner in which degradation is measured (Andrady and Neal 2009). However, it is clear that, from the substantial quantities of litter entering aquatic habitats daily, it presents a range of negative economic and environmental consequences ( Jambeck et al. 2015; Werner et al. 2016).

The accumulation of marine litter has been identified as a major global conservation issue and a key priority for research (Sutherland et al. 2010). It has also been identified as a major issue by the United Nations Environment Assembly and in the G7 Leaders' Declaration of 2015 (GESAMP 2016; UNEP 2017; Werner et al. 2016). There is broad recognition that



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marine litter presents a substantial problem, so the key action must be to reduce the quantity entering the water from the land. In addition, we need to define further the scale of the problem in terms of quantities of litter and types of impact, but in our view there is already enough evidence for people to take action to stem the flow of plastics into the environment. In this chapter, we consider the problem and some of the solutions currently being implemented or considered.

## The Impacts

Plastics debris in marine environments has been found to affect a wide range of organisms as a consequence of entanglement and ingestion (Gall and Thompson 2015; Sutherland et al. 2010; Wang et al. 2016). Over 700 species of marine organisms have been reported to encounter plastics debris, which can result in severe physical harm and death or have more subtle effects on behaviour and ecological interaction (e.g., the ability to escape from predators or migrate) (Gall and Thompson 2015). A range of sub-lethal effects that have not yet been recognized is also likely.

The impacts of plastics in the marine environment vary according to type and size of debris and can occur at different levels of biological organization in a wide range of habitats (Browne 2015). Encounters between plastics litter and organisms can negatively affect individuals and a substantial proportion of some populations: for example, over 40 percent of sperm whales beached on North Sea coasts had marine litter—including ropes, foils, and packaging materials—found in their gastrointestinal tracts (Unger et al. 2016), and over 95 percent of the population of northern fulmars (*Fulmar glacialis*) might contain plastics litter in some European waters (Van Franeker et al. 2011). There are further concerns about the potential for ingestion to facilitate the transfer of chemicals to marine life (Bakir, Rowland, and Thompson 2014). Although there is clear evidence of chemical transfer from plastics to biota, there is no evidence that this mechanism adds a substantial additional chemical burden compared with other pathways, such as via food.

Another source of concern is the colonization of organisms on plastics debris. Species found on plastics debris can differ from the free-floating microbial communities in the oceans: for example, microplastics collected


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in the surface waters of the North Atlantic were colonized by a variety of organisms, including bacteria, cyanobacteria, diatoms, ciliates, and radiolaria (Zettler, Mincer, and Amaral-Zettler 2013). Plastics have been reported to travel over long distances, and they can contribute to the dispersal of alien or invasive species (Barnes 2002).

Contamination of the marine environment with plastics debris can also have negative economic consequences on aquaculture, tourism, navigation, and fisheries. With fisheries, such debris can reduce or damage catches and vessels. It is expensive to remove on a large scale: for example, the total cost of removing litter of all types from thirty-four UK harbours was estimated at £246,000 per year. Based on this estimate, it was determined that marine litter costs the ports and harbour industry in the United Kingdom approximately £2.1 million each year (Mouat, Lopez Lozano, and Bateson 2010). There is also emerging evidence that even small quantities of litter on beaches can have negative effects on human well-being (Wyles et al. 2016).

## Waste Management

The accumulation of plastics litter in the oceans is actually a symptom of a wider, more systemic problem: the linear use of plastics and the rapid accumulation of waste. Litter can be defined as something of little or no value, and the problem can be exacerbated because plastics are inexpensive, thus facilitating short-lived applications. The vast variety of plastic types presents a complication for the viability of recycling, and the quantity and diversity of single-use products puts increasing pressure on waste management infrastructures. Studies have shown that, unless waste management improves profoundly in the coming years, by 2025 the amount of plastics waste entering the ocean from land will be three times greater than it was a decade previously ( Jambeck et al. 2015). Consequently, effective waste management and recycling are critical elements in preventing loss into the environment.

Waste management practices are typically designed to help minimize such loss but can differ considerably between nations. Incorrectly managed landfills or waste management systems can cause waste to escape into the environment. In industrialized countries, waste deposited in landfills is


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often covered with soil or a synthetic material, and landfills are cordoned by fences to prevent any debris from blowing away. However, in developing regions, this is often not the case (Barnes et al. 2009; Jambeck et al. 2015). There are also circumstances in which waste management will not suffice in preventing plastics from getting into the ocean. For example, in the immediate aftermath of a tropical storm, resource management is understandably focused on human health, toxic spills, and air quality as opposed to waste management (Institute of Medicine 2007).

There are solid waste management strategies used as alternatives to landfills, such as recycling (Singh et al. 2017), reusing, or upcycling (recycling to improve the value of a material) (Braungart 2013). However, the applicability of different approaches depends on the quality of the waste, and a common issue is that the end-of-life disposal pathway has not been appropriately considered at the design stage. If the quality is insufficient, then energy recovery via incineration is an option. Even in developed countries with robust waste management infrastructures, there are obstacles to recycling, including the lack of collection points, the contamination of recycling feedstock, and the limited marketability of some recycled materials (Andrady 2005; Law 2017). Residues from plastics recycling can also escape unintentionally into the environment (Moore 2008).

Focusing on the thirty-five top-ranked countries for the mass of mismanaged plastics waste, Jambeck and colleagues (2015) suggest that, to achieve a 75 percent reduction in this waste, waste management would have to improve by 85 percent. This strategy would require time and substantial investment in infrastructure primarily in low- and middle-income countries (Löhr et al. 2017). Within these countries, the main focus is now on improving solid waste collection and management, and some outstanding efforts are being made. Indonesia, for example, set targets at the World Ocean Summit in 2017 to reduce plastics waste in twenty-five coastal cities and to reduce marine litter by 70 percent by 2025 (UN Environment 2017).

## Education and Behavioural Change

Education is crucial for promoting change in reducing waste, limiting indiscriminate disposal, and increasing awareness of marine litter,


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especially if it includes principles of behavioural change and goes beyond merely teaching facts. Programs to help encourage this change are being considered and could be very successful in reducing litter and waste. For example, a study by Hartley and colleagues (2015) found that schoolchildren in the United Kingdom significantly improved their understanding of the causes and negative impacts of marine litter, as well as their self-reported behaviour, after an education intervention related to marine plastics debris. Education of and behavioural change in children are crucial since they have an important influence on their peers, parents, and communities (Hartley, Thompson, and Pahl 2015). Hartley and colleagues (2018a) demonstrated similar results following a European video contest for schools and training specifically tailored to educators. Therefore, making resources available to incorporate marine litter awareness into the school curriculum could spread knowledge of the issues and greatly improve collective understanding.

Citizen-focused activities such as beach cleans are also well recognized for their educational value. They are also effective in terms of litter removed (Nelms et al. 2016) and might even have benefits for human well-being (Wyles et al. 2016). These activities can be combined with monitoring exercises and the involvement of local communities. Annual cleanup operations are now organized internationally (Barnes et al. 2009) and often run by voluntary organizations. Volunteer involvement in two of the largest cleanup schemes in the United Kingdom (Marine Conservation Society Beach Watch and Keep Scotland Beautiful National Spring Clean) has been estimated to provide a value of £118,500 annually to cover the cost of beach cleans, which suggests that the total cost of voluntary action to remove marine litter is considerable (Mouat, Lopez Lozano, and Bateson 2010).

Additionally, we need to consider the role of society and the processes of social perception and influence among a range of actors (Hartley et al. 2018b). Unless the efficacy of solutions is properly evident and understood, there is a significant risk that interventions made in haste will not be socially acceptable and/or might lead to unintended negative consequences.

In simple terms, it is important to raise awareness of the need to dispose of end-of-life items properly and not to litter in addition to raising


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awareness of the often unnecessary use of plastics, such as single-use bags, cutlery, plates, and drinking straws. However, educating the public about the damage alone is unlikely to achieve the substantial change required; we need to harness powerful motivators for managing waste differently, such as the great affinity that many children (and adults) feel with the ocean (Pahl, Wyles, and Thompson 2017). Moreover, beyond raising public awareness, systemic change is necessary to reduce the substantial accumulation of end-of-life plastics waste. This change will require a transition within the industry, right from the product design stage, in order to ensure that maximum value can be recovered at end of life. In the absence of such changes, educating the public is, to some extent, merely educating them about a broken system.

## Industry and the Circular Economy

Industry has a key role to play in reducing the potential for end-of-life plastics to become waste and litter. The current use of plastic materials is predominantly linear, and this is leading to the rapid accumulation of persistent waste. Long-term sustainable solutions lie in moving from a linear economy toward a more circular economy (Ellen MacArthur Foundation 2016; European Commission 2012). This approach involves utilizing more sustainable patterns of production and consumption and the circular use of materials that will ultimately lead to a reduction in waste, for example by designing products for reuse/recycling and avoiding the unnecessary use of plastics. Most plastics are inherently recyclable, yet many single-use items are not designed to be widely compatible with recycling programs. A key challenge, therefore, is to ensure that end-of-life disposal via recycling is appropriately considered at the design stage. For these interventions to be successful, a tax might be required on non-recyclable products, or an incentive might motivate the use of recycled materials in new products so as to encourage reuse and/or design for recyclability.

In addition, we need greater awareness of the applicability of alternative approaches, which from a narrow perspective might appear to present environmentally friendly alternatives. These approaches need to be considered in terms of their overall environmental footprints and how they interact with existing schemes of collection to ensure that there are not


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unintended negative consequences, for example plastic products designed to have greater degradability or made from renewable rather than fossil carbon sources.

Materials with enhanced degradability can reduce the amount of highly visible macroplastic waste. However, it is challenging to deliver products that are durable while in service yet can degrade in a meaningful time scale if they become litter in the environment. Some formulations merely fragment, compromising the potential for product reuse and accelerating the production of microplastic fragments (Thompson et al. 2009). Even when disposed of properly, most degradable formulations are not compatible with recycling and can be disposed of only as residual waste in landfills or incinerated. These plastics do have a role but might present solutions in specific settings only where the associated waste collection is specifically managed and provides conditions suitable for degradation and products are labelled accordingly to facilitate appropriate disposal. Similarly, altering the carbon source for plastics by utilizing plant-based carbon, rather than fossil carbon from oil and gas, is a distraction to some extent. Although this approach utilizes a renewable and hence a more sustainable carbon source, by itself it will not reduce the generation of waste or the accumulation of litter and might even conflict with other uses of the resource.

In summary, industry has a key role in helping to maximize the benefits that plastic products can bring to society while helping to minimize emissions of plastics during life in service and at end of life. This requires greater recognition of unintended consequences via extended producer responsibility. Had this approach been in place when the patent on the use of microbeads in cosmetic products was first filed some fifty years ago, much unnecessary contamination and the eventual need for costly legislative measures could have been avoided. Similarly, it is now clear that some types of garment construction release fibres more quickly than others (Napper and Thompson 2016). This is not in the interests of consumers because clothing wears out more quickly and results in a more rapid release of fibres into the environment. The key step is to consider this at the design stage to minimize the avoidable emission of synthetic textile fibres. In addition, the development of washing machine filters to capture any released synthetic fibres in the washing cycle might be advantageous.



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The introduction of appropriate labelling on products to indicate their environmental footprints in terms of recycled content, material use, and recyclability could be instrumental in guiding product choice along the supply chain. Such information is just as important to major retailers as it is to consumers since it paves the way to helping ensure sustainability and ethical choices made upstream—taking the burden off the consumer.

## Policy Measures

The United Nations Development Goals request that nations "prevent and significantly reduce marine pollution" by 2025 (UNGA 2015). This can be facilitated by policy measures to help reduce the unnecessary use of plastics. However, there are numerous applications in which plastics are clearly the best materials, and here policy measures can help to nudge behaviours toward more circular material use, such as deposit return schemes. Ultimately, these measures need to help us move toward more resource-efficient circular material use (Lieder and Rashid 2016). The European Union has set this in motion in its "Action Plan for the Circular Economy," implementing a waste hierarchy in which prevention, reuse, recycling, and energy recovery—in this order—are favoured over landfills (European Commission 2015).

Solutions linked to management strategies and policies are also already in place to reduce marine litter (GESAMP 2015). They include the use of targets, taxes, education, and bans. Banning microbeads in cosmetics is an example of such legislation. However, based on the level of concern and the scale of the marine litter problem in general, it appears that the measures currently used are insufficient. In some cases, there are difficulties associated with enforcement: for example, the regulation of dumping at sea (MARPOL–The International Convention for the Prevention of Pollution from Ships) is extremely difficult to monitor.

Taxes introduced on plastic items have been instrumental in changing consumer behaviour. A fifteen euro cent tax on plastic bags in Ireland led to a 90 percent reduction of their use in the early 2000s (Convery, McDonnell, and Ferreira 2007). The tax has successfully removed the widespread use of plastic bags throughout Ireland and inspired similar taxes globally. In San Francisco, a ban on conventional plastic bags has


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been introduced, forcing the use of alternative bags such as cotton tote bags (Romer 2010). Unfortunately, these taxes do not always work effectively. South Africa has struggled to achieve similar rates of reduction in plastic bag use through taxes (Dikgang, Leiman, and Visser 2012).

Plastics debris does not recognize international boundaries, and regulations need to be enforced at the international scale. Global commitments and goals provide a good basis for this enforcement, but measures and actions then need to be applied at national and regional levels. There are substantive differences at these levels in the causes of plastics pollution, both on land and at sea, therefore effective solutions must take into consideration local conditions, such as waste management infrastructures (Jambeck et al. 2015; Van Franeker and Law 2015). Hence, design and implementation of effective, efficient, and legitimate actions need to be based on a thorough understanding of the issue as well as the local context.

## Conclusion

Although the suite of potential solutions is well recognized, there is no one-size-fits-all solution. In the current thirst for action, a major challenge is matching appropriate solutions to particular problems. We think that, to address this type of challenge, an interdisciplinary and intersectoral approach will be necessary to reconfigure how modern societies engage with plastics. Profiting from the current groundswell of public opinion, transformative change could be achieved by harnessing the potential of the social and behavioural sciences to understand and influence the decisions and behaviours underlying the plastics challenge. In addition, the arts and humanities can help to inspire creative change yet be firmly integrated within the evidence base of the natural sciences.

Beyond integrating different academic perspectives, such an effort should work with stakeholders, practitioners, policy makers, and industry. This approach would be able to capture how plastics are currently viewed and managed in society, truly representing the user perspective. It would also identify and respond to both intrinsic and extrinsic motivations plus constraints along the supply chain. More importantly, the approach could demonstrate how the current situation can change by facilitating evidence-based dialogue with design and waste management,


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economic and legal studies, and arts and other creative disciplines. Looking at the system in such an integrated way could trigger an irreversible course toward more sustainable design, use, and disposal of plastics and be adapted to other societal challenges.

There are solutions to the global problem of marine litter. To a large extent, such litter is a symptom of a more systemic issue originating on land that relates to the design, use, and disposal of waste (particularly single-use plastic items). Solutions to this problem require coordinated actions among industry, policy, and the public at levels from local to global. This will involve the interactions of consumers, producers, policy makers, managers, local residents, tourists, industries, and many other key players. Unity, collaboration, and ownership of solutions among these groups will provide the greatest potential for success. Currently, the scopes, time frames, and dynamics of all these initiatives are distinctly different, and close collaboration and orchestration at all levels are lacking.

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2

# Slow Violence

## The Erosion of Marine Plastic Debris and of Human Health

*Sasha Adkins*

> *The long dyings—the staggered and staggeringly discounted casualties, both human and ecological—are often not just incremental but exponential, operating as major threat multipliers.*
>
> —Rob Nixon (2011b)

No one knows how long it will take plastics to degrade. Speculation about precisely how many hundreds of years a plastic straw will last under various temperature regimes is a sideshow. The plastics industry has co-opted well-founded concern about the environment and misdirected it toward facile solutions that function as alluring red herrings. No matter what colour of bin plastics are ultimately sorted into, fossil fuels were extracted to make them. Oil or gas molecules were heated until they split apart to create benzene, toluene, xylene, and the other building blocks of plastics. Before a plastic straw has even taken shape, it has already left a toxic footprint.

The full impact of this toxic footprint has yet to be realized. Some of the chemicals associated with plastics are altering the expression of DNA, not only in ourselves, but also in those yet to be born. Rob Nixon's



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description of "slow violence" as "formless threats whose fatal repercussions are dispersed across space and time" seems to be a particularly apt warning (2011b, 10). Unless regulators take the full life cycles of plastics into account, as noted in Chapter 12 of this volume, efforts to forestall the serious public health and ecological consequences of disposable culture might fall short.

## Biochemical Violence

Plastics are seeping into our bodies. Microscopic plastic fibres in the air wend their way into our lungs (Gasperi et al. 2018). Nano- and microplastics in food are taken up through our digestive tracts (Lundquist 2016; Volkheimer 1975). Once inside us, they can move into the placenta (Wick et al. 2010) or even the brain (Mattsson et al. 2017) before making their way out of us again (Schwabl et al. 2018). What are these uninvited guests up to? The honest answer is that we have no idea. Science is much better at identifying acute effects than it is at understanding the delayed consequences of our long-term cohabitation with plastics and the chemicals associated with them.

One emerging area of research looks at how prenatal exposures can have consequences not evident until adulthood. One classic example of the "developmental origins of health and disease" is the case of diethylstilbestrol (DES). This synthetic estrogen was widely prescribed to pregnant women. It was assumed to be safe because the mothers and their babies appeared to be unharmed—until the exposed children reached puberty. As young adults, DES daughters had such high rates of an otherwise rare cancer, vaginal clear-cell adenocarcinoma, that physicians and epidemiologists were able to demonstrate a causal connection—a rarity in a discipline that sets such a high bar for what constitutes "proof" of causality.

Long lag times like these are expected when looking at cancer causation. It can take a decade or more, and the interaction of multiple exposures over time, for the cancerous cells to proliferate. What is new is that so many other health problems, from obesity to diabetes to asthma, might have long lag times too. Some of these problems can even persist from generation to generation through what is known as transgenerational


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epigenetic inheritance. In simple terms, exposures alter which genes are expressed and which genes are silenced. For example, laboratory studies in various species have found transgenerational inheritance of alterations in the brain after exposure to bisphenol-A (BPA), the monomer (building block) of polycarbonate (Drobná et al. 2018), as well as from styrene (the building block of polystyrene) (Katakura et al. 1999). When whole plastics were tested, nanopolystyrene was transferred to subsequent generations through the gonads, with deleterious effects (Zhao et al. 2017). The danger is that, outside the controlled conditions of the laboratory, it is very difficult, if not impossible, to connect the dots between exposures so far removed in time from their effects. When it is difficult to prove causality, it is impossible to demand accountability.

Not all plastics are alike, of course, and different plastics carry different toxicological risks. According to the database Chemicals Associated with Plastic Packaging (CPPdb),

> of the 906 chemicals likely associated with plastic packaging, sixty-three rank highest for human health hazards and sixty-eight for environmental hazards according to the harmonized hazard classifications assigned by the European Chemicals Agency within the Classification, Labeling and Packaging regulation implementing the United Nations' Globally Harmonized System. Further, seven of the 906 substances are classified in the European Union as persistent, bioaccumulative, and toxic, or very persistent, very bioaccumulative, and fifteen as endocrine disrupting chemicals (EDC). Thirty-four of the 906 chemicals are also recognized as EDC or potential EDC in the recent EDC report by the United Nations Environment Programme. (Groh et al. 2019, 3253)

Persistent and bioaccumulative chemicals do not go away. The expression "a moment on the lips, a lifetime on the hips" was originally intended to warn against overindulging in desserts, but it could just as easily explain how toxics bioaccumulate—except that toxic chemicals can enter the body not only through our lips but also carried on our breath or absorbed through our skin. There are more ways in than out, however. Most persistent compounds are lipophilic, meaning that they are attracted to fat and oil. They hide in the fatty parts of our bodies. Unlike most compounds,


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they are not converted by liver enzymes into water-soluble forms, so they do not pass out of us in urine, sweat, and tears. Breastfeeding is one of the few ways to detoxify the body of its accumulated load of persistent organic contaminants, but the toxic compounds are transferred to the nursling.

Chemicals do not just store up in the fatty parts of people; they also bioaccumulate in other species, particularly in species high up on the food chain.[1] In each bite of prey, top predators take in all of the toxic compounds that the smaller creature had bioaccumulated over its lifetime. The higher up on the food chain, the more concentrated the poisons. This is called biomagnification.

The chemicals, then, are indeed "dispersed across time and space." They build up vertically, bioaccumulating within a single organism over its lifetime and then moving into its progeny. They also build up horizontally, moving from species to species and between air and water and soil. Just as the toxic chemicals add up, so too does the damage. Repeated assaults overwhelm the capacity of the body, or of the environment, to repair itself. Chronic low-dose exposures lead to cumulative effects.

Of course, the production, use, and disposal of plastics are not the only sources of toxic chemicals in the environment. They are, however, an illustration of slow violence: causing harm across time and space in ways that might be difficult to trace given our current tools of analysis. It is difficult to trace in the sense that epidemiology will continue to struggle to demonstrate a causal relationship between impaired health and plastics, and it is untraceable in that the victims of this slow violence often die unremarked and uncounted.

Nixon opens his book with an epigraph from Arundhati Roy: "I think of globalization like a light which shines brighter and brighter on a few people and the rest are in darkness, wiped out. They simply can't be seen. Once you get used to not seeing something, then slowly, it's no longer possible to see it" (2011b, 1). Those most affected by the slow violence of plastics are the invisible people who work in some of the most dangerous industries: extraction, chemical production, and waste management. Insofar as their invisibility contributes to the perception that they are disposable, one strategy for resistance is to shine the light back on them and on the processes by which they are put at risk.



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## Extraction of Fossil Fuels

From extraction to use to disposal, plastics are inextricably entangled in a linear economy that exploits humans, non-humans, and the planet. Since 99.8 percent of plastic is derived from fossil fuel, it is apposite to consider the impacts of fossil fuel extraction (Künkel et al. 2016). From the regional scale to the global scale, from Ogoniland in the Niger Delta to Yasuní, Ecuador, there is a legible pattern of disproportionate exploitation of fossil fuels on Indigenous lands and in other vulnerable minority communities. In the United States, 20 percent of fossil fuel reserves are found on Native American reservations even though they comprise only 2 percent of the American land base (Osborne 2018). Each nurdle[2] that bobs on the tide represents more than careless "matter out of place" (Douglas 1978). It carries a story of embodied toxicity and embodied injustice.

I will use hydrofracking[3] as an illustration since a recent increase in plastics production in the United States has been linked to an increase in domestic fracking (Taylor 2017). Nearly $180 billion US have been invested since 2010 in new "cracking" facilities that turn natural gas, or crude oil, and their derivatives into raw ingredients for plastic synthesis: ethylene, propylene, butadiene, and benzene (Plotkin 2016).

Fracking well pads are no longer hidden in remote locations. They can be found in dense urban neighbourhoods without a buffer zone (Sweas 2018). Residents nearby complain of incessant noise, of light pollution, and of the diesel fumes of the hundreds of trucks coming to and going from the well pad. Investigation of the human health effects is ongoing, but studies suggest that air and water pollution associated with fracking might increase the likelihood of adverse reproductive outcomes, asthma, and childhood leukemia (Boulé et al. 2018; Epstein 2017; Sapouckey et al. 2018; Shamasunder et al. 2018).

Workers involved in fracking under routine conditions can come into contact with airborne crystalline silica and a proprietary mix of chemicals while handling the hundreds of thousands of pounds of "frack sand" (American Public Health Association 2010). They are also exposed to the emissions of diesel trucks and equipment and to established risk factors such as excessive noise and vibration (Schneider 2013). Spills and accidents are ever-present risks. At least four deaths have been reported


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when workers monitoring flowback (the fracking fluids that return to the surface) were exposed to lethal concentrations of hydrogen sulphide gas and volatile hydrocarbons (Snawder et al. 2014).

One of the increasingly scarce resources depleted by the production of plastics (and, of course, by other uses of oil and gas) is water. Fracking requires 9.6 million gallons (36,339,953 litres) of fresh water per well (Gallegos et al. 2015). This is one reason that 22 gallons (186 litres per kilogram) of water are required to produce each pound of plastic derived from unconventionally drilled oil (Grace Communications Foundation 2017). The spoiled water returns to the surface along with some of the chemicals[4] from the fracking operation itself and the salts, chemicals, and naturally occurring radioactive material (with the euphemistic acronym NORM) that leach from the earth into the high-pressure flow of water. This brine is typically either reused in another frack or injected deep into the ground, a practice tied to an increase in the frequency and intensity of earthquakes (Bao and Eaton 2016; Ellsworth 2013; Schultz et al. 2016). Sometimes it is used to irrigate crops (Duke University Nicholas School of the Environment 2017) or sprayed on roadways for de-icing or dust control (Marusic 2018; Veil 2016).

To bring the extraction problem full circle, fracking "sand" itself can be particles of plastic (Parker, Ramurthy, and Sanchez 2012), such as polyacrylamide (Xiong et al. 2018), styrene-divinylbenzene copolymer, or a styrene-ethylvinylbenzene-divinylbenzene terpolymer mixed with a proprietary nanofiller, or real sand coated in a synthetic polymer such as (BPA-based) epoxy resins, furan, polyesters, vinyl esters, and polyurethane (Liang et al. 2016). In other words, in order to produce plastics, we inject microplastics deep underground. Coating raw sand with plastic increases its strength and resistance to being crushed.

Once the natural gas has been extracted, the ethane is separated from the methane. Ethane is taken to a cracker, where a good deal of energy is used to heat it to 1,500 degrees Fahrenheit (816 degrees Celsius).[5] The heating process breaks some of the carbon-hydrogen bonds and causes a new molecule to form: ethylene. Ethylene is the building block of polyethylene (a plastic used to make shopping bags, milk jugs, and many other familiar items). However, if it is subjected to a complex set of chemical reactions, it can be made into styrene (which in turn can be expanded


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into Styrofoam™), polyester, synthetic rubber, vinyl acetate (the base of some chewing gums), or vinyl chloride, the building block of PVC (vinyl).

## Manufacturing of Plastics

Workers' health and safety rarely make headlines. A tragic exception occurred in 1984 when a pesticide factory in Bhopal, India, released a cloud of methyl isocyanate gas over the surrounding community where workers and their families lived. Thousands perished. The official version of events, as told by Union Carbide (now Dow), blames the disaster on a worker rather than on any contributing structural factor (Saxon 1986).

Such spectacular instances are hard to ignore, but they are readily dismissed as accidents, as exceptions to an otherwise tolerable safety record. Slow violence done to workers in the plastics industry is much different. In fact, it can be hard to see without specialized training in occupational epidemiology. It is what Nixon (2011a) would call the "attritional lethality" of everyday, cumulative exposures.

Among workers in past generations, exposure to high levels of vinyl chloride monomer (VCM) was linked to an otherwise rare liver cancer called angiosarcoma as well as to acroosteolysis, a painful condition in which the bones in the fingertips and sometimes the toes are resorbed. Permissible exposure limits in the United States for PVC industry workers have been lowered substantially,[6] but it is unclear whether workers abroad, particularly in China, where nearly 40 percent of the world's VCM is made, enjoy similar protections (IHS Markit 2017; Kielhorn et al. 2000).

Vinyl chloride is just one of hundreds of dangerous chemicals associated with the production of plastics. Warning signs are emerging about others. Handling BPA is linked to a long list of health problems, among them impaired sperm production (Li, Frey, and Browning 2011). Styrene (the monomer used in the production of polystyrene) can cause, among other maladies, hearing loss (Johnson 2007). Antimony, used as a catalyst in the synthesis of polyethylene terephthalate (PET) (single-use plastic water bottles are frequently made of this material), is linked to cardiac arrhythmia, an altered sense of smell, pneumoconiosis (a lung disease), chronic bronchitis, and skin irritation (Sundar and Chakravarty 2010). One of many problems associated with phthalates (chemicals used


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as plasticizers to soften PVC and used in many cosmetics and fragranced products) is that they interfere with the body's ability to regulate testosterone.

There is evidence that this effect, and other toxicants that act on the body's hormonal systems, do not necessarily follow the usual Paracelsian logic of "the dose makes the poison." There is not always a safe threshold below which harm is not anticipated. Instead, some toxicants follow decelerating exposure-response curves (Lanphear 2017; Vandenberg et al. 2012) in which smaller doses can be more harmful than larger ones. When zero is the only safe dose, we put those tasked with regulating permissible exposure limits in a predicament. As long as we manufacture these chemicals, there will be some degree of risk to plastics industry workers.

## Disposing of Plastics

Much is obscured behind the racist caricature of the "ecological Indian" in the iconic 1971 Keep America Beautiful ad campaign. Italian American actor Espera de Corti, himself not Indigenous, is dressed in buckskin and paddles a canoe. Upon viewing the environmental degradation and carelessness of the modern world, he sheds a single tear, silently pleading with Americans not to litter (Gilio-Whitaker 2017). Aside from the evident problems of cultural appropriation and the troubling implication that the presence of the Indian in "modern" society is an anachronism, the ad was part of an "astroturf"[7] campaign by the beverage industry to deflect criticism of the introduction of disposable packaging for drinks (Dunaway 2017). This set the stage for the popularization of disposable plastics.

The garbage placed "responsibly" in rubbish and recycling bins tends to end up in the bodies of Indigenous people and in other socially vulnerable communities (Cerrell Associates and California Waste Management Board 1984). Landfills, incinerators, and even materials recovery facilities where items are sorted for recycling are disproportionately sited in low-income communities of colour—and not by accident ( Jaramillo et al. 2007). They are called LULUs (locally undesired land uses) for a reason.

The transnational movement of trash also flows from the over-resourced to the under-resourced. Now that China is refusing shipments of waste plastics for recycling, evidence suggests that some of this "recyclable"


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plastic is finding its way to Malaysia, Vietnam, and Thailand, where there is no trash management infrastructure to receive it. Western waste can be found littering waterways or piled in open fields. When everything of market value has been reclaimed, the rest is burned, sending plumes of noxious smoke over the workers and the surrounding residential areas (Greenpeace International 2018). Meanwhile, American consumers who put their waste plastic in the blue bins provided are encouraged to feel pride in having "recycled."

Even under the best circumstances, trash and recycling collection/sorting is a risky business. It ranks as one of the five most dangerous professions in the United States, with 34.1 fatalities per 100,000 workers (Bureau of Labor Statistics 2017). Workers face accidents with machinery, exposure to chemical and biological hazards (including blood-borne pathogens), repetitive stress injuries, and noise. In a survey of unionized materials recovery facility (MRF) workers in the Bay Area of California, most workers self-reported eye irritations (68 percent of respondents) and coughs (57 percent), which they attributed to excessive dust. One worker remarked that, "whether I wore my mask or not, when I blow my nose at the end of the day, black stuff comes out" (Jamison 2013, 10). Informal sector waste pickers and incarcerated workers face much more serious risks (Jackson, Shuman, and Dayaneni 2006; Mothiba, Moja, and Loans 2017).

Even incineration and its cousins, pyrolysis and "waste-to-energy," do not make plastics go away. The by-products of both of these processes are a toxic ash (which then must be disposed of) and air pollution. Which by-products of combustion are created depends on the particular mix of materials in each load, on the level of oxygen present, and on the temperature of the burn. Burning polyvinyl chloride at certain temperature ranges, for example, in the presence of oxygen and organic material such as paper, can produce dioxins, some of the deadliest and most persistent synthetic compounds known to science. Some plastics release hydrogen cyanide when burned, a fact that firefighters know all too well (Burke 2006). Although some of that pollution can be trapped by filters, the filters themselves then become a toxic solid waste problem and are typically moved to a landfill. Consequently, there is growing organized resistance to burning plastics (GAIA 2019).



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Yet greenwashing paints burning trash as a sustainable solution, again deflecting attention from the inherent unsustainability of a disposable culture. The Cerrell Report suggests that, to disarm environmentalists, "the concept of a Waste-to-Energy project should be introduced to the public at the onset as part of a recycling program" (Cerrell Associates and California Waste Management Board 1984, 31). Japan has endorsed this strategy wholeheartedly. There the national recycling tally includes the tonnes of trash burned in *sāmaru risairingu* ("thermal recycling") facilities (Yolin 2015).

## Conclusion

Privileged consumers do not see the communities poisoned by the extraction and refining of the oil and gas that become their straws and shopping bags and water bottles. They send their plastic waste overseas so that they do not have to see the mountains of it piling up or breathe the acrid smoke as it burns. The false morality of recycling shields wilful ignorance behind a smokescreen of pro-environmental virtue.

### NOTES

1. Curiously, the levels of persistent and bioaccumulative compounds such as PCBs and mercury appear to vary by sex in fish (Madenjian et al. 2016). The authors speculate that testosterone levels can affect mercury toxicokinetics in fish and possibly in humans.
2. Nurdles, sometimes called "mermaids' tears," are prefabrication resin pellets. They are transported to factories that melt them and mould them into everyday objects. Because they are lightweight, spills are common. That they are inexpensive disincentivizes investing in measures to contain them.
3. Readers unfamiliar with hydrofracking can refer to a BBC explainer ("What Is Fracking?" 2018) that reads in part "fracking is the process of drilling down into the earth before a high-pressure water mixture is directed at the rock to release the gas inside. Water, sand and chemicals are injected into the rock at high pressure which allows the gas to flow out to the head of the well. The process can be carried out vertically or, more commonly, by drilling horizontally to the rock layer and can create new pathways to release gas or can be used to extend existing channels. The term fracking refers to how the rock is fractured apart by the high-pressure mixture."


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4. The Endocrine Disruption Exchange maintains a set of spreadsheets online representing the results of its ongoing effort to catalogue the constituents of fracking operations and to identify their potential health impacts. See https://endocrinedisruption.org/audio-and-video/chemical-health-effects-spreadsheets.
5. For an excellent treatment of environmental racism in the siting of ethane crackers, see Lerner and Bullard (2005).
6. In 1975, based on numerous reports of angiosarcoma of the liver in vinyl chloride workers, the US Occupational Safety and Health Administration dropped the time-weighted average permissible exposure limit from 500 parts per million to 1 part per million. Toxicologists at Dow and B.F. Goodrich had been aware since the 1950s, however, that exposures as low as 200 parts per million led to liver cancer. They colluded to keep this information hidden from government regulators (Sass, Castleman, and Wallinga 2005).
7. "Astroturf refers to apparently grassroots-based citizen groups or coalitions that are primarily conceived, created and/or funded by corporations, industry trade associations, political interests or public relations firms" ("Astroturf" n.d.).

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# 3

# How Seabirds and Indigenous Science Illustrate the Legacies of Plastics Pollution

*Stephanie B. Borrelle, Jennifer F. Provencher, and Tina Ngata*

Plastics pollution in aquatic ecosystems is recognized as one of today's most pressing environmental issues (UNEP 2016). The knowledge of how plastics are affecting marine organisms is crucial for developing strategies to address this intensifying global issue and for improving our understanding of the potential human health impacts (UNEP 2018). Seabirds have migration pathways that can span hemispheres, and they feed along the surfaces of ocean currents, rendering this group disproportionately affected by the impacts of plastics pollution. As a result, seabirds have been sentinel species at the forefront of marine pollution issues, and they continue to illustrate the extent and potential toxicological impacts of marine plastics pollution. Importantly, seabirds are a culturally harvested species for a number of Indigenous groups globally (e.g., muttonbird in Aotearoa New Zealand; see Moller et al. 2004). Thus, Indigenous communities might be disproportionately affected by contaminants associated with the ingestion of plastics through their consumption of seabirds.

Indigenous peoples are uniquely positioned to contribute to this growing research field and benefit from the effective communication of results as they pertain to the species consumed. Coalescing the enduring



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knowledge of Indigenous science with non-Indigenous science can help to illustrate the legacies of plastics pollution and facilitate action to address the intensifying issue. In this chapter, we discuss how plastics pollution and seabird researchers can amalgamate diverse perspectives and approaches to advance our understanding of plastics pollution through meaningful communication and collaboration with Indigenous partners. We also develop a collective understanding of the legacies of transboundary contaminants and mobilize the international community on policy actions. We focus on the ways forward but acknowledge that there are many challenges involved in achieving collaborative relationships among Indigenous scientists and the Western academy, yet these relationships are necessary to overcome the injustices of colonial systems that have damaged these relationships (Switlo 2002). Specifically, there is a need for more critical analyses of how Indigenous science and non-Indigenous science can facilitate a greater understanding of this emerging global contaminant.

## Bioindicators of Plastics Pollution

Ingestion of plastics by fish was first documented in the scientific literature in 1949 by Edgard Gudger. Now more than 700 species are affected by the ubiquitous contamination of the environment by plastics (Gall and Thompson 2015; Provencher et al. 2017). Although plastics pollution poses a threat to all marine biota, the most examined group has been seabirds (Provencher et al. 2017), perhaps because they are conspicuous, abundant, and present in all of the oceans and seas of the world (Schreiber and Burger 2002). Seabirds are particularly susceptible to ingestion of plastics because they feed at the surface of the ocean, often mistaking plastics debris for food (Cadée 2002). Ingestion of plastics by seabirds has been documented from the Arctic (Provencher et al. 2010; Trevail et al. 2015), to the Antarctic (Van Franeker and Bell 1988), to the oceans in between (Avery-Gomm et al. 2013; Ryan 2008). Seabirds are also the taxa used in the only established plastics monitoring program developed to date (Provencher et al. 2017; Van Franeker et al. 2011), and they have been used to study changes in plastics pollution at different temporal and spatial scales (Ryan 2008; Van Franeker et al. 2011).



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The physiological effects on seabirds from ingestion of plastics debris include internal and external wounds, skin lesions and ulcerating sores, diminished body weights and fledgling success, reduced reproductive capacity, starvation, dehydration, drowning, and impairment of predator avoidance (Auman et al. 1998; Lavers, Bond, and Hutton 2014). Chicks and fledglings are often the most visible victims of ingestion of plastics because of large loads of plastics debris regurgitated by their parents, reducing fledgling success rates (Gregory 2009; Hutton, Carlile, and Priddel 2008).

Concerningly, there is growing evidence of acute and chronic poisoning of seabirds from adsorption of toxic compounds found in marine plastics (Lavers and Bond 2013; Tanaka et al. 2013; Tanaka et al. 2015). The "sponge"-like properties of plastics can concentrate contaminants from the water column, which can be transferred to the tissues of marine animals via ingestion (Lavers and Bond 2013; Rochman 2015; Tanaka et al. 2015). Indeed, there are strong links among marine plastics, persistent organic pollutants (POPs), and other contaminants. For example, Kosuke Tanaka and colleagues (2013) found polybrominated diphenyl ether (PBDE) in the tissues of short-tailed shearwaters (*P. tenuirostris*). PBDE is a flame-retardant used in the manufacturing of plastic and transferred to an animal's tissues through ingestion (Tanaka et al. 2015). High concentrations of POPs, heavy metals, and chemical additives, such as PBDE, have been shown to cause a litany of adverse effects, including cancer, metabolic disorder, cardiovascular and immune system disease, and endocrine and central nervous system disruption, leading to developmental and behavioural impairment ( Jones and De Voogt 1999; Perkins et al. 2016).

Although the plastics themselves are thought to stay mostly in the guts of the seabirds, the contaminants that plastics carry into birds' stomachs unfortunately might not (Lavers, Bond, and Hutton 2014; Tanaka et al. 2013; Tanaka et al. 2015). The adsorption and desorption of POPs and chemical additives by marine plastics pollution, and the subsequent transfer through the food chain, are only beginning to be understood, and the degree to which they affect animal and human health is a matter of debate (Rochman et al. 2016). The research to date indicates that internal organs likely concentrate microplastics and their associated contaminants


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differently (Clukey et al. 2018; Ding et al. 2018; Tanaka et al. 2015). There is also evidence that plastics-derived contaminants can be passed to the eggs of seabirds, indicating that maternal transfer can also occur (Lu et al. 2019). As more is learned about contaminant transfers from plastics to biota, there is growing concern that toxins might be transferred through the food chain to people who consume marine resources, which has human health implications (Rochman et al. 2015; Seltenrich 2015; UNEP 2018; see also Chapter 12 of this volume). Therefore, it is imperative that plastics ingestion researchers engage a wide variety of disciplines and partners as work is undertaken to evaluate the potential health impacts of this ubiquitous environmental pollutant.

As illustrated above, chemists and eco-toxicologists have added to our understanding of the effects of plastics pollution via detailed examinations of how plastics and contaminants might interact in the ocean and within biota (Clukey et al. 2018; Tanaka et al. 2015; Yamashita et al. 2011). Understanding how plastics pollution can be a vector for contaminants is a critical part of understanding how plastics pollution can affect biota and human health. However, the variety of plastic polymers and how numerous contaminants interact in different concentrations, distributions, and environmental conditions (Rochman et al. 2019) present complex challenges in answering basic questions about the population-level impacts of ingestion of plastics and the associated transfer of toxins in marine life (Rochman et al. 2016). To understand the extent and severity of plastics as conduits of hazardous chemicals via ingestion to marine life and human health, cross-disciplinary and collaborative approaches are required.

## The Burden of Plastics

Coastal Indigenous communities are often disproportionately exposed to high levels of POPs and contaminants in the oceans because of their consumption of marine top predators (Mallory 2006; Schæbel et al. 2017; Selin and Selin 2008). As researchers and communities learn more about plastics pollution in the environment, local and national research organizations are pushing for closer examinations of how plastics pollution might be affecting species regularly consumed by local Indigenous communities



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(Lavers and Bond 2013; Provencher et al. 2013). Therefore, a comprehensive understanding of how plastics pollution is distributed through ecosystems, and its potential to carry contaminants through the marine food web, requires an Indigenous context in the research and communication of studies of plastics ingestion. Indigenous communities regard the health of local ecosystems, land management, and resource extraction as critical issues for their health and well-being (both spiritual and physical), and they have routinely advocated for improved environmental governance on these issues (Dahl, Hicks, and Jull 2000; Selin and Selin 2008).

The inclusion of Indigenous science—often referred to as Traditional Ecological Knowledge (TEK) or Indigenous Knowledge (IK)—is increasing in research, particularly in the ecological and environmental sciences (Simpson 2004). Although the acceptance of Indigenous science might be well intentioned, it can be used along a gradient of inclusion, from the simplistic practical baseline that ignores spiritual, communal, and holistic aspects of Indigenous science to a more fulsome inclusion of all aspects (Simpson 2004). Indeed, the Western scientific academy is founded upon racially based epistemologies (Rigney 1999). Therefore, for a respectful collaboration to occur, there is a need to acknowledge and understand how colonial history has affected the relationships of Indigenous peoples with their lands and eroded trust between Indigenous peoples and the Western academy (Rigney 1999). Furthermore, an expansion of the often narrow interpretation of Indigenous science, and an acknowledgement that Indigenous science concepts encompass social and spiritual components of the world, not just biophysical aspects, are warranted (Tester and Irniq 2008). Indigenous philosophers have advocated for this recognition and recovery of Indigenous science in society, arguing that it is an important component of decolonization (Ngata 2018; Rigney 1999; Simpson 2004).

Below we discuss two examples of beneficial collaboration among Indigenous scientists and seabird and plastics pollution researchers, one in Nunavut, Canada, the other in Aotearoa New Zealand, where the foundation has been laid for research collaborations that can expand our understanding of the legacies of plastics pollution.


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## The Canadian Arctic

Reports of ingestion of plastics by seabirds in the Arctic date back to 2002 (Mallory, Robertson, and Moenting 2006). Although the original report was about seabirds caught in a long-line fishery, almost all of the reports on plastics ingestion since that time have been collaborations with local Inuit hunters or from areas co-managed with Inuit communities (Mallory 2006, 192; Provencher et al. 2013, 237–41). More than a decade into plastics research in Arctic Canada, most seabird species consumed by Inuit have been assessed for plastics ingestion since communities are interested in knowing which hunted species are exposed to this emerging contaminant (Provencher et al. 2014). *Inuit Qaujimajatuqangit* (*IQ*) can be translated as "that which has long been known by Inuit" (Tester and Irniq 2008, 49). *IQ* includes many concepts, which can be considered as communal laws, centred on how to live one's life as an Inuk. Pertaining directly to plastics pollution is *Avatimik Kamattiarniq*—the concept of guardianship—which stresses the strong relationship between Inuit and their environment and their role as environmental stewards (Arnakak n.d.; Government of Nunavut 2013, 4).

Moving beyond identifying which species might be vulnerable to plastics ingestion, Indigenous science is shaping research questions aimed at understanding the movement and fate of plastics in species and the environment. For example, the Inuit community of Qikiqtarjuaq, Nunavut, is working with researchers to examine how seabirds might be vectors and concentrators of microplastics in the Arctic. This is of particular concern where communities are co-managing national wildlife areas that protect habitat for migratory birds. To date, four of the most common and abundant marine bird species have been shown to ingest plastics in the Arctic (Poon et al. 2017; Provencher et al. 2013, 238), and a recent study has demonstrated that seabirds can shed ingested plastics in the form of microplastics in their guano (Provencher et al. 2018). This suggests that seabirds can act as vectors for microplastics movement in the marine environment and potentially the terrestrial environment. To test whether seabird excretion of microplastics is contributing to an accumulation of microplastics around seabird colonies, Inuit hunters from Qikiqtarjuaq are working with researchers to collect biotic and environmental samples, using standard


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laboratory methods, from around two local seabird colonies known to be breeding sites of birds with high rates of plastics ingestion. Importantly, Indigenous science will direct where samples around these colonies are taken in relation to where flotsam and jetsam normally wash ashore using longitudinal knowledge of seasonally variable hydrology. This coalescence of Indigenous and non-Indigenous science will inform decisions about where samples should be taken to detect microplastics in the environment to further our understanding of the fate of plastics in the food chain in these co-managed protected areas.

In a broader sense, in response to the desire to understand the local impacts of plastics and associated contaminants, the Northern Contaminants Program (NCP) and the Nunavut Wildlife Management Board (NWMB) are two funding bodies focused on northern Canada and co-managed by Indigenous partners (NCP 2018; NWMB 2017). This attests to Indigenous voices being heard in relation to plastics pollution and its associated contaminants, indicates that the communities of northern Canada are concerned about microplastics, and shows that they have a desire to understand how long-range contaminants might be affecting their local ecosystems. Both groups have funded community-based research that examines how plastics are ingested by wildlife and the effects of plastics pollution in the North (NCP 2018). This important research contributes to our understanding of how the chemical burden of plastics pollution can transfer to the Indigenous communities that consume the species sampled. Sampling from local bird populations within a protected region co-managed by the federal government and the local community of Resolute Bay is done in collaboration with Inuit communities. Furthermore, the birds sampled for chemical contaminants in Nunavut are used as a teaching tool as part of the Wildlife Contaminants Workshop of the Environmental Technology Program delivered each year and funded by NCP (Provencher et al. 2013). This research and community education—developed by local hunters and communities and researchers connected to the international science community—have led to a broader understanding of plastics pollution in Arctic seabirds and how it compares with that in other regions (Mallory 2006; Poon et al. 2017; Provencher et al. 2017).


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The Arctic Council's Arctic Monitoring and Assessment Program (AMAP) also demonstrates a growing understanding of the potential health impacts on Indigenous communities, and most recently plastics pollution has been listed as a chemical of emerging concern at the international level (AMAP 2017). The Arctic Council itself recognizes the permanent participants (Indigenous groups) as integral partners in all of its working groups, and in the spring of 2019 AMAP formed a Marine Litter and Microplastics Expert Working Group that specifically includes the development of community-based tools with Indigenous partners.

### Aotearoa New Zealand

Māori in Aotearoa New Zealand have a concept similar to *Avatimik Kamattiarniq* within their Indigenous science or *mātauranga Māori* (Pihama, Tiakiwai, and Southey 2015, 138). The concept of *kaitiakitanga* is an expression of the interconnection between people and the environment and their role as guardians (*kaitiaki*) of *taonga* (natural treasures) (Pihama, Tiakiwai, and Southey 2015, 138). *Kaitiakitanga* is the way of managing and interacting with the environment based on the Māori worldview. The sustainability of wild harvests and the maintenance of food resources were and continue to be managed through *kaitiakitanga* principles, using mechanisms such as *rāhui*, temporary bans on harvesting certain species or fishing in specific areas. The traditional harvest of *tītī* or seabirds (e.g., sooty shearwaters, *Ardenna grisea*), known as "muttonbirding," is an important cultural resource beyond simple nourishment. Providing food is a reflection of *mana* (prestige/charisma), which demonstrates skill, *kaitiaki* in the form of ensuring the sustainability of resources, and a source of *ahi kaa*: that is, the "sustained fires of occupation" (Ngata 2018). *Ahi kaa* is a way of maintaining connections to *whakapapa*, or the genealogical fabric of Māori, ancestral knowledge that includes ancestors in the form of people but also the non-human forms of *Atua* (the gods). Plastics pollution in the environment and in food resources is part of the colonial history of disconnecting Māori from their *whakapapa*. Therefore, the role of *kaitiakitanga* for Māori can be fulfilled only when the connection to place is returned or maintained and with the continuation of cultural practices such as muttonbirding (Ngata 2018). Looking forward,


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knowledge of how plastics pollution affects harvested populations, and the potential transfer of contaminant burdens to Māori who consume seabirds, will be important to allow Māori to make informed decisions about the management of culturally harvested marine resources.

To our knowledge, there is currently no research on or monitoring of the potential for POPs or other plastics-related toxins to be transferred through the consumption of harvested seabirds in Aotearoa. However, research partnerships to do this are being forged with Rakiura Māori (the southernmost Māori tribe) (Tāne Davis, personal communication 2018). The foundations of these current and future collaborations have been laid with the partnerships among Indigenous scientists to understand cultural resources better. Muttonbirding by Māori represents an iconic example of customary use and *kaitiakitanga* of natural resources. The muttonbird harvest is culturally and economically valuable, and its management is retained almost entirely by Māori (Moller 2009; Moller et al. 2009). In recent decades, a partnership, *Kia Mau Te Tītī Mo Ake Tōnu Atu* (Keep the Tītī Forever), was formed between scientists and Rakiura Māori. The aim of this partnership is to evaluate the sustainability of the tītī harvest in their region by drawing on *mātauranga Māori* to determine population changes and tītī body condition over time. Such partnerships have resulted in heightened awareness of the conservation issues facing harvested species and facilitated dialogue on options for mitigating threats (Moller et al. 2009), including from plastics pollution.

## Echoes of the 2001 Stockholm Convention

Plastics have been recognized as an environmental issue for more than fifty years. However, there has been little to no international action on assessing or reducing the main sources of plastics pollution (Borrelle et al. 2017). Tackling the issue requires local and international collaboration at the community-science-policy interface. Indigenous groups have had, and are increasingly having, considerable influence on the discourse and policy on global environmental issues at multiple levels of governance, explicating how non-state stakeholders' interests can direct political processes. The integration of Indigenous science into political processes has occurred through the participation of Indigenous communities in


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scientific assessments, lobbying of national governments, and direct advocacy in public and political forums (Selin and Selin 2008). For example, Indigenous communities in the Arctic, who are particularly vulnerable to exposure to contaminants through the consumption of marine top predators, have expressed a strong interest in local and international pollution issues that relate directly to individual and collective human rights (Selin and Selin 2008). Such engagement of these Indigenous communities on environmental issues has shaped circumpolar consciousness and catalyzed political activism among different Indigenous groups (Semenova 2007; Watt-Cloutier 2015).

A notable example of Indigenous science and advocacy on contaminant issues is the Stockholm Convention, an international agreement to outlaw the "dirty dozen": twelve persistent organic pollutants. These contaminants bioaccumulate through the food web, thereby posing a risk to human health, wildlife, and the environment (Selin and Selin 2008). In 1998, Sheila Watt-Cloutier, an Inuk woman from Quebec, Canada, was president of the Inuit Circumpolar Council of Canada. She gave a face and name to those who argued for global action on POPs. Her testimony at the Inter-Government Negotiating Committee toward a Global Convention on Persistent Organic Pollutants during the Stockholm Convention negotiations was the catalyst for parties to take urgent action on controlling the release of the dirty dozen at the international level ( Johnson 2014). Watt-Cloutier humanized the issue, providing evidence that Indigenous peoples were experiencing the disproportionate burden of these chemicals in their home territories far from where the chemicals were produced or used (Watt-Cloutier 2015).

Involvement of Indigenous groups in the establishment of the Stockholm Protocol and concern about additional contaminant exposure in the Arctic have resulted in the continued engagement of Indigenous groups in the Arctic Monitoring and Assessment Program and the Arctic Council on hazardous substances (Selin and Selin 2008). AMAP has set an important international precedent for collaboration between Indigenous groups and state agencies in addressing the impacts on Indigenous peoples from harmful contaminants in the marine environment.



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## Understanding the Legacies of Plastics Pollution

Indigenous science has been incorporated into monitoring programs for seabird species in Aotearoa New Zealand, the United States, and Canada, where customary resource use occurs (Mallory 2006; Mallory et al. 2003; Moller et al. 2004), and has an important role in plastics research. The knowledge of species movements, population sizes, and body conditions, and the provision of tissue samples by Indigenous communities, can provide insights into the legacies of plastics pollution that might otherwise not be collected. For example, records kept of the annual *tītī* harvests by the Rakiura Māori, in southern New Zealand, showed a decline in catch rates and changes in body condition of the harvested birds, indicating that extrinsic influences during migration were affecting the populations (Moller et al. 2004). Similarly, Indigenous science—including longitudinal and intergenerational knowledge from observations over time—can reveal if there is a seasonal or temporal nature to plastics pollution ingestion in a region or species or whether some areas might be more sensitive to such pollution based on knowledge about local tides and currents. Thus, Indigenous science, such as *Inuit Qaujimajatuqangit* and *Mātauranga Māori*, can facilitate a comprehensive approach to understanding the legacies of plastics pollution ingestion and the potential toxicological ramifications for communities that consume contaminated marine resources.

The partnership between Rakiura Māori and science to evaluate the sustainability of *tītī* harvests was successful largely because of the trust between parties, equitable decision making, scientific and financial support, and, importantly, effective communication (Moller 2009; Moller et al. 2009). Although this partnership did not come without challenges, once a respectful dialogue was established, Rakiura Māori expressed that the partnership and outcomes expanded their knowledge and allowed for the continuation of their muttonbirding heritage (Moller et al. 2009). Conversely, in northern Canada, poor communication about PCB levels in harvested species and breast milk resulted in Inuit mothers choosing not to breastfeed; however, now the public health messaging about contaminants in traditionally harvested food is balanced with messages about


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the benefits of a balanced diet and breastfeeding, allowing for informed choices by community members (Watt-Cloutier 2015).

Past experiences, such as in northern Canada, emphasize the need for meaningful partnerships. *Piliriqatigiingniq*—the *IQ* concept of collaborative relationships—epitomizes the approach needed to expand our collective understanding of the legacies of plastics pollution. Our collective knowledge needs to be built upon respect, reciprocity, responsibility, and relatedness (Kimmerer 2011). These concepts are fundamental principles of *Inuit Qaujimajatuqangit*, Māori, and other Indigenous communities around the world. Indeed, *Inuuqatigiitsiarniq* is the concept of respect, *Tunnganarniq* is the concept of openness, and *Aajiiqatigiingniq* is the concept of consensus decision making. Indigenous science concepts are not mutually exclusive; rather, there is overlap among them, and it is a living technology, meaning that the concepts are not static but build in new knowledge (Arnakak n.d.). Likewise, the collective philosophy and research practices of Māori in Aotearoa, known as *kaupapa Māori,* include the principles of Āta, the principle of growing respectful relationships, and *ako Māori*, the principle of acknowledging learning and teaching practices unique to Māori (Pihama, Tiakiwai, and Southey 2015). Importantly, both Indigenous and non-Indigenous scientists have a role in communicating any information related to contaminants and harvested species to community members, ensuring that findings are communicated within a local context. It is crucial that there is mutual respect for each other's knowledge, that trust is built between parties, that decision making is equitable, that scientific and financial support is provided, and that there is effective communication between parties (Kimmerer 2011; Moller et al. 2009; Selin and Selin 2008). Hard work must be done to develop authentic reciprocal relationships beneficial to all parties involved (Shackeroff and Campbell 2007).

Importantly, there is a need to re-evaluate how different modes of science interact and to adjust accordingly. For example, when the nuances in Indigenous science vary, important knowledge might be lost when it is filtered through non-Indigenous data management and statistical methods (Simpson 2004). Therefore, viewing research through an Indigenous lens might be a more effective way of translating new knowledge of the legacies of plastics pollution. This means being careful to avoid appropriating



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Indigenous science to fit contrarily within a non-Indigenous science framework (Tester and Irniq 2008).

Finally, though we have discussed two case studies in which Indigenous knowledge and Western science have collaborated to increase our understanding of plastics pollution as an emerging contaminant, there is still much work to be done on examining the extent, benefits, and challenges of this work within a formal critical analysis. As we discuss above, many lessons have been learned from past experiences; the more a critical lens in the context of truth and reconciliation can be applied to these relationships and documented, the more we can learn collectively from these case studies and use these lessons in other applications.

## Conclusion

Unlike many POPs created in the 1970s and addressed within decades of their first use through the Stockholm Convention, the toxicological threats from plastics pollution remain understudied. Moreover, plastic pollution itself has yet to be addressed within international policy frameworks (Borrelle et al. 2017). Many branches of science are contributing to our understanding of the legacies of plastics pollution, and Indigenous scientists have a critical role to play. Indigenous peoples who have lived on coastlines for millennia and continue to harvest marine resources, such as seabirds, are uniquely positioned to shape research related to plastics pollution.

Here we have focused on the examples of beneficial collaborations that have led to greater understanding not only of the legacies of plastics pollution but also of the value of letting Indigenous science share the discourse on working to solve seemingly intractable ecological challenges. The voices of Arctic Indigenous peoples were woven into the Stockholm Convention, with the acknowledgement that Arctic ecosystems and Indigenous communities are disproportionately at risk from the dirty dozen, serving to strengthen the impact of the convention (Selin and Selin 2008). Although not without challenges, the cross-disciplinary, collaborative approach of Indigenous groups working alongside policy makers and non-Indigenous scientists generated the understanding needed to facilitate purposeful legislative action at the international scale. This


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collaboration resulted in a meaningful response to a burgeoning environmental and human health crisis. Western science approaches do not have to be exclusive or in conflict with Indigenous science approaches. When they coalesce well, they can be a powerful way to improve the collective understanding of the legacies of plastics pollution and to encourage action to address this global problem.

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# 4

# Dawn of the Plastisphere

## An Experiment with Unpredictable Effects

*Sven Bergmann*

Even though the history of plastic in mass production and consumption is rather short, we are still haunted by its accumulation. Jennifer Gabrys writes that "our material lives are an ongoing and often problematic experiment with unforeseen effects" (2014, 57). Almost every piece of plastic that has been produced is still present on the planet because it degrades very slowly (Andrady 2015). Plastics have particular and unexpected afterlives, as seen in oceanic microplastics. Following Gabrys, I am interested in the specific processes related to the physical, chemical, and biological degradation of plastics from a *natureculture* perspective. The term "natureculture" marks theoretical and empirical developments at the intersections of social and cultural anthropology, (more than) human geography, and science and technology studies (STS) in interaction with the natural sciences (Castree and Braun 2001; Haraway 2003; Latour 2012; Subramaniam 2014). Natureculture perspectives are critical of a dichotomous and distant view of nature and society; rather, they remind us of human and material implications and entanglements with the environment.

In this chapter, I discuss plastics, and in particular microplastics, as materials with unpredictable futures: although microplastics are ubiquitous, their effects on ecosystems are not yet fully understood. The



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smaller plastics become, the more they become inseparable from the surrounding environment. For example, they might form plastiglomerates (see Chapter 5 of this volume) or be aggregated with plankton through hetero-aggregation (Long et al. 2017). Following the editors' introduction, these examples show a certain ambiguity between pollution and persistence. A natureculture perspective therefore calls into question existing notions of what belongs and what does not belong in a particular environment, thereby contesting simple ideas of management. Kim de Wolff (2014) has poignantly elaborated this problem through her ethnographic analysis of how to deal with nature-plastic entanglements discovered on an expedition in the Pacific Ocean to sample plastics. Nonetheless, ambiguity must not lead to political indifference in problematizing plastics pollution. As I show in this chapter, it might help to understand better the emergent and contingent relationships among plastics, their scales (macro-, meso-, micro-, and nanoplastics), the ocean's biota and other materials, and the novel microcosms that they can produce when seeking solutions to marine plastics pollution.

Whereas many proposed solutions to the crisis of plastics pollution focus on objects that can be recognized as waste or "litter" (see the "Our Plastic Inheritance" chapter in this volume), knowledge of microplastics found in marine ecosystems offers a pathway different from those critical for land-based waste management. The definition of microplastics in the marine context might lead to a fundamental change in the perception of plastics, both in the ocean and on the land. The term "microplastics" rather than marine "litter" emphasizes the ubiquity and pervasiveness of plastics and contests the idea that there is still some place "out there" untouched by anthropogenic materials. However, the term "microplastics" is seldom well understood outside the natural sciences. This might be because of their relative invisibility and the complexity of the science that emphasizes their potential harms.

First I will introduce how the term "microplastics" created a new perspective on plastics pollution in the ocean. Then I will discuss the entanglements of microplastics and the new microcosms that emerge from their presence in the marine environment, also called the "plastisphere." These entanglements problematize the current ways in which plastic is described not only as litter but also as pollution. Finally, I will discuss


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why a natureculture perspective is important in order to understand how to care for plastics in the environment and to understand which policies are involved in this care and which are triggered by it (Bergmann 2019; Martin, Myers, and Viseu 2015).

## Microplastics and the Problem of Their Visualization

To introduce the topic of microplastics and why the definition of a novel category and classification is crucial here, I start with an example from my fieldwork on oceanic plastics in which I accompanied marine scientists and environmentalists and other people in several countries and sites such as labs, beaches, and meetings.[1] This example is from a project on Lanzarote (Canary Islands) that combines citizen science plastics monitoring and environmental education for children. I focus on how emerging classifications (e.g., microplastics) shape and challenge representations of plastics and their "solutions" in the ocean.

But first let me introduce how the category of microplastics emerged. The term "microplastics" was introduced by Richard Thompson and colleagues in 2004 to denote plastic particles less than five millimetres in diameter (Thompson et al. 2004). Microplastics are further distinguished as primary and secondary:

(1) Primary microplastics are items that are manufactured at microscopic scale (e.g. microspheres or microbeads used in cosmetics and pharmaceuticals).

(2) Secondary microplastics are degraded from larger plastic debris due to weathering and other physical impacts (e.g. photo-degradation via ultraviolet light) (Ter Halle et al. 2017).

Recent studies underline that over 92 percent of plastics in the ocean are less than 4.75 millimetres in size and can be considered secondary microplastics (Eriksen et al. 2014). The size of microplastics ranges from still visible pieces (as monitored in the example from Lanzarote) to particles of a few micrometres.[2] So, as a technical term, "microplastics" might rely on the mesh size of conventional laboratory sieves of 4.75 millimetres (Eriksen et al. 2014).


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From an STS perspective, it is interesting to question how this term can influence research and political agendas: "The result of the change in category . . . is a shifting of balances of distinctions, a change in the architectural relationships. Every newly constructed difference, or every new merger, changes the workability of the classification in the ecology of the workplace. As with all tools and all knowledge, such classification schemes are entities with consequences, to be managed, negotiated, and experienced all at once" (Bowker and Star 2000, 231). Categories "span the boundaries" (Bowker and Star 2000, 285) in communities of practice, such as marine science and its new subdiscipline, marine litter research (Ryan 2015). Consequently, if unintentionally, they can create a separation between macroplastics and microplastics that might divide citizen science and environmentalism from hard science. That is, research on microplastics often requires expensive tools, infrastructures, and techniques, from surface sampling nets ("manta trawls") to complex and costly spectroscopic methods to identify polymer types of microplastic particles.[3] Macroplastics, conversely, are easily visible and more accessible, often requiring fairly rudimentary equipment and techniques that can be used by the public with limited training. Besides this, the focus on microplastics has changed the scientific landscape. For example, in the past few years, there has been a huge growth in funding opportunities for microplastics research in Europe, financed by agencies such as the Joint Programming Initiative Healthy and Productive Seas and Oceans" ( JPI Oceans) launched by the Council of the European Union or the research focus Plastic in the Environment launched by the German Ministry for Education and Research (BMBF).[4] Environmental agencies, NGOs, and local initiatives are also addressing the issue via awareness campaigns, beach cleanups, and citizen science programs like the one in Lanzarote, to which I now turn.

In December 2017, I met Manuel, who works for a local initiative against plastics pollution in the ocean, at Famara Beach in Lanzarote.[5] He wanted to show me the situation there and demonstrate how the initiative has employed citizen science plastics monitoring as an educational model for beach surveys with schoolchildren. Arriving at the beach, I could easily spot tiny plastic particles of different sizes (mostly between 1 and 100 millimetres) and colours. On other sandy beaches on the island,



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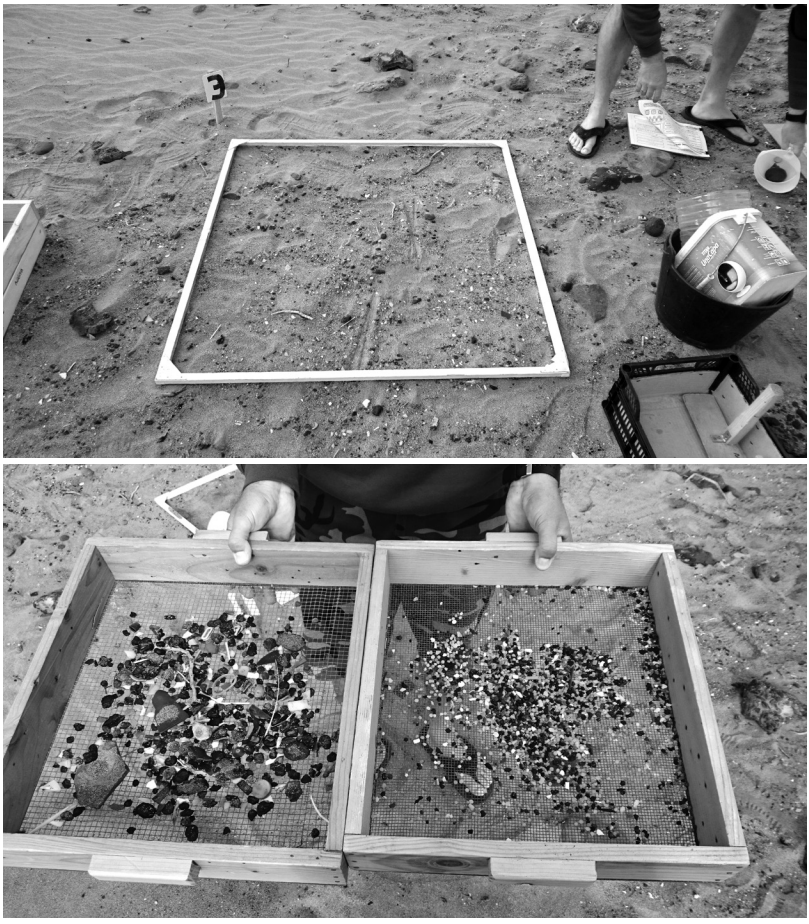
I found plastic fragments mostly in the wash margin. At Famara Beach, they were spread all over the two-kilometre-long sandy beach, which, in some places, was 200 metres wide. Because of heavy winds, Famara is the hot spot for surfing on Lanzarote.



**Figures 4.1 and 4.2.** Citizen science plastics monitoring at Famara Beach, Lanzarote in the Canary Islands. Photos by Sven Bergmann.

The monitoring equipment that Manuel brought along was mostly DIY stuff, such as two shovels made out of oil canisters. Following the initiative's protocol and questionnaire, we monitored a transect of one square metre with sieves of two and five millimetres. Manuel told me that



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the monitoring procedure was aimed primarily toward environmental education rather than production of reliable data (process over product). We sorted out biological and mineral materials via visual perception by putting the sample in a bucket full of water: what did not sink was counted as microplastics. Finally, we weighed the samples. We found 200 grams of plastics bigger than five millimetres in diameter and 215 grams of plastics between two and five millimetres in diameter. Among them were a large quantity of transparent pearl-shaped plastic pellets. Also known as "nurdles," they are the raw material used in the production of plastic products.

That day we monitored only one square metre. Usually, the children analyze more samples to achieve a more accurate estimation of the number of plastic particles on the whole beach. They convert the number of particles to determine the approximate number of half-litre PET bottles that might have generated the fragments. Although the particles were from a variety of polymer types,[6] meaning that the plastics obviously came from different sources, a PET bottle was used as a tool for visualization because it is one of the most ubiquitous plastic objects on the island. In Lanzarote, nearly all potable water is imported and shipped to the island in PET bottles and plastic canisters. They supply 140,000 inhabitants and 2.4 million tourists annually.

Extrapolating from the sample that we collected that day to the whole Famara Beach (5,000 square metres), we counted an equivalent of 137,000 half-litre PET bottles. Participants are instructed to display their results by colouring in isotope pictorial diagrams, each of which represents 1,000 PET bottles.[7] The resulting accumulation of PET bottles serves as a powerful visual device for projecting an environmental problem from a small sample to a larger scale. Because microplastic particles are very small in the millimetre scale and nearly invisible in the micrometre scale, the initiative in Lanzarote translates results into estimates of macroplastics, easier to comprehend. A huge accumulation of PET bottles is easier to imagine (because they form a part of daily lives) than a large amount of microplastics because they are often too abstract to imagine even though the participants on Famara Beach have experienced microplastics everywhere there during monitoring. Although posters from environmental organizations scandalize the slowness of the degradation of plastics in the ocean, in marine litter research the rapid degradation into micro- and


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nanoplastics itself is regarded as part of the problem. During a conference on microplastics that I attended in Capri, Italy, in September 2017, British ecotoxicologist Tamara Galloway stated that "the smaller the net size, the more particles we see." And this might be one of the pivotal points in the construction of the term "microplastics."

At the same time, metaphors such as "plastic islands" or "garbage carpets" in the ocean continue to circulate in public perception and reporting because they are supposedly simple representations of the problem. Kim de Wolff characterizes this phenomenon as "The Materiality of Things that Aren't There" (2014, 65). Based on participant observations during an expedition to the Great Pacific Garbage Patch, de Wolff shows how the high concentrations of plastics in this accumulation zone can be produced and determined only by taking water samples and analyzing them in the laboratory. There is a lot of plastic in the ocean, not in the form of "carpets" or "islands" but in dispersed and fragmented form, mostly as tiny particles (see also Liboiron 2016). In contrast to these projections, science is increasingly concerned with microplastics, which have to be made into reliable data via monitoring, sampling, and classification through microscopy and spectroscopy. Therefore, the definition of microplastics challenges common perceptions of plastic's materiality and disposability. Nevertheless, mainstream representations shape the problematization of plastics pollution and the politics of solutionism. If plastic in the ocean is continually understood as something large enough to be removed from the water, then it promotes ideas for solutions that "cleanse| the ocean. It is easier to clean or remove something clearly visible—and macroplastics are visible. They can be perceived as waste objects, as something that does not belong, as "matter out of place" (Douglas 1966, 36).

Macroplastic items such as a PET bottle or a pair of flip-flops that float in the ocean or get washed up on the shore are identified as symbols of consumption. Although these things were discarded, they can still be recognized as consumer products with a specific purpose: if one can recognize a story in them, then they are less abstract visual objects than microplastics. If these objects have not fallen from a container ship, then they have probably played a role in a human life from consumption to the intentional or unintentional end of their use. Sometimes these


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things even reveal their origins or manufacturing sites. However, when these items degrade into tinier fragments, their identification becomes more difficult. Scientists are able to distinguish microplastics as polyethylene or polypropylene using infrared spectroscopy, but they cannot be tracked back to their sources (production sites).

In addition, the classification into macroplastics and microplastics has triggered new differentiations, both at the level of representation and at the level of material effects. The impact of macroplastics on sea life is typically illustrated using photographs of sea animals such as seals or turtles that have been entangled in fishing nets or six-pack rings. The presentation of the effects of microplastics, many of which are invisible to the human eye, is more difficult because there are less impressive illustrations and research is still in its infancy. Although the "ingestion of MPs [microplastics] by aquatic organisms has been demonstrated, . . . the long-term effects of continuous exposures are less well understood" (Lambert and Wagner 2018, 1). Thus, the effects of microplastics have a different temporal dimension than some of the more spectacular effects of macroplastics. Rob Nixon (2011) calls the slow manifestation of pollution and toxicity "slow violence," and the relatively unexplored effects of a phenomenon contribute to this uncertain condition. Furthermore, monitoring reveals the significant presence of plastics not only in the sea but also in freshwater systems, in the soil, and in aerial emissions. A research team recently investigated the aerial dispersal of textile fibres in Paris and detected air pollution from synthetic fabric (Dris et al. 2016). Whereas plastic is not easy to control in its macroscopic form, in its microscopic form it has proven to be almost impossible to control. Synthetic microfibres and microplastic particles are found almost everywhere: in the most remote regions of the ocean, in animals, in the air, and in the bodies of living beings. Microplastics as a novel category affect the perception of and the proposed solutions to the phenomenon. The invention of the term "microplastics" in the marine sciences confronts concepts of plastic management and waste disposal.

Microplastics or even nanoplastics inform us about the importance of classification in dealing with materiality. According to Bowker and Star (2000), changes in classification also have effects on architectural


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relationships (perspectives and scales). Depending on the context, these perspectives might turn a physical problem—or sometimes a symbolic problem (waste as "matter out of place")—into a chemical (or ecotoxicological) problem. The focus shifts from the harmful potentials of macroscopic materials to unstable and more uncertain conditions of pollution and toxicity related to the limits of scientific knowledge. Beyond that, polymers never act alone. As explained in the introduction to this volume, they are produced with hazardous materials (e.g., bisphenol-A), additives such as plasticizers, or flame retardants. In addition, in water they adsorb (attract) other hydrophobic (oil-loving, water-resistant) substances such as heavy metals (mercury, cadmium, or lead) or persistent organic pollutants such as DDT and PCBs. The use of POPs was restricted through the Stockholm Declaration in 2001. Nonetheless, because of their persistence, these toxicants remain in the ocean.

## "There Is No Virgin Plastic in the Ocean"

In 2013, a team of marine biologists from Woods Hole, Massachusetts, found a huge presence of eukaryotic and bacterial life on samples of microplastics from the Sargasso Sea. The microbial communities on these plastic surfaces differed considerably from the communities in the surrounding seawater. Microbes had gathered in pits on the surface and created habitats in the form of bacterial biofilms, which the researchers termed the "plastisphere" (Zettler, Mincer, and Amaral-Zettler 2013).

When I met Tracy Mincer, a plastisphere researcher in the Woods Hole lab in September 2016, he remarked ironically that plastics are like "nirvana" for bacteria. Tracy explained that, in extreme and competitive environments such as the Sargasso Sea, microbes scavenge for elements such as phosphorus. There are only a few available surfaces in the open sea. Microbes usually attach to algae. However, these surfaces are not as long-lasting as plastics. Therefore, tiny plastic fragments become novel habitats for microbial life. Tracy and his colleagues assumed that they would see the same variety of bacteria as on algae, but instead they were astonished to find different compositions of microbial communities.


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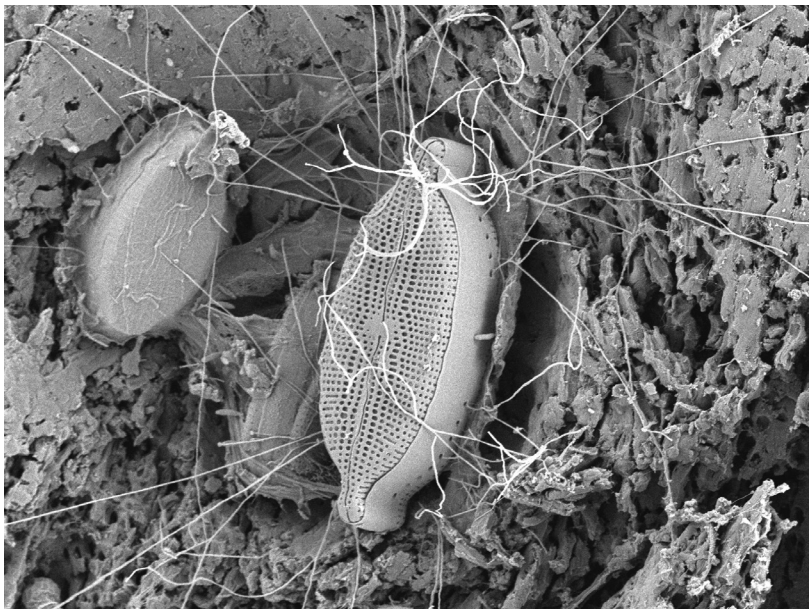

**Figure 4.3.** An image of a diatom the size of a few micrometres amplified by an electron microscope. In the background is a piece of fragmented polyethylene, which serves as a surface for the microbe. Diatom on microplastic, reprinted with permission from Erik Zettler, originally published in Zettler, Mincer, and Amaral-Zettler (2013).

I had the opportunity to interview Tracy together with his colleagues Linda Amaral-Zettler and Erik Zettler, who told me that they were surprised no one had ever carried out electron microscopy on microplastics, though it was already known since the 1970s that micro-organisms stick to plastics in the ocean. Indeed, in the first known article about plastics in the ocean, the authors mentioned that they found diatoms and hydrozoa on tiny particles of plastic in the Sargasso Sea (Carpenter and Smith 1972). Linda indicated that in the literature there had been the "dogma" that "plastic is a very smooth surface" that would be too challenging for microbes to attach to. Erik then remarked that "this is a little surprising" because "any microbial ecologist will tell you all microbes grow on anything." Linda further explained that the initial point of their research had been the question of where all the plastic in the ocean is going and how it is modifying the ocean. Therefore, they were especially interested in low



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nutrient areas of the ocean and what role microbes play in the biodegradation of plastics. Linda indicated that

> there are so many forces in the ocean that help to shape what happens to a piece of plastic in the ocean which you cannot separate easily. Is this biodegradation? Well, it is physical, it is chemical, it is biological. It's all three, it's not one. To separate those is very challenging because it is not what is natural, it is not what happens in nature. So the fate of plastic is complicated. It is not an easy experiment, so to speak. It is a natural experiment going on in the ocean. . . . It is an unexplored part of the ocean. And it is so interesting because we created it, we are responsible for it. . . . We are introducing chemicals that do not naturally occur in the ocean. . . . Bacteria can metabolize all different types of compounds in materials, but these materials [plastic] do not occur everywhere in the ocean, so they have never seen them before. So we are selecting for very rare organisms that can potentially survive or take advantage of those substrates.

What the marine scientists discussed here is an environmental experiment between a synthetic material and biological life. It is not manipulable like experiments in the laboratory or outdoor experimental systems (mesocosms) often used to bridge the gap between lab and field. The impact of the interaction between synthetic material and microbial life remains unexplored. What is evident is that plastic does not remain unescorted in the ocean; it serves as a habitat for emergent life forms. I started this chapter by drawing on reflections from Gabrys about plastic as an experiment with unforeseen effects. Gabrys highlights the "speculative aspect of organisms . . . , their capacity to not just eke out a living, but to transform environments and to become different organisms in the process" (2014, 57). Either way, as Linda Amaral-Zettler remarked, the experiment with plastics was created by human agency, which involves responsibility for its present and future effects. Hence, the production and consumption of plastics and their unplanned afterlives have effects on remote marine environments. The novel ecologies of the plastisphere challenge Eurocentric scientific understandings of nature and culture. Material culture and the environment are more intertwined and amalgamated than scientists ever


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imagined. Even the plastisphere researchers who observed the emergence of these hybrid life forms were surprised that remote regions of the ocean previously considered virtually untouched by anthropogenic markers are no longer as pristine as they had imagined.

For this reason, plastics cannot be conceptualized as merely debris or "matter out of place" because that would disregard the ocean's adaptability to changes and disturbances. Terms such as "parasite" might come closer to capturing plastics' entanglements and relationships with marine life, and Michel Serres (2007, 16) reconsiders the concept of the parasite following the ambiguous meaning of the French word *hôte*, which means both guest and host. Plastic in the ocean complies with this parasitic role: it is an alien intruder in the ocean but offers a promising surface and habitat for microbial life. Plastics do not exist in isolation in the sea or in freshwater systems; they are rapidly colonized by microbes that form a bacterial biofilm. "There is no virgin plastic in the ocean; it is all covered with microbes," remarked Linda.[8] The researchers also emphasized the relational aspects of the plastisphere. Most ongoing research on microplastics concentrates on the ingestion of plastics by marine species but does not take into account the role of the bacterial biofilm in ingestion. Tracy and Erik specified that bacterial biofilms and their particular scents might be an underexplored reason for ingestion by other species, such as turtles and seabirds.[9] Addressing these relational aspects of microplastics is important. Through the process of relating, nothing remains unchanged. Like the notion of "relatedness" in the anthropology of kinship (Carsten 2000; Strathern 2005), relating (the creation and emergence of relations) is an active and complex process, a "doing" of relations. To place the relationship in the centre asks for the in-between, for the association. However, this does not imply ascribing agency to plastics (alone); rather, it reflects on processes and networks with distributed agency: only what is in relationship can act, and agency emerges not from individual actors or elements but "through the number of connections [that they] command" (Latour 1996, 372). In a critical discussion of studies of the "new" materialism that overstate the agency of things, Abrahamsson and colleagues write that, "if matters act, they never act alone" (2015). The authors plead for a sensitivity to a "relational materialism" that shifts from cause and agency to complex


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doings, responses, and affordances. The ambiguous (parasitic) role of plastic as both guest and host in the ocean, and its role between risk and potential, refer to that picture.

Besides the well-known physical hazards of larger plastic items, the chemical risks of marine plastics are complex. This is because toxicological analyses of plastics involve the specific chemical compositions of synthetic polymers, their additives, and the capacity for plastics to adsorb other pollutants (see also Chapters 1, 2, and 12 in this volume). The adsorbance of metals and pollutants starts in contaminated rivers and basins that transport plastics into the ocean. Beyond the chemical hazards associated with plastics are biological attachment and formation of new habitats on plastics such as the plastisphere. For some marine species, ingestion of microplastics might be rather harmless, but ingestion will definitely alter the composition of the bacterial community in the gut. Accordingly, fish or other species that ingest microplastics with a bacterial biofilm will later excrete these plastics with a modified biofilm, which might contain harmful bacteria such as pathogens from the Vibrio family (Kirstein et al. 2016). Furthermore, plastic particles might play a role as a vector for the transportation of species and the change in biodiversity (see Chapter 1 of this volume). Again, it is not just the erratic materiality of plastic that might become problematic but also its relational aspects, such as absorbing and interacting with other chemical and biological agents. For example, recent studies address novel biological interactions with phytoplankton (Long et al. 2017), marine snow (Summers, Henry, and Gutierrez 2018), and dune plants (Poeta et al. 2017). These studies show further amalgamations of ecosystems in the sea and on the land with micro- and nanoplastics. However, biological life in the plastisphere is limited to microplastics, for microbes cannot find a sufficient place to create a bacterial biofilm on nanoplastics. During a conference on microplastics in Italy, I learned from researchers in nanobiology that viruses can attach to nanoplastics. Microplastics and nanoplastics can also enter through cell membranes, making them interesting new objects of study in ecotoxicology.


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## An Ongoing Experiment (Not Only) in the Ocean: Reflections from a Natureculture Perspective

When biological life becomes entangled with the non-living, these emerging entities and arrangements should be studied thoroughly, also regarding different logics of care in dealing with them (de Wolff 2017; see also Chapters 7 and 8 of this volume). At the beginning of this chapter, I discussed how the construction of the term "microplastics" generated a new field of research. Here mostly quantitative studies display a perspective on plastics pollution that might signify change and disturbance in marine ecosystems. Beyond that, studies of microbial life in the plastisphere introduce another perspective on biological adaptation and on the emergence of new life forms between the biological and the synthetic. In his study of the production of nuclear natures, Joe Masco characterizes the connections among nature, politics, space, and possible futures as a "mutant ecology" that generates "biosocial transformations over time" (2004, 518). Through the lens of plastics as an (unintended) experiment, we can see possible mutations "in both natural and social orders"—ranging from new hybrid life forms in water bodies to persistent organic pollutants in the food web via ingestion of plastics that need different conceptualizations of how to problematize, how to care for, and how to deal with them politically (Masco 2004, 533). Precisely for this reason, the conceptual divide between nature and culture as a legacy of the modernism and structuralism of Eurocentric knowledge systems is no longer appropriate for understanding contemporary phenomena from global warming to ocean plastics. A perspective on natureculture could serve methodologically as a "sensitizing concept" (Blumer 1954) to perceive and understand new entanglements of humans with other species and the environment, when nature and society have become "networks of interwoven processes" (Swyngedouw 2004, 129). Thus, the plastisphere changes ways of viewing the world: no more pristine nature but an ocean filled with plastic "confetti" colonized by microbes and part of an ever-emerging ecosystem of new relations and connections.

Emphasizing the diffusion of microplastics and the emergence of hybrid relations foregrounds a topological scale different from the conventional representation of the problem. Here plastics are not represented



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as something outside nature. Rather, they are considered as components of emerging habitats. Synthetic materials such as plastics have already become part of the environment. They take part in the reassembling of environments and ecosystems by forming novel aggregates, habitats, and interactions with other species. These new habitats and life forms between the spheres of the natural and the synthetic challenge scientific knowledge production and complicate issues of environmental politics. From this perspective, modernist projects to clean the natural environment of alien species and other "impure objects" are contested. However, fascination with the erosion of categories and the alignment and orientation of hybrid objects should not blind us to the social and political implications. For example, we have to live with the disasters that modernity and capitalism have created (Fortun 2014). Caring for naturecultures has to deal with that problematic. In my theoretical and methodological framework, natureculture serves as a tool that sensitizes us to and might warn us about technological fixes whose epistemologies rely on the separation of nature and society. For example, proposed solutions such as The Ocean Cleanup gain media exposure because they claim that removing plastics from the oceans is possible (see Chapter 9 of this volume). These projects operate with great visions and on grand scales, but they neglect the existent microcosms of the ocean and can harm marine ecosystems. Furthermore, they can be characterized as end-of-pipe solutions that shift attention away from the economic and social dimensions of the problem (Liboiron 2015). From a post-developmental perspective, Arturo Escobar (2004, 209) critiques the kinds of technological fixes that attempt to combat "the symptoms but not the cause[s] of the social, political and ecological crises of the times. . . . In short, the modern crisis is a crisis in models of thought; modern solutions, at least under neoliberal globalisation (NLG), only deepen the problems."

Not only state or economic stakeholders are prone to this prevailing logic of modern "solutioneering"; environmental activism is also pervaded by such ideas. From a postcolonial and feminist STS point of view, modern solutions and technological fixes can be criticized as sticking with the problem instead of stepping outside it. Technological fixes, on the one hand, enforce end-of-pipe solutions that treat effects rather than sources; concentration on the individual consumer, on the other hand,


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shifts the focus away from production- and growth-oriented economies. Like Escobar, the editors of this volume, in their introduction, have therefore characterized these ways of managing oceanic plastics as a neoliberal approach because it favours market-oriented interventions such as ethical consumerism and technological solutionism. Furthermore, some solutions might be more problematic than the original problems or even misleading. For example, there is a hypothesis about how bacteria that dwell on plastic might metabolize the synthetic material (Zettler, Mincer, and Amaral-Zettler 2013), and people try to capitalize on that knowledge. Although bacteria might biodegrade microscopic pits in microplastics, it is ridiculous to expect to dispose of large amounts of plastic on land via microbial biodegradation. Plastisphere researchers have underlined that the slow degradation of plastics by bacteria cannot match the increasing rates and volumes of global plastics production.

In this chapter, I have shown that the definition of microplastics has changed the material, social, and discursive dimensions of plastics in the oceans. With Bowker and Star (2000), I have pointed out that categories and classifications have impacts on these spheres. The definition of microplastics has changed perspectives on pollution, persistence, and politics, such as criticizing solutionist approaches to oceanic plastics that still do not take microplastics into account. In contrast, the prospect of more complexity has led to the production of knowledge about the plastics crisis, and there is now a stronger distinction between science and other actors. But that has led to tension and mediation between scientific hesitance in interpreting research findings and immediate calls to action from activists. Consequently, can we neglect microplastics in suggesting approaches to and solutions for marine pollution just because their impacts have not been fully studied?[10] On the one hand, it is helpful to understand the dispersed and complicated conditions and the rather speculative dimension of how microplastics alter or harm the environment, as my argument has supported. On the other hand, the concept of microplastics in the ocean has not yet been translated concisely into the use of plastics in everyday life (see Chapter 7 of this volume). In the public debate, plastics in the oceans are discussed mostly as a result of inadequate waste management and less often as a problem of the materiality of plastics. But in everyday life most people are confronted with the abrasion


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of plastic, for example when using a plastic cutting board for vegetables. In such cases, the emergence of microplastics occurs not far out in the ocean but in the kitchen, bathroom, or garage. But plastics in the ocean and plastics in social life still seem to represent two different spheres. The fear of eating microplastics in fish seems to have no relation to wrapping food in plastic film or drinking water from PET bottles. Finding microplastics in food can have an emotive impact on consumers. Thus, they see themselves as part of the experiment with plastics, which has taken place for decades without risk assessments. Even though much more hazardous substances (e.g., DDT, TNT, or radioactive substances) have contributed to the pollution of the ocean in addition to plastics, the attention paid to plastic waste is an excellent entry point for creating a better understanding of oceanic ecologies. In addition, the plastics crisis, like global warming, offers a good way to reflect on the excesses of capitalist accumulation from a natureculture perspective. This could lead to new and unexplored alliances and collectives among natural and social sciences, the environmental movement, and other social actors.

## NOTES

1. My research was funded by a grant from the Volkswagen Foundation (2016–17) and within the research project Knowing the Seas as Naturecultures by the University of Bremen (2017–18).
2. So far there is no strict division between micro- and nanoplastics; typically, nanomaterials are defined as below 100 micrometres (Koelmans, Besseling, and Shim 2015).
3. Therefore, the Civic Laboratory for Environmental Action Research (CLEAR) in Newfoundland is working against the grain of conventional science by implementing cheaper citizen science and DIY techniques from feminist and postcolonial perspectives (see https://civiclaboratory.nl/).
4. For JPI Oceans, see http://www.jpi-oceans.eu/calls/proposals/microplastics-marine-environment; for BMBF, see https://bmbf-plastik.de/en.
5. Names are changed to pseudonyms with the exception of more established scientists (postdoctoral or higher) whom I met in the field and whose papers are cited in this chapter.
6. According to Hidalgo-Ruz and Thiel (2013), particles greater than one millimetre can be identified as synthetic polymers and distinguished from


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glass or minerals by citizen science actors with adequate guidance and illustrative material.

7. See examples at https://de.m.wikipedia.org/wiki/Datei:Isotype-neurath.jpg.
8. The term "virginity" or "originality," often used in discussions about "pure" nature (here ironized by the example of sculpture), contains a specific symbolism of gender and sexuality, which I do not pursue further here, but it could be the subject of further analysis.
9. Every piece of plastic in the ocean is colonized rapidly by microbes. Therefore, biofilms lead to biofouling processes that might generate dimethyl sulphide. This process might act as an olfactory trap for seabirds when they get attracted to the sulphurous smell. See Dell'Ariccia and colleages (2017) and Savoca and colleagues (2016) for the controversial debate about "infochemicals" in marine sciences.
10. Indeed, Napper, Pahl, and Thompson state clearly in Chapter 1 of this volume that there is "enough evidence for us to take action."

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PART II

# PERSISTENCE

# 5

# Plastiglomerate

## Plastics, Geology, and the New Materialism of the Anthropocene

*Christina Gerhardt*

On April 24, 2018, a study carried out by the Alfred Wegener Institute at the Helmholtz Centre for Polar and Marine Research stated that the levels of plastics[1] in sea ice from the Arctic Ocean were higher than ever measured previously (Peeken et al. 2018).[2] The plastics had travelled there from regions as far away as the Pacific Ocean at the other end of the globe. Furthermore, the different types of plastics showed a unique footprint in the ice, allowing the researchers to trace them back to possible sources. These sources included the massive garbage patches in the Pacific Ocean. In 2017, research led by Alan Jamieson of Newcastle University found plastics in microscopic species in the deepest reaches of the ocean (Newcastle University 2017). In 2017, another study discovered that 83 percent of water sampled from a dozen nations was contaminated by plastic fibres (Tyree and Morrison 2017). Taken together, this research illustrates that plastics contamination can be defined in a number of ways: be it by geographic range, by species range, and scale of contamination.

Additionally, plastics have deep temporal ranges and thus relate to the Anthropocene. Proponents describe the Anthropocene as a new geological era distinct from the previous epoch, the Holocene, because of the traces that it leaves in the geological record of human (anthropo-)action.



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The term "Anthropocene" is widely attributed to freshwater researcher Eugene F. Stoermer. Stoermer coined the term in the 1980s but did not formalize its use until contacted by Nobel Prize–winning atmospheric scientist and chemist Paul J. Crutzen (Crutzen and Stoermer 2000). Environmental journalist Andrew Revkin used the variant "Anthrocene" in his 1992 book *Global Warming: Understanding the Forecast*. In 2008, lead scientist Jan Zalasiewicz, in a co-authored report published in *GSA Today*, asked "Are We Now Living in the Anthropocene?" and explored the scientific basis for use of the term.

Not all humans, as suggested in the introduction to this volume, contribute equally to climate change. The disproportionate wealth between the Global North and the Global South or the economic inequality within a nation plays a vital role. These disparities call for a careful consideration of the impacts of colonialism and imperialism on ethnicity, gender, and class when attributing responsibility for the drivers of climate change and plastics pollution and their unevenly felt impacts (see Malm and Hornborg 2014). To capture these variations, scholars have put forward different terms: Donna Haraway (2016) has proposed "Chthulucene;" and Jason Moore (2015) put forward "Capitalocene." The Holocene, the period preceding the current era, lasted for a staggering 11,700 years, providing Earth with a relatively stable environment. For the term "Anthropocene" to be accepted, a geological marker is needed. Plastics have been a commonly accepted marker.

Plastiglomerate is a "stone" that consists of plastics and organic debris such as sand, wood, or lava fragments. Oceanographer Charles J. Moore, better known for having discovered the "Great Pacific Garbage Patch" in 1997, first discovered these geological formations when he visited Kamilo Beach on the Big Island of Hawaii in 2006. In 2012, geologist Patricia Corcoran brought Moore to Western University in Ontario to give a guest lecture about plastics pollution. On one of his slides, Moore featured a stone that he had found on Kamilo Beach, without yet having developed a name for it. The stones piqued the curiosity of Corcoran, keen to investigate the site and stones. Kelly Jazvac, an artist who also teaches at Western University and had worked with the plastic material vinyl, also known as polyvinylchloride (PVC) (Lossin 2012), attended the talk and spoke to Corcoran afterward. Jazvac expressed


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interest in collaborating if Corcoran pursued the topic of oceans and plastics further (Valentine 2015). In 2013, Corcoran and Jazvac headed to Hawaii on a research trip and sampled twenty-one sites on Kamilo Beach (Valentine 2015). They gathered rocks on the surface of the beach or buried in the sand or nearby vegetation. Later that year Moore, Corcoran, and Jazvac proposed plastiglomerate as the geological marker of the Anthropocene (Corcoran, Moore, and Jazvac 2013) and relatedly climate change.

Plastics are petroleum-derived substances. In the United States, petroleum use is a key driver of climate change because of its high levels of greenhouse gas emissions (GHGs). After the production of electricity generation through burning fossil fuels, such as coal and natural gas, petroleum use for transportation is the second largest emitter of GHGs. According to the Environmental Protection Agency (2019a), in the United States 29 percent of GHGs are produced by transportation and 28 percent by electricity. In 2007, the Intergovernmental Panel on Climate Change found that more than 90 percent of transportation fuels produced globally are petroleum based (as cited in Environmental Protection Agency 2019b). Plastics call attention to the scale of the petroleum industry. They are present in a range of products that move globally but manifest locally. Plastics will long remain as one of the markers of the petroleum age.

In what follows, I discuss plastiglomerate, an interdisciplinary, ecocritical, or environmental humanities project that focuses on plastics in the Pacific Ocean. Plastiglomerate draws on and bridges the humanities, natural sciences, and social sciences, reflecting how an interdisciplinary approach can help to address climate change and the Anthropocene. As Corcoran, Moore, and Jazvac (2013, 1) put it, plastiglomerate reveals how the "imminent dangers [that plastics] pose to marine organisms and their ecosystems" manifest geologically.

Plastiglomerate shows how plastics appear in locations thousands of kilometres away from the sources of their extraction, production, consumption, and managed disposal—thus highlighting their spatial ranges. Additionally, plastiglomerate "indicate[s] that this anthropogenically influenced material has great potential to form a marker horizon of human pollution, signaling the occurrence of the informal Anthropocene epoch" (Corcoran, Moore, and Jazvac 2013, 4), thus marking its temporal range.


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Plastiglomerate reveals both the spatial and the temporal stakes of plastics pollution.

Towards the end of this chapter, I discuss how this interdisciplinary project, focused on oceanography but also engaged in the arts, grapples with spatial and temporal scales. I consider, too, various solutions, global and local in scale, to the problems that Corcoran, Moore, and Jazvac (2013) put forward and the limitations of these solutions. Plastics in the Pacific Ocean also raise larger questions about historical and contemporary responsibilities. Finally, I consider some possible actions and solutions, highlighting broader theoretical ramifications that relate specifically to the deep-time implications of plastics as evidenced by the discovery of plastiglomerate.

Moore discovered the first Great Pacific Garbage Patch in the northeast Pacific Ocean in 1997 and mentioned it to oceanographer Curtis Ebbesmeyer, who called it the "Eastern Garbage Patch" (Moore 2003). The 2010 Ocean Conservancy report, *Trash Travels*, estimates that 60 percent of the garbage in the Earth's oceans consists of disposable items. Some estimate that as much as 80–90 percent of the garbage in the oceans consists of plastics. Regardless of the exact percentage, most of the marine litter found in the oceans is made of plastics. Natural plastics do not entirely degrade. Instead, when the sun hits them, they gradually break down into smaller and smaller pieces through a process known as photodegradation. As plastics photodegrade, toxic chemicals are released into the ocean (American Chemical Society 2009). Sea creatures from molluscs, plankton, and others lower on the food chain to fish, sea turtles, and monk seal further up the food chain then ingest the plastics. In this way, toxins slowly travel up the food chain.

Contrary to popular opinion, the majority of what constitutes the Great Pacific Garbage Patch does not float visibly on the ocean's surface (Hoarde 2009). "The actual scenario is even more insidious," says photographer Chris Jordan, who has documented the impacts of plastics on albatross. "The plastic is all underwater, suspended invisibly below the surface, and breaking apart into smaller and smaller pieces. Much of it has already broken down into tiny fragments about the same size as plankton, being ingested by the hundreds of billions into the small fish that are the bottom of the food chain for all marine life" (cited in Hoarde 2009, para.



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3). According to the Ocean Conservancy, the top ten items found in oceans worldwide by count include (from most common to least common) (1) cigarettes; (2) food wrappers; (3) plastic beverage bottles; (4) plastic bags; (5) plastic caps and lids; (6) plastic cups, plates, forks, knives, and spoons; (7) plastic straws and stir sticks; (8) glass beverage bottles; (9) beverage cans; and (10) paper bags (2010, 13). Petroleum-derived plastics constitute the majority of the items listed.

It is stunning to consider, however, the invisible end of plastics in the Pacific Ocean. The Great Pacific Garbage Patch is known for what is visible, measuring 1.6 million square kilometres (617,000 square miles) or twice the size of France (Lebreton et al. 2018). It is understood as something that can be photographed from the air by satellites and planes and from the surface of the water by cruise and cargo ships as well as boats. It can be seen in the remains of albatrosses, which deftly negotiate the region between air and water, skimming the surface. However, despite this visibility, it is what is less visible and remains undocumented that daunts us. In terms of terrain, the Great Pacific Garbage Patch includes the vast expanse below the surface line in which the plastics linger. Plastics photodegrade into increasingly smaller particulate matter, making them harder to track. To assess the scale of plastics pollution, then, suggests a consideration not only of the size of the Great Pacific Garbage Patch but also of the discovery of a garbage patch in both the northeast and the northwest Pacific Ocean and a patch in the South Pacific Ocean close to Rapa Nui (Easter Island).[3] In addition, it suggests a consideration of what is not visible below the surface, what is not visible any longer because it has disintegrated into particulate matter invisible to the human eye, and plastic fragments and plastic-related toxins ingested by marine wildlife. Then there is the distance that all plastics travel from either Asia or North America. It is estimated that most of the plastics in the Pacific Ocean derive not from ships or boats but from Asia and North America. It takes plastics about a year to travel from Asia's East Coast and about six years from North America's West Coast to the northwest Great Pacific Garbage Patch.

Art can help to visualize plastics in the ocean, but it also raises questions about how to image (or imagine or address) what is *not* visible to the human eye. This issue of visibility has implications not only for the


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petroleum industry's plastics but also for the petroleum industry–generated greenhouse gas emissions and climate change. It also raises questions about how to imagine an issue of such vast scales, in terms of the size, both horizontally and vertically, of the Great Pacific Garbage Patch(es) and in terms of the numbers of deaths of marine sea creatures, seabirds, plants, and other forms of life affected by the plastics. Thom van Dooren (2014, 22), in his study of albatrosses in the Pacific Ocean, raises questions about a vast *temporal* scale: "The plastics and other toxic compounds circulating in [the] world's oceans . . . threaten not only the lives of individual birds but the future of their species, too."

In 2013, the interdisciplinary team led by Corcoran and Jazvac conducted research on plastics on Kamilo Beach. As they explored the stones on the beach, they discovered that most of them consisted of a combination of plastics and organic materials, such as sand, wood, coral, and lava rock. This plastiglomerate, they argue, leaves a geological trace of our modern era, the Anthropocene. The geographic scope of their discovery is vast: plastiglomerate tracks the manifestation of the global use of plastics in a specific location. Additionally, the temporal scale of their research—taking note of a geological trace that plastics will leave on the historical record—is immense. It is a stark indicator of plastics' deep-time implications. Scientific organizations such as the International Commission on Stratigraphy and the International Union of Geological Sciences are using the term "plastiglomerate," as Jazvac outlined in an interview, as evidence that we have entered a new geological period, the Anthropocene (Valentine 2015). Plastiglomerate has the potential to be one of the most powerful images today and a valuable visual tool with which to facilitate policy and behavioural change to respond to global and local plastics pollution.

The work of Corcoran, Moore, and Jazvac (2013) brings what is far away for some nearby and makes it visible. The stones that they discovered often were buried in sand or intermingled with nearby vegetation and underbrush. Yet plastiglomerate is plastic that has been mingled with natural material and thus might not break down well and instead be preserved. Temporally, it documents plastics in our present geological era. Plastiglomerate has its origins in organisms long since extinct and its traces will persist long into the future. Plastiglomerate offers a powerful visual


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tool capable of raising appreciation of the deep-time impacts of plastics production, consumption, and disposal than any other known artifact.

Since his discovery of the Great Pacific Garbage Patch in 1997, Moore has organized over fifteen ocean trips. He has also personally made ten voyages between Hawaii and California, gathering plastics along the way and documenting the changes in quantity and content. His 1998 trip and 1999 study revealed that plastics outnumbered plankton by six to one (Moore et al. 2002). His 2002 trip and 2003 study conducted along the same route revealed that plastics outweighed zooplankton by a factor of five to two (Moore 2003). Moore founded Algalita, a non-profit organization, in 2005. Algalita is devoted to eliminating plastics pollution in the oceans, and its researchers have published annual reports on the plastics that they have gathered from the ocean. Moore and his team carry out these investigations in the Pacific Ocean not only on the shores of his home state of California but also on the shores of the starting point of his ocean trips, Hawaii.

What brings the plastics to this southeastern tip of Hawaii Island, where Moore discovered them, is a great oceanic current or gyre. Globally, there are five major oceanic gyres, which include the North Pacific Gyre and the South Pacific Gyre. The North Pacific Gyre moves in a clockwise direction from the shores just east of Asia across the ocean. It heads east, turns south far off the shores of North America, and then gradually circles back west again toward Asia. The path of the North Pacific Gyre thus encircles the broad stretch of ocean from Midway Atoll in the northeast to the southeastern tip of Hawaii Island.

The plastics that wash up on Kamilo Beach by way of this gyre meld with natural materials found on the shore, such as sand, lava rock, and wood. The dense matter that results makes the rock heavy and unlikely to be transported by wind or water. It also means that the rocks are likely to be buried and thus preserved. Plastiglomerate can be considered a marker of the Anthropocene because plastics are an "anthropogenically derived material" (Corcoran, Moore, and Jazvac 2013, 4) and because "the fragments were formed anthropogenically," in this case "by burning plastic debris in an open environment" (6). That is, the plastics were burned on Kamilo Beach in barbecues or campfires. When the plastics melt, they meld with the natural materials around them. The subsequent


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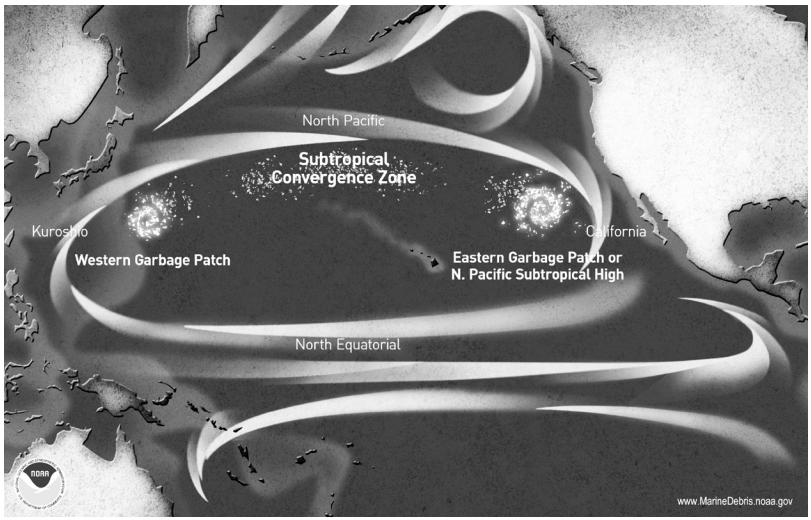
entanglement is plastiglomerate. In their research, Corcoran, Moore, and Jazvac found the plastiglomerate to be "buried by sand and organic debris, as well as having been trapped by vegetation, which demonstrates the potential for preservation in the future rock record" (6). They also cite the possibility of finding "similar deposits where lava flows, forest fires and extreme temperatures occur" (7).




**Map 5.1.** NOAA, "Marine Debris," 2012.

To the wide geographic scale that is the Pacific Ocean, its North Pacific Gyre, and the plastics found there, the study by Corcoran, Moore, and Jazvac (2013) adds a long temporal scale since they present plastiglomerate as the first "stone" to mark the Anthropocene in geological terms. How, then, do we address the deep-time and broad geographical scales of the plastics carried in the Pacific Ocean?

After returning from his tenth and most recent trip to the Great Pacific Garbage Patch, Moore (2014, A23) stated that "no scientist, environmentalist, entrepreneur, national or international government agency has yet been able to establish a comprehensive way of recycling the plastic trash that covers our land and inevitably blows and washes down to the sea." He also indicated that the effects of plastics, in terms of pollution in the environment and among marine wildlife and humans, are only now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revealing themselves. Although environmental groups organize beach cleanups, they "will never be able," he argues, "to clean up remote garbage gyres." The Ocean Cleanup, for example, claimed to offer a solution to the global plastics crisis by removing plastics from vast oceanic areas, yet this proved to be a failed example of "techno-solutioneering."[4]

The only solution, Moore (2014, A23) concludes, is to prevent plastics "from getting into the ocean in the first place." Thus, the solution, like the problem, must be global. Moreover, the solution must be focused on prevention at source. Moore's solution shares the environmental justice movement's ethos of "Leave It in the Ground" (LINGO) in regard to fossil fuels. Failing LINGO, our next best option might be to prevent the production of the aforementioned list of plastics mostly commonly found in the ocean by the Ocean Conservancy: Cigarettes, food wrappers, plastic beverage bottles, and plastic bags. The "cigarettes" are actually shorthand for the cigarette filters, the only part that does not biodegrade. If they are not banned through legislation, then the next best option (at least in terms of environmental protection) might be to ban plastic-based filters. Food wrappers could be replaced with biodegradable food packaging, and plastic beverage bottles could be replaced with fully recyclable glass bottles alongside a container deposit scheme and the provision of refill options in stores and public areas.

Finally, to date no nation-wide ban on plastic bags exists in the United States. California has a ban on single-use plastic bags that went into effect in November 2016. In Hawaii, all counties have a ban on single-use plastic bags. Although these bans do not constitute a state-level legislated ban, it is de facto a state-wide ban that went into effect on July 1, 2015. The ban in Hawaii was phased in first on Kauai and Maui in 2011, on the Big Island in 2013, and then in Honolulu in 2015 (National Conference of State Legislatures 2019). With the passage of Senate Bill 1508 in 2019, New York became the third state to ban plastic bags. As of August 1, 2019, Connecticut has placed a fee on single use bags. Twenty US states are considering banning plastic bags, and the American territories of American Samoa and Puerto Rico have banned them.

Plastic products are linked to a wide range of externalities.[5] It is often forgotten that plastic bags are typically derived from petroleum.[6] One could thus question whether the cost of single-use plastic production


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is worth the cost of the ever-increasing contortions of the oil industry. They include increased prospecting and extraction and the human rights abuses and conflicts that they have perpetuated. As the oil industry is under increasing pressure due to the shift to renewable energy and the phase-out of fossil fuel-powered vehicles, it might well shift is focus to plastics. The full cost must also include the additional fossil fuels used in the transportation of plastic products around the globe, further contributing to climate change.[7]

The true cost of plastics could be included in, and measured by, corporate accounting systems to internalize the negative externalities of plastics production. This approach would transfer the costs of negative externalities back to producers and consumers and relieve the state and municipalities of these financial burdens. Doing either would lead to a dramatic shift in the market and a dramatic reduction in plastics production and consumption. Paying for a plastic bag, for example—as is the current system in places as different and geographically distant as California and Germany—is an economic instrument commonly used to curb plastic bag use,[8] but it does not even begin to address the environmental and health costs associated with them. One could also consider the "twelve leverage points" indicating where to intervene in the plastics industry or the broader economic system when it is fixated on growth (see Meadows 2008, 145–65). Thus, an array of options exists to reassess the detrimental impacts of plastics: (1) to ask whether an economic system fixated on growth is desirable; (2) to address the costs typically externalized, such as environmental and health effects; (3) to shift these typically externalized costs back onto the producers; and (4) to shift the costs typically externalized onto consumers.

The real cost of plastics raises questions about the extent to which industrialized countries, in particular the United States, have built their economies on the backs of petrochemical and plastics industries (UNEP 2014). Considering the true cost of plastics would also invite scrutiny of how and why federal agencies responsible for effective environmental regulation have been defanged, co-opted, and gutted. For example, after Donald Trump took office, entire pages of the Environmental Protection Agency website were deleted or edited (see Zoë Schlanger 2017).



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The issue of plastics in the Pacific Ocean and the related project discussed here—Corcoran, Moore, and Jazvac's (2013) plastiglomerate—raise fundamental questions about spatial and temporal scales. The solutions to the problems of plastics are equally vast. Spatially, are the solutions local, national, or global? Or some combination? Economically and ecologically, are they at the sites of production or consumption? Finally, if plastiglomerate is a marker of the Anthropocene, then the global community needs a solution that radically recasts the current global economic system in such a way that prevents plastics pollution and ensures environmental justice.

## NOTES

1. The word plastics is used in the plural throughout to highlight the heterogeneity of the materials and uses. See the introduction to this volume for more on this matter.
2. This chapter is an extensively revised version of Gerhardt (2018).
3. A garbage patch exists in every ocean where there is a gyre. So, though in this chapter I focus on plastics in the Pacific Ocean, the geographic scale of the issue is global.
4. See Chapter 9 of this volume.
5. See Chapters 4, 6, 7, and 11 of this volume for discussions of the less well-known effects associated with plastics.
6. Plastic bags, of course, are not the sole product made from petroleum. Petrochemicals constitute products used by people virtually daily—such as cosmetics, upholstery, paints, and lawn fertilizers—and present an issue of scale because of the range of products used.
7. See also LeMenager (2014).
8. See also Chapter 1 of this volume.

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# 6

# Dressed in Plastic

## The Persistence of Polyester Clothes

*Elyse Stanes*

Debates about the social and ecological reverberations of the fashion industry are building. Polyester clothing has emerged as an iconic, and increasingly troublesome, form of plastics. Polyester clothes are varied, ambiguous, and complex. They are a coalescence of materials, manufacturing processes, distribution systems, labour forces, and environmental transformations (Stanes 2018). In their assembly from component materials to plastic objects, polyester clothes generate various ethical and moral complexities that require careful interpretation within the parameters of environmental and social justice (Castree 2004). What transpires across the production and consumption of polyester clothes is not only messy and complex but also opaque (Brooks 2015). It is challenging to trace the interrelationships among the polyester clothes consumed and the various environmental, social, and economic impacts of the unfurling plasticity (Cook 2004).[1]

What further complicates the problem of polyester are questions of lifestyle and comfort provided by clothing (Stanes 2018). Clothes are both utilitarian and superficial. They protect and shelter the body while presenting a visual and material assertion of identity that embodies who people are or want to be (Belk 1988; Crane 2012). Clothes deliver a certain level of security, belonging, and gratification. Polyester clothing in



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particular is symbolic of the medley of human-made fibres that has shaped modern (and increasingly rapid) consumption (O'Connor 2011; Schneider 1994). It is appreciated by both producers and consumers for its flexibility, malleability, and low cost, factors that also represent its material plastic qualities.

Increasingly apparent, however, are the problems associated with escalating rates of polyester production and manufacture, use, and disposal. Over half of the clothing made and discarded globally each year now features polyester, which draws on toxic and finite resources, including crude oil (IVC 2019; Textile Exchange 2018). The annual production of polyester now exceeds 53 million metric tonnes globally (IVC 2019; Textile Exchange 2018). Global carbon dioxide emissions from polyester fabrication reached 282 billion kilograms in 2015, almost three times that of cotton (Cobbing and Vicaire 2016; Kirchain et al. 2015).[2] In use, a single polyester garment releases over 1,900 microplastic fibres per wash (Browne et al. 2011). Based on Napper and Thompson's (2016) findings that a standard six-kilogram wash load of human-made garments can release between 137,951 (polyester-cotton) and 728,789 (acrylic) microplastic fibres, journalist Lucy Siegle (2017) estimates that the inclusion of polyester in the daily clothes-washing routines of a population the size of Berlin (3.5 million people) is akin to releasing 540,000 plastic bags into the ocean per day.[3] And, as geographer Louise Crewe (2017, 39) points out, many consumers (specifically those in the minority world) "own more items of clothing than any other commodity." Although the chatter about the "problems" of clothing has undoubtedly become louder, in an age of distributed global production networks, complex subcontracting, and material recalcitrance, Crewe also argues that, compared with other mundane objects consumed in everyday life, consumers "know the least amount about their clothes" or the fibres and textiles that make up garments (39). This is certainly the case for polyester.

The ideas in this chapter transpire from an interest in the travels and transformations of polyester clothes. Where and how is polyester produced? In what clothes can you find polyester? How can polyester be responsibly disposed of, and where does it go? And in a system composed of so many processes, networks, and scales, where, or with whom, does the responsibility to act on such lively and agentic materials lie? I draw on



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diverse and attempted disentanglements of polyester encountered during my doctoral research, in which I traced a material-cultural geography of clothing use in the everyday lives of a group of twenty-three young adults from Sydney, Australia (Stanes 2018).[4] Although I initially tried to follow the movement of clothing, stories of clothing use soon went beyond the confines of shops, wardrobes, or particular modes of disposal. Practices of material consumption refused to be bounded as discrete events that marked their presence in the "social life of things" (Appadurai 1986, 3).[5] Nor could they be explained simply via their "passage from one regime of value to another" (Gregson 2007, 20). Clothes, I found, are far more unruly.[6] They are spontaneous, lively, intimate, and sensuous. Such associations intersect variously with bodies, spaces, materials, and practices.

Polyester emerged as one material that illustrated such unruliness. It is an example of assembled materials in transition, undergoing various stages of composition and decomposition (Stanes 2018). Although this chapter hints at a linear following of polyester via production, use, storage, divestment, and reuse and recirculation, I also signal complex trails and flows that connect variously across scales to the labour of manufacture, chemicals and toxicity, the deep time of fashion, and the persistent decay of polyester in environments and bodies. Polyester, then, is not static, muted, or stable. It is a network of various materials, skills, and processes, an assemblage of components held together provisionally (Stanes 2018). Here I unpack the vitality and complexity of polyester by engaging with such "processual materialities" (Gabrys, Hawkins, and Michael 2013, 2). The material plasticity of polyester thus extends "not just to [its] multiple uses" but also to the indispensability of polyester in cycles of fashion and how it is a part of various socio-material relations, including more "undesirable modes of material transformation" such as "environmental or bodily accumulations" (2). Like other case studies that have emerged across the social sciences and humanities in recent years, the production and exchange of polyester buck "fixed, vertical and unidirectional" tellings (Gregson, Watkins, and Calestani 2010, 1067; Hughes 2000, 178; Lepawsky and Mathers 2011, 243). Following Lepawsky and Mathers (2011, 243–44), I advocate for the "jettison[ing] of beginnings and endings" in considerations of the materialities and temporalities of things and matter.


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This chapter paves the way for a more fluid representation of the "on-going-ness" of polyester (Lepawsky and Mathers 2011, 243), disrupting notions of where garments begin, how and where they are consumed, and where they end. Alongside my own experiences documenting the everyday use of polyester, I draw variously from scientific facts that highlight the persistence, movement, and transformation of polyester, broadly, through various conduits, including its (re)production, (re)circulation, and pollutant capacities. The travels of polyester clothes do not follow neat beginnings and endings. I shed light on our relationship, as wearers, with the long material and temporal endurance of plastic clothes, and identify seldom-discussed elements of our relationship with polyester during the life spans of objects implicated in their production, use, and disposal. "Unbracketing" the linear architecture of following polyester also gives space to contemplate its revaluing (Lepawsky and Mathers 2011, 247). I suggest that reconfiguring concepts of plastics in clothes consumption requires us to reassess the material and temporal composition of commodities, how polyester changes through various transformative states, how redundant polyester clothes become "worn out," and how their plastic material memories live on in recycled materials, stockpiles of hand-me-downs and second-hand clothes, slowly transpiring objects in landfills and as micro- and nanoplastics in air, water, and soil that persist well beyond the intended life of polyester.

## Tracing Polyester: The Lingering of Plastic Clothes

It is common to view clothes as cultural and symbolic objects. And, though clothes have social lives (Appadurai 1986), they also have biological and chemical lives (DeSilvey 2006). Clothes are a provisional gathering of matter and materials, formed and unformed by their movements in and with social and physical situations. How such materials are held together in constellations—as clothes—signals one moment in their productive lives as objects (Stanes 2018). Perspectives on both objects and materials as "fixed" or "static" have been troubled by a range of varied scholarly traditions, including geography, science and technology studies (STS), material culture, and political ecology. Drawing from empirical cases—including aluminum (Sheller 2014), e-waste (Lepawksy and Mathers 2011),



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asbestos (Gregson, Watkins, and Calestani 2010), and (notably) plastics (Meikle 1997), including polyethylene terephthalate (PET) water bottles or plastic bags (Hawkins 2010, 201), nylon (Handley 1999), and bioplastic (Tonuk 2016)—an overarching theme in this debate is that materials come to be via various iterative processes made possible in and through different subjects and practices. However, to date, the seemingly static world of clothing has mostly evaded attention. Here I am interested in the wearable factors at the surfaces of polyester clothes: durability, strength, and appearance. I am equally interested in the processes that underpin the "interconnectivity and co-constitution" of polyester clothes (Tolia-Kelly 2013, 153), their persistent material geographies, and their vital capacities to "set into motion relationships between things that become sites of responsibility and effect" (Gabrys, Hawkins, and Michael 2013, 5).

Endorsed as a "minor miracle" with "quick drying, non-iron, permanent press qualities . . . and neon colours" (Schneider 1994, 2), polyester became widely popularized across Britain (Terylene), the United States (Darcon), and Europe (e.g., Trevira in Germany) in the post-war boom during the 1950s and 1960s. Advertised as a technological solution to issues of scarcity of and "nature's shortcomings" for clothing and household fabrics (Blaszczyk 2008, 86),[7] polyester fabrics were seen by industrialized nations in the minority world to lessen their dependence on the variability of natural textile producers (Schneider 1994). Polyester now makes up over 50 percent of total textile consumption globally, over double that of cotton (Textile Exchange 2018). It is a material that has both shaped and been shaped by the rise of fast fashion. Polyester is the only fibre over the past twenty years to have increased its market share, and it is predicted to grow 4 percent annually to 2020 (Pensupa et al. 2017; Textile Exchange 2016). The expansion of polyester over the past two decades has radically challenged the market viability of other fibres. The price of cotton, for instance, has fallen by 25 percent over the past ten years (Textile Exchange 2016). Relatively low and stable oil prices and recent changes in the global trade of waste have also suppressed developments in recycled and biobased fibres (Textile Exchange 2016; Textile Exchange 2018).

Polyester now sits alongside other plastics "emblematic of economies of abundance and ecological destruction," pollutant, toxic, and


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persistent well beyond the afterlife of the object for which it was originally made (Gabrys, Hawkins, and Michael 2013, 3). Some of these issues are unpacked in the sections that follow. However, unlike plastic bags or water bottles, in which the derivation is upfront, and frequently a site of political contestation (Hawkins 2009, 186), polyester appears to be other than their petroleum-based relations. Because of their chameleon-like character, polyester fabrics evade consumers' critical scrutiny. This is not to label polyester a "bad" material (Liboiron 2016, 89; see also the introduction to this volume). Rather, the challenge as posed in this chapter is to further understand the heterogeneity and complexity of polyester's transformations and in turn how they affect bodies, habits, and ecological awareness (Hawkins 2010). By arbitrarily imposing a directionality to polyester, I identify moments of its transformations: that is, how polyester interacts with other places and things and how they trouble the geographical boundaries of clothes.

## A "Provenance" of Polyester: Entanglements with Science

Derived from the Greek words *polús méros* for "many parts," polyester (like other plastics) is made from chains of thousands of molecular units called monomers (derived from the Greek words *mono méros* for "one part") (Freinkel 2011, 5). Perhaps the most common polyester used in the clothing textile industry is the polymer poly(ethylene terephthalate), otherwise commonly known as PET. In its most basic material form, PET is coarse, rigid, and a slightly transparent, off-white shade. But polyester polymers do not become polyester fabric "in isolation" (Liboiron 2016, 95). Hundreds of polyester varieties exist. Polyester polymers can be manipulated easily to produce desired characteristics of dyeability, resistance to mildew and aging, flame resistance, static-free quality, and comfort (Wright and Pugh 2015). To manifest the material characteristics of polyester—flexible, soft, vibrant, fluffy, or light—various monomers, additives, or plasticizers are added at different stages of the production process (Fries et al. 2013; Scheirs and Long 2003). Adding a delustrant such as powdered titanium dioxide (TiO2), for instance, removes the gloss of polyester and creates a slightly rougher surface on fibres, reducing sheen and transparency and increasing opacity (Windler et al. 2012). Others



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additions might improve or modify appearance, elasticity, mechanical or thermal resistance, durability, or performance (Fries et al. 2013; Napper and Thompson 2016). Indeed, the length of polyester molecules via the addition of chemical additives defines "plasticity": its flexibility (Freinkel 2011, 5).

The process of making monomer components into polyester materials can be carried out in several ways. A mechanical approach to polyester fibre production, for instance, grinds and melts hard and inflexible plastic chips before extruding hot liquid through fine spinneret holes. This approach is also used in the recycling of other PET materials (e.g., plastic bottles) to create polyester fibres. More commonly, the (re)production of polyester uses a chemical process of repolymerization, producing textile material of a much higher quality than mechanical methods (Shen, Worrell, and Patel 2010). However, though simple by design, at the time of writing only 2 to 5 percent of polyester used in clothing is produced from recycled materials such as plastic bottles or ocean plastics waste (Ellen MacArthur Foundation 2017; Textile Exchange 2016). Regardless of the plastic source used or the process, polyester fibres transform into textiles either by winding them at high speeds into fine filaments for weaving into fibres that resemble satin and silk or by combing, spinning, and knitting them into matte-finished fabrics that mimic cotton or wool (Schneider 1994).

The physical qualities of polyester are also achieved through various assemblages of its production: the relations among chemical manufacturers, global shifts in the price of oil, technological infrastructures of production, the knowledge and haptic awareness of comfort and aesthetics among clothing designers and makers, and increasingly changing environmental regulations (Tonuk 2016). It is also through these assemblages that an understanding of provenance, persistence, and transformation of polyester becomes possible.

Described by chemists as "bad actors," some of the monomer, additive, and plasticizer components added for aesthetics or comfort are now understood to have harmful effects on bodies and environments since they "intervene in 'natural' systems" and can "change genetic material, easily travel and escape containment," and "readily accumulate" in environments (Liboiron 2016, 89; see also Chapter 2 of this volume). So varied are the


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chemical compositions of polyester that it can be difficult to trace them and their effects on humans and non-humans. Of particular concern are the possible effects of microplastics, the residual effects of plastic monomers, and endocrine disruption, described further below (Gabrys, Hawkins, and Michael 2013; Liboiron 2016; Napper and Thompson 2016). Also, many of these additives and compounds are resilient and resist biodegradation, so they have long decay times (Fletcher 2014; Li, Frey, and Browning 2010). Because of the variety of polyesters, dilemmas arise about how producers, consumers, and environments might cope with the unknown impacts of these materials.

The instances described here, in which the materials are evaluated only in terms of the product forms, tell but part of the story of how the qualities of polyester are both fixed and challenged and how they become known as "problematic." In the next section, I review the interactions of polyester, as clothes, with wearers. Unlike other forms of PET, such as those commonly known in plastic bags or water bottles where its plasticities are haptically detectable, the plasticity of polyester fabrics is rarely acknowledged, unclear on clothing labels, or unknown among consumers. Through their affordances of feel, texture, durability, and/or (dis) comfort, interactions with polyester force us to look beyond clothes as coherent, singular objects and toward the component materials and innate capacities of polyester that exemplify an entirely different set of plastic materialities.

## Wearing Polyester: Translation, Transformation, Valuation

Consumers are confronted with the material qualities of polyester daily, but rarely is it recognized as plastic (Stanes and Gibson 2017). Where organic textiles such as cotton or wool are actively marketed as "natural", the "derivation of polyester is passively concealed" (Stanes and Gibson 2017, 28). Fabric engineering and manufacture, and garment design typically hide the plastic provenance of polyester, not mentioning it on labels and thus deceiving wearers (Stanes and Gibson 2017). Furthermore, the complexity of textile chemistry means that, even if one is comparatively well attuned to the properties of clothing textiles, a wearer can never be certain of where, how, and with what polyesters have been made (Küchler


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2015, 268). Polyester is chameleonic in its tactility, mimicking or approximating the "natural" feel of organic fibres.

My doctoral research revealed a range of complex embodied engagements between consumers and polyester: from attachment to disgust, comfort to discomfort, pleasure to deception, nonchalance to neglect (Stanes and Gibson 2017). I used the varied haptic experiences of clothing[8] to explore how clothes felt at different points in their prosaic biographies, from purchase to wear, from wardrobe to washing, and ultimately to their deterioration. To be clear, all twenty-three wardrobes contained polyester. It was in underwear, trousers, dresses, blended with cotton in t-shirts and jumpers, and it materialized most obviously in collections of second-hand clothes. And though polyester was always present, there were mixed perceptions of what it should feel like or which clothes should contain it. Composed of layered and added compounds, polyester often appealed to the senses as light, flexible, and soft, its composition measured by an embodied and sensory perception of comfort (Hebrok and Klepp 2014; Stanes and Gibson 2017). The properties and performance of polyester were also shaped by personal ideas of durability, quality, aesthetics, affordability, and luxury. Such haptically informed ideals often render the plasticity of polyester undetectable. And with the derivations of polyester concealed, its mimicking properties manifested a type of "material ambivalence" (Stanes and Gibson 2017, 31).

Equally, the plastic provenance of polyester was veiled by trademarks and brand names. Polar fleece, for instance, was often mistaken for wool. Lycra is so normalized as a high-performance fibre for athletic wear that its inorganic origins were rarely realised. Accompanying Lycra were a host of additional high-performance textiles whose names evoke both high-tech science and a degree of bodily comfort (Stanes and Gibson 2017). Polyester in this form was celebrated by young adults for its performance. The technical aspects of active wear, for instance, allow people to achieve a particular vision of fitness. And though the durability of polyester is deemed suitable for work or exercise, this is less the case for everyday wear, in which different configurations of comfort, class, and materiality prevail (Stanes and Gibson 2017). Polyester, then, conjured up feelings of joy or discomfort based on the context of its use.


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With wear, wash, and decay, our bodily relations with clothes reconfigure (Stanes 2019). Such material and temporal changes unfold in different ways. Some polyester clothing–body relationships reconfigure noticeably, such as when a garment warps or no longer fits after being altered by the contours of the body. Likewise, the body can encounter discomfort from friction with the skin, such as when polyester fabrics bobble or pill (Stanes 2019). Other changes in the texture of polyester clothes can be so microscopic that it is impossible to "feel" them with our bodies.

As polyester garments are washed and worn, the weakening of the polyester filaments leads to more rapid breakup, contributing to greater fibre release during laundering, as shown in Napper and Thompson's (2016) investigation of microplastics fibre release during washing. It is these polyester transformations that contribute to microplastics pollution. The accumulation of microplastics, including monomers, additives, and plasticizers that leach from polyester clothes, are now known to contribute to global plastics pollution (see Chapters 1 and 12 of this volume), and this is where polyester's component materials work together in harmful ways (Liboiron 2016; Rochman et al. 2019). For instance, because of their polarity, microplastics act as absorbent vessels, attracting oily chemicals such as pesticides and flame retardants (Liboiron 2016). Thus, when consumed by marine or aquatic life, both the original polyester monomer and the absorbed chemicals accumulate in tissues and travel up the food chain. Although more research is needed, some plastics are known to be associated with endocrine disrupting chemicals (Rochman et al. 2019). They are known to mirror, compete with, or disturb the synthesis of endogenous hormones, with risks for metabolic problems, hormone-sensitive cancers, and birth rates in humans and non-humans (Gabrys, Hawkins, and Michael 2013; Liboiron 2016; Rochman et al. 2013). Thus, even when polyester clothes are repeatedly used, much loved, and cared for, their residual effects and very plasticity continue to transform in use.

As scientists continue to expose the lingering environmental implications of polyester, clothes that contain polyester are beginning to acquire an identity and politics more common to plastic bags and water bottles. California recently published a bill proposing that clothing that contains more than 50 percent polyester have a label stating that "this garment sheds plastic microfibers when washed, which contribute to marine plastic



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pollution" (California State Assembly 2018).[9] Polyester clothes, it seems, are being transformed from desirable to "destructive matter"; although such campaigns animate the materiality of polyester and human relations with it, they also deploy "a command morality" designed to remind consumers that polyester clothes are "now problematic" (Hawkins 2010, 119). Wearers of such clothes have been compelled to act with some responsibility. Patagonia (2017), for instance, now sells a "guppy bag" designed to trap polyester microfibres during laundering. How much this political "microplastics" moment drives change in the consumption of polyester remains to be seen.

The insights here on the blurred boundaries of polyester clothes in use propose a kind of refusal to view polyester as if it exists in isolation to sensorial, emotional, and evaluative engagements. In light of new evidence of polyester's capacity for microplastics pollution and long decay time, this prompts a rethinking of how the challenges of polyester clothing can be conceptualized and confronted. The "problem" of polyester becomes not just a question of the materials involved and the forms that it takes but also of the troublesome ways in which people relate to these materials as parts of their wardrobes and everyday domestic routines (e.g., doing the laundry or exercising).

## Persistence: The Enduring Qualities of Polyester

Because polyester is made from petroleum, it signals a lingering and indefinite material and temporal process of environmental degradation (see also Chapter 5 of this volume). However, unlike the accumulation of microplastics discussed above, polyester accumulates in other ways: as unused and unwanted clothes. Globally, roughly 73 percent of clothing disposed of annually is incinerated or landfilled (Ellen MacArthur Foundation 2017; Norris 2017; Textile Exchange 2018). It is estimated that just 20 percent of the world's used clothing is collected. Of that 20 percent, 55 percent is recovered for second-hand economies, 40 percent for down-cycling initiatives, and 5 percent is returned to landfills as waste (Rhoades 2016, cited in Norris 2019).[10] Of clothes donated directly to second-hand networks, up to 75 percent contain human-made fibres such as polyester.[11]


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My encounters with young adults who buy, use, and dispose of clothes in the minority world revealed that polyester or polyester-blend clothing was the most common textile to amass, unused, in wardrobes (Stanes and Gibson 2017). Polyester, it turns out, is not so easily disposed of. In some cases, there was a reluctance to dispose of such clothes because of their persistence, having neither fallen apart nor worn out but no longer aesthetically pleasing. Such clothes sat idle in wardrobes. Others had anxieties about how best to get rid of polyester clothes deemed too worn for reuse but not completely worn out. Such examples illustrate that disposing of unwanted garments can be an emotionally fraught venture because of polyester's durability.

Of the polyester garments and textiles that do reach landfills, a new series of material temporalities emerges. The slow decomposition of polyester is difficult to track because of complex chemical compositions and trade-offs in the fabrication of clothing such as manufacturing quality, fabric thickness, and material composition. In landfills, a different set of interlocking temporal factors determines decomposition: how much waste is added to the landfill, how long it takes for the landfill to become closed, and the time it takes microbial life to break down synthetic fibres (Reno 2015). In any case, the decomposition of polyester is far from its end point. Other long-term factors are connected to polyester degradation, such as the leaching of additives and plasticizers that contaminate air, soil, and groundwater in landfills. Polyester, then, persists—in wardrobes, in second-hand economies, as slowly decaying detritus in landfills, and as microfragments in air, water, and soil.

## A (Re)valuing of Polyester?

The problems of polyester have provoked some responses. In this final section, I turn to how the persistence of polyester is being (re)valued, namely based on different interpretations of the circular economy. The holistic approach to the circular economy has become one of the most dominant conversations in the sustainability of the fashion industry to date (Norris 2017). The plastic materialities of polyester have been of particular focus. Driven in part by the visibility of fast-fashion brands, including H&M's "conscious campaign" or Zara's "Join Life," textile



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recycling has emerged as one solution to extend the life of polyester clothing. High-street fast-fashion retailers have taken on the responsibility to collect clothing donated in stores (often with resulting discounts for consumers) and resell, reuse, or recycle it. Critiques of such campaigns have followed. A tiny fraction of clothes, less than 1 percent, is actually part of fibre-to-fibre recycling schemes (Ellen MacArthur Foundation 2017), and the transparency of recycling initiatives has provoked a series of questions. What proportion of clothes is resold? What kinds of recycling techniques are used? Which actors are involved in recycling or repurposing clothes? What is the process?

Notwithstanding the critiques above, there is more positive evidence that the (re)production of polyester is disrupting waste hierarchies, extending the material plasticity of polyester, and moving it from waste to resource. In 2005, Patagonia's Common Threads program worked with Japanese company Teijin to reprocess its own polyester fleeces into polyester filaments. Elsewhere, Dutch label aWEARness works in partnership with companies to ensure circularity across a range of polyester work wear garments. Disruption has also occurred in the recycling of other forms of PET. Denim company Gstar RAW partnered with Bionic Yarn in 2014 to harvest plastic microwaste from oceans and waterways to use as feedstock for denim fibres, extending the temporal capacity of plastic while also absorbing and concealing the material waste in new garment materials (Binotto and Payne 2017). The Thread Ground to Good program is also actively downcycling PET bottles into polyester fibres while also paying plastic bottle collectors in Haiti and Honduras a fair working wage. Although largely in their infancy and small in scale, such programs have positive signs of textile innovation and waste recovery, ranging from the development of less toxic human-made materials to new technologies that can transform old polyester clothes or PET materials into new garments.

Nonetheless, many of these initiatives are critiqued as promoting a "myth of reuse and recycling" (Cobbing and Vicaire 2016, 5; Ellen McArthur Foundation 2017, 20). To date, the technologies required to recycle polyester are not advanced enough to do so en masse. Because of the complicated chemical makeup of polyester, multiple processes are required. Moreover, it remains technically complex to recycle clothing made of blended natural and human-made fibres. Because of the various


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material components of polyester textiles, the ability to process large volumes of material quickly while also being commercially viable still appears to be a few years away. An underlying concern is that clothes taken back through high-street recycling initiatives will sit hoarded within factories. Crucially, all of these initiatives skirt around a core issue in the use of polyester: subsequent laundering and care of these recycled polyester garments will still leach microplastics into oceans and waterways.

## Conclusion

A challenge set out in this chapter was to trace the unruliness of polyester from monomer combinations to their everyday use, storage, divestment, reuse, and recirculation. Rather than a sense of directionality, the ongoingness of polyester highlights the relations and relationalities of polyester clothes, their transformation, and their persistence. Polyester, as described here, has traversed many routes: toward the choice of garment textiles and the toxicity made known via textile science; haptic engagements and material interactions of consumers; the multiple temporal and spatial scales of fashion markets and the messy and complex injustices of fast fashion; and the prolonged materialities and temporalities of polyesters (un)assembling in wardrobes and second-hand markets, in landfills, in oceans and waterways, in air and soil, and in bodies. Polyester has material and temporal impacts that go well beyond the imagined realm of everyday consumer culture. And though there have been recent technical, structural, and institutional interventions—from collection and recycling schemes to new products intended to "catch" microplastics from clothes during washing—such responses stem from new knowledge about the troubling future of polyester. Such efforts, according to De Wolff (2017, 42), are "always exceeded by the indeterminacies" of polyester's entanglements and "the vibrancy of plastic matter," for "there will always be more plastic to separate."

Understanding the vitality of polyester and clothing made from it is one starting point for unleashing more novel ethical, political, and environmental understandings of the otherwise opaque geographies of clothes. Indeed, viewing clothes as inert objects that move between "wear" and "waste" merely "feeds human hubris and our earth-destroying fantasies



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of conquest and consumption," and the very assumption of clothes as inanimate matter "may be one of the impediments to the emergence of more ecological and more sustainable modes of consumption" (Bennett 2010, ix). As polyester has revealed, the objectification of materials hides their disturbing natures. Even scratching the surface of polyester's transformation and persistence, as I have done here, allows new questions to emerge, opening up new possibilities for material politics of clothing and plastics, investigations of contemporary consumer cultures, and assessments of everyday ethics and responsibilities.

## NOTES

1. Following Gabrys, Hawkins, and Michael (2013, 2), my interpretation of plasticity includes both the tangible properties of polyester—as a plastic—and the ways in which polyester itself is a material process of transformation, giving way to varied environmental and bodily accumulations across its production, circulation, and pollutant capability.
2. To compare the carbon dioxide emissions of cotton and polyester, Cobbing and Vicaire (2016) based this calculation on the same percentage of each fibre used in apparel textile production.
3. Notably, this figure is based on calculations from the clothes laundering routines of households that use standard plumbed washing machines. Two-thirds of households globally wash clothes with methods other than washing machines (Gibson et al. 2013).
4. This chapter draws from ethnographic fieldwork conducted between 2013 and 2015 with twenty-three young adults from Sydney, Australia. Participants were recruited via advertising in local media and snowballing methods. Ethnographic data were collected via shopping go-alongs, participant diaries, photo elicitations, sketches, and reflexive field notes. These sources combined provided an ethnographic portal into the everyday microgeographies of clothes use, the unspoken rhythms of wearing in and wearing out clothes, and their unruly associations. I acknowledge the privilege implicit in this dataset, including how clothes are purchased, worn, and disposed of. It is my intention not to universalize the modes of consumption represented here but to give a certain representation of the use and wear of polyester at a certain moment in time.
5. Appadurai's The Social Life of Things: Commodities in Cultural Perspective addresses the relations and relationships between humans and the material


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world. It illuminates the varied ways that people find value in things and, conversely, how those things make and sustain social relations.

6. The notion of "unruliness" is useful in describing the materials and practices of clothes use: animated, heterogeneous, rough-hewn, and unpredictable as opposed to their traditional alternatives as stable, linear objects bought, used, and divested.
7. Dorothy Liebes, a textile designer and marketer for US-based DuPont, famously told the Kanas City Star that "sheep and goats can't produce enough natural fibres for the mushrooming population of persons . . . and man-made fibers can help supply enough fabric" (cited in Blaszczyk 2008, 86).
8. This research did not focus just on polyester clothing. Polyester, however, emerged as one particular textile that polarized wearers. It was a common source of guilt and shame: items that were bought on a whim, given as gifts, rarely worn, never worn out enough to justify throwing out, or never worn in, in that nice way that organic fabrics become softer, fading and aging gracefully with time. These items hung around in the backs of wardrobes or the bottoms of drawers, unloved yet unable to be discarded. Equally, polyester was loved for its strength and durability.
9. The AB-2379 Bill for Waste Management: plastic microfiber was tabled for consideration, but the time of writing, the bill was inactive.
10. Yet, as Norris (2019) notes, these figures vary widely, with approximately 40 percent in the United Kingdom and 14 percent in the United States.
11. Research has uncovered a mixed story of vernacular creativity and pollutant labour in supposed "dumping grounds" of second-hand clothes, particularly in the Global South (Gregson and Crang 2015, 164; Norris 2015, 184).

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7

# Caring for the Multiple Cares of Plastics

*Tridibesh Dey and Mike Michael*

In this chapter, we approach the notion of plastic legacies through an engagement with the multiplicity of uses and cares of plastics as encountered in India. In particular, we aim to trace such plastic legacies through the ways in which they entail and incorporate other legacies—whether associated with religion, caste, class, gender, or bodily capacity and social responsibility. We approach this through an initial "ethnographic trajectory" that assembles a range of anecdotes. We then subject that trajectory to an analysis that focuses on how the environmental "care" of plastics draws from and is parallel to many other forms of care. As we show, efforts to affect the legacies of plastics by caring for them in particular ways can entail forms of caring that reinforce existing cultural, political, or social legacies. In addition, we attempt to theorize the *multiplicity* of cares through the notion of plasticity as it is manifested both in the complex and fluid repurposing of plastics and in the complex and fluid enactments of care.

## An Ethnographic Trajectory

### *Engineer*

Some years ago, Tridibesh Dey was working as an engineer with a French NGO near the deserts of Rajasthan, India. This work involved assessing



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feasibility for a plastics recycling project conceived to help semi-urban and rural communities in the Jodhpur district manage plastic waste accumulating in open spaces. The NGO, supporting responsible ecotourism in the region, was sympathetic to a local grassroots movement, comprising Bishnoi men mobilized against the use of "plastic," and wanted them to be involved meaningfully in the project.

These (mostly young) men would dress in traditional whites and march through town centres and villages carrying banners and shouting slogans. With much fanfare, they would urge people to give up "plastic," to protect the planet, to care for the environment, and so on. Occasionally, they would surround perplexed pedestrians and take away their plastic bags or walk up to shopkeepers and pointedly encourage them not to offer polythene "carry bags." At the same time, they also seemed to be enjoying themselves in groups, taking pictures and videos on smartphones, and uploading them to social media. Often media photographers and tourists would be present at the mobilization, furthering enthusiasm among the participants of the movement and encouraging varying interests. As the rallies progressed, a few of these men would bend down and gather plastic debris strewn about—candy wrappers, aluminized crisp bags, polythene carry bags, plastic foam slippers, single-use tea and coffee cups, and so on—all partly degraded under the sun and mixed with hot sand. They would pick these items up by hand and gather them into piles by the roadside before moving on with the crowd. Over time, the wind would disturb the piles and blow the plastic objects away in different directions.

The NGO wanted to project itself as working hand-in-hand with the Bishnoi movement, not only supporting its cause but also "advancing" its scope by facilitating modern means of recycling the plastic debris localized, eventually "cleaning up" rural spaces marred by undesired pollutants, and reinvigorating local communities with jobs and monetary surplus from the enterprise. So, the operational model loosely agreed upon by the funders and managers, entrusted to Dey and his colleagues on site (some engineering students and staff from a local technical institution whom he invited to collaborate), was to maximize and render efficient the collection of plastics by members of the rally as they moved through spaces strewn with plastic waste. These objects would then be sorted by


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basic polymer type, thickness, and so on, cleaned, compressed, and sent away to factories nearby for reprocessing.

However, within only a few months, the initial plan met with critical roadblocks. The quantity of plastics that the rally ended up collecting varied considerably, and even a month of collecting was not sufficient to run a single cycle (of single-source polymers) on the smallest-capacity baling machine available. This was not suitable for the successful integration of the project into existing recycling networks, which demanded a steady and "good-quality" supply of recyclables. It also became clear that not all members of the rally were doing their part in plastics picking and as a result considerable plastic debris remained on the sides of the roads along which the ralliers travelled. When gentle persuasion went unheeded, a candid conversation between Dey and two leading members of the rally revealed areas of concern, earlier overlooked when the project was conceived. The actual work of hand-picking plastic items, discarded by (ambiguous) others, generated concerns about bodily hygiene and, more critically, social status. Waste removal was predominantly associated in "upper"-caste circles with particular "lower"-caste or Dalit identities, and most of these men were clearly uncomfortable doing this work on a regular basis. "Bishnois consider themselves of a caste similar to Brahmins," Dey was reminded. Furthermore, some of them did not appreciate being asked to do dirt-removal work by similar-aged or younger Indian men (the engineers) of dubious—possibly "lower"—caste identities who worked mostly from offices and were rarely seen picking up plastic items themselves.

It also became apparent that participation in the anti-plastic rallies reflected unexpected dimensions of the engagement with plastics. It appeared that rallies seemed to mediate a wide range of different projects under the banner of environmentalism. These dimensions included the exercise of masculinity and authority (e.g., plastic bags were mostly snatched away from female/child pedestrians); the enactment of individual agency and mobility within the group and larger community (e.g., some Bishnoi men joined the rally primarily during media coverage); and the exercise of specific Bishnoi selves that entangled environmental and religious activism with broader socio-political projects (e.g., Hindutva) and processes (e.g., mobilisation for higher caste identities, which Srinivas


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calls "Sanskritization" (1956)). Put otherwise, the agenda of (re)claiming public space (and order) for a certain kind of environmental aesthetic and ethos was problematized by a series of caste, class, religious, and gender-based interests.[1]

Within this nexus of identities and interests, the emphasis was less on removing discarded plastics for economic reintegration and more on practising one's complex politics by moving plastics from "here" to a relatively proximal though sufficiently distant "there." Of course, this does not mean that participants in the rallies were any less passionately committed to environmental politics, issues of plastics pollution, animal (especially cows, which Bishnois consider holy) deaths from plastic ingestion, and so on. Indeed, some of them walked several kilometres from places of residence to join such a rally.

### *Observer*

To the extent that collecting and recycling plastics with the Bishnoi men were severely limited, we can say that the engineers' original project failed. Some later attempts at upcycling plastics and/with other waste materials on small scales with local groups also proved to be unpromising because of the social taboo against the regular handling of waste, labour-intensive processes, insufficient capital, and lack of time commitment by participants. Reflecting on these problems and on his processual encounters with particular enactments of plastics (which we try to make visible by the selective use of quotation marks—"plastic"), Dey determined to travel across Rajasthan and to several other parts of the country during that year and subsequently over another two years. He did so to observe what plastics meant to people and how plastics featured in the multiple practices of everyday life. These trips were facilitated by colleagues—engineers, academics, activists, and friends who shared contacts and insights and often joined Dey.

In his travels, Dey experienced many specific reiterations of plastics. Discarded plastic objects were reconfigured—cut, moulded, pressed, joined, and compounded in a wide variety of ways using locally available tools and materials and in unexpected sites by people not formally trained in engineering. It was as if the material affordances and agencies of


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particular plastic objects were being thoroughly measured, harnessed, (re) configured, and assimilated through situated practices. Out of these local inventive practices (some nevertheless problematic) emerged new forms of employment, reconfiguring local economies in meaningful and often empowering ways. One example was a group of Dalit women living in the "slums" by one of India's largest landfills in Delhi. These women organized into self-help groups, facilitated by a local NGO, and crafted flowers, wall hangings, and other decorative products from polythene bags collected from the landfill. These items were subsequently sold to tourists or international organizations to raise funds for the local community.

Such engagements with plastics manifested across regions and diverse sites such as people's homes, village grounds, schools, technical institute laboratories, roadsides, and landfills, in heterogeneously composed forms. Out of such entanglements, new plastic uses, and complex plastic identities emerged. PET bottles were tied together to form rafts or filled with detergent water and fixed to holes in tiled roofs to diffract the sun's rays and lighten the dark interiors of desert homes without electricity. Sometimes such bottles were cut and redesigned as water sprinklers in agricultural fields or reused as volume enhancers for mobile phones, or they were partially cut and used as hanging bins or filled with soil and used as flowerpots. PET bottles were cut transversely close to the mouth and fixed to window holes; by compressing the inflow of warm summer air, they served as a form of air-conditioning for homes. Aluminized plastic crisp bags were crumpled up as scrubs for cleaning utensils; plastic bags were worn as head caps for protection against the rain or as socks for working in the muddy monsoon farmlands or urban landfills; plastic bags—half-degraded in the sun and lying along roadsides or in landfills—were recovered and used as filler and adhesive in asphalt road laying; plastics were stuffed en masse into intramural channels to heat/insulate residential buildings; and so on.

Visiting Mumbai, accompanied by local academic-activists, Dey experienced the vast and largely unregulated commerce of recyclables recovered from city landfills (often during the night to avoid detection and detention by authorities or by paying bribes), the manufacture and sale of recycled plastic disposables, and so on, based at the numerous informal settlements of India's commercial capital. This was an enormous


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parallel economy of plastics (Hawkins, Potter, and Race 2015) embedded in local and global socio-cultural and political hierarchies. Here was innovation as inventive, collective living, negotiating material, microbial, and political-administrative resistances, within critically stratified and hazardous ecologies. Simultaneously, plastics lay accumulating among Mumbai's over-burdened infrastructures and exploited ecologies: roadsides, fields, water bodies, mangrove forests, and so on. Rivers, filled with tonnes of plastic debris, stopped flowing, and clogged drains caused floods during monsoons. Life would come to a standstill for days on end, essential services would stop, and, lives and livelihoods were impacted. The most vulnerable suffered the worst, and lives were routinely lost. Fires would break out frequently at landfills when methane, naturally emitted during decomposition, combusted. These fires were in turn further fuelled by the plentiful plastic debris. Harmful smog would engulf urban regions for months, regions where millions of humans and non-humans live, including some of Dey's close relatives and friends.

A few times among the Bishnois in Rajasthan, Dey came across cows lying dead, or taking their painful last breaths, suspected of dying from the ingestion of plastics. Concerned and curious crowds cut the dead animals open, and twisted, stinking mounds of plastics fell out of the intestines. On occasion, crowd sentiments ran high, and people became incensed and seemed to express a violent desire to be rid not just of *these* plastics but also of *all* plastics at once. Yet people also took pictures on their smartphones (which invariably contain various forms of plastics), uploaded concerned commentary on social media platforms, and mobilized various forms of politics over plastic-mediated online infrastructures. At other times, people attempted to save animals, notably when Dey observed a leader of the Bishnoi anti-plastic movement dragging a stubborn ox by the horns away from a white polythene bag, which it wanted to eat, finally capturing the bag and containing it within his *kurta* pocket, at great risk of personal injury. Ironically, Dey also saw him feed a baby antelope milk from a plastic milk bottle later. Such careful practices of humans feeding animals were common among Bishnois, yet the complex disposition toward different kinds of plastics at different times was hard not to notice. We will return to such ironies below.



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### *Son*

From these broadly "public" sites, we now turn to a "private" site. Over the same period, Dey made occasional visits to his parental home in Kolkata. There, he began to note his parents' domestic engagement with plastics, especially his mother's. This revealed new dimensions of the socio-material (re)use of plastics.

Dey's mother's kitchen cupboards were a meticulous arrangement of plastic entities. There were spices and cereals in transparent plastic containers of different shapes and sizes. Entire rows were composed of collected plastic bags and milk sachets, stacked compactly onto each other. Below, hanging from hooks, were big bulging nylon bags filled with empty plastic containers—transparent PET bottles and jars, carefully detergent-scrubbed, dried under the sun, and stored for future use; many more sacks went into the lofts, under the beds, and into cupboards elsewhere. Sometimes Dey's mother would preserve plastic bags by placing them under a mattress in a consciously devised method for smoothing out any folds or crumples, eventually "making them like new again." Unusually coloured, uncommonly textured, or particularly sophisticated-looking bags were precious possessions for her and were particularly deserving of this preservative treatment. Most of these straightened-out, "new-again" plastic bags would be used to wrap up gifts for relatives and friends, to package boxes of home-cooked food and other personalized valuables for near and dear ones or given out in a tacit hierarchical order in which the "best" plastic bags were reserved for the most cherished social relations.

On other occasions, plastics were put to more personal uses. Dey observed his mother sitting down for her meals with a medium-sized opaque plastic bag and a plastic bottle refilled with water by her side. Since she was physically constrained by an acute case of rheumatoid arthritis, after the meal she would wash her hands and rinse her mouth with water from the bottle directly into the plastic bag and slide in the food leftovers. She would then tie up the mouth of the bag with a makeshift knot and carefully place it on the ground. The bag would sit there, securely containing compromised fluids and leftovers, ready to be taken away by a relative (usually Dey's father) and placed in the bin, all without giving the slightest hint (sight, smell, or touch) of what was inside, thus serving


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both the (neat) enactment of dignified everyday life and the preservation of privacy. After her meal, Dey's mother would sit back and relax and often take a nap. The mixed-polythene bag and PET bottle, in this way, were key companions in exercising control over her corporeal and social selves: they enabled her to manage bodily incapacities (by limiting the strains of getting up from her seat, limping to the wash basin, and turning on the tap), but also, they spared those around her from witnessing this distress, thus sustaining her existing relations and social self.

Deeply spiritual, Dey's mother would often offer food and drinks to her favourite deities. These elaborate offerings would subsequently be redistributed among family members, friends, and neighbours in socio-spiritual gatherings. A few years ago, she decided to replace stitched leaf plates—long used to distribute *prasada* to devotee-guests—with plastic plates made of white polystyrene foam. On being asked (with some reproach) by her environmentally concerned son why she had made this change, she made a rather strong case for the use of plastic plates. Her reasons included a cleaner and more comfortable eating experience; associations of white polystyrene with purity and allusions to its suitability for a special divine occasion; a contrast to the mouldy brown plates between whose leafy layers dust collected; the cheaper price and better storability of plastic plates in the household lofts (saving multiple shopping trips); and the fact that, unlike leafy plates, they did not attract insects and fungi in the tropical climate of Bengal.

But at times there was also frustration with the sheer volume of plastics that had been so carefully accumulated by Dey's mother. They simply took up too much space in the house, and both father and son would urge her to sell a bag or two of her prized possessions. During the occasional purge, she would oversee the sale, making sure that a fair price was agreed to, reminding the *kabaadiwala* (itinerant scrap buyer) at every stage of the negotiation that this was "all useful stuff."

## Initial Reflections

We have termed this introductory account an "ethnographic trajectory"—a series of encounters with plastics that spans different molecules, objects, species, uses, practices, activities, sites, politics, identities,



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relations, bodies, and so on. Given the multiplicity and ubiquity of plastics that Dey experienced, we prefer the notion of ethnographic trajectory to that of multi-sited ethnography (e.g., Falzon 2009; Marcus 1995). After all, the unifying element—plastic—that might tie together the sites of a multi-sited ethnography comes in so many forms, and involves so many heterogeneous relations, that multi-sited ethnography (with its tactic of follow-the-object) does not quite capture what the present disparate ethnographic encounters with plastics entail. Additionally, unlike the methodological planning entailed in multi-sited ethnography, the foregoing examples indicate an accidental or opportunistic engagement with plastic. As such, rather than following a more or less prescribed route through a series of cases, an ethnographic trajectory traces a fortuitous path through a range of plastic encounters.

If there is a unifying dimension here, then it is the ethnographer himself—Dey. However, this is not quite right, for Dey is hardly a unity: his understanding of plastic emerged from these encounters with its complexity. As it turned out, these encounters were life changing and led him to sidetrack a career in engineering and development for an immersion in the social sciences and anthropology. It became clear to him that engineering solutions needed social and political dimensions and empathy and, in any case, simply could not address the complexity, heterogeneity, multiplicity, and ubiquity of plastic's persistent presence. The accounts provided above can also be understood as anecdotes or, more precisely, as a process of anecdotalization (Michael 2012) in the sense that they report events in which, directly or indirectly, Dey was embroiled and that have shaped him and, iteratively, his subsequent accounts of those events. We should also note here our use of the third-person singular, meant to underscore the anecdotalized emergence of Dey.

Be that as it may, the difficulty in situating the present approach lies as much in the objects of the study themselves. The complexity, heterogeneity, multiplicity, and especially ubiquity that attach to plastics render them hugely problematic—perhaps even intractable—as objects of investigation. Yet these very aspects of plastics render them so urgently in need of investigation.

Of course, not only we must deal with these expansive features of plastics. The various individuals, groups, communities, and movements that


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Dey encountered along his ethnographic trajectory also dealt with them. One way in which they did so was by exercising care. As we have seen, this was multifarious and involuted care that spanned the care of plastic objects and plastic wastes, the care of body and identity, the care of religious beliefs and animals, the care of relations of power and prestige, and so on. How do we, as authors, address the various patterns or configurations of care that have been witnessed? Or, within the framework of care, we might ask how do we care for (others') care, in the sense of carefully addressing both our own and our participants' careful immersion in the ubiquity and heterogeneity of plastics.

To be caring and careful is also to be responsible—or response-able (in the dual sense of taking responsibility and being attuned to/skilled in responding to the proximal, suffering other [e.g., Davies et al. 2018; Haraway 2008]). To be able to respond to, and to be responsible in relation to, a matter of care require the making of judgments about what to care for. We thus also ask how does one, at once, limit and exercise care? How does one make the cuts and draw the boundaries while also making the connections and traversing the borders in the process of being careful about care? In the next section, we extend these questions by situating them within the literature on care. Following that, we return to our opening accounts of encounters with plastics and reread them through analytical and ethico-political lenses of care (and caring for care) both separately and en masse.

## Matters of Concern and Care

Bruno Latour's (2004a) Politics of Nature entails an effort to refigure what it means to respond to seemingly imminent global ecological disasters. Central to this effort is the project of giving a political voice to nature, to those "new beings that have previously found themselves under-represented or badly represented" (9). The key is wresting nature from the predominant voice of Science (with a capital 's') that "render[s] ordinary political life impotent through the threat of an incontestable nature" (10). This requires the deprivileging of Science. Obviously, this has become a far thornier issue in the era of fake news and the concerted


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onslaught against "expertise." However, Latour's argument still holds because his version attempts to overcome the ironies of critique.

Rather than critiquing Science because of its animation by social interests (a critique that finds parallels in fake news/corrupt expertise arguments and can be applied to critique itself), Latour aims to move beyond this debunking of matters of fact by focusing on how matters of fact come to be fabricated and stabilized. Thus, Latour (2004b) asks us to grasp the multiplicity and heterogeneity that compose this or that matter of fact (here "this" or "that" body of plastic). To do so would be to shift to a concern with "matters of concern." As he puts it, "reality is not defined by matters of fact. Matters of fact are not all that is given in experience. Matters of fact are only very partial and, I would argue, very polemical, very political renderings of matters of concern" (231–32).

The notion of "matters of concern", therefore, suggests that things are composed of a multiplicity of disparate elements, materializing from complex negotiated relationalities—efforts, affinities, interests, concerns, troubles, and cares in these elements (themselves hybrid entities "held together") adhering together, enduring time, space, and resistance. Latour's aspiration is to render these elements not subject to critique, as a mode of debunking, but available for acknowledgement and debate in what he calls, borrowing from Isabelle Stengers (2005a, 2005b), "cosmo-politics"—working together with heterogeneous expertise and positions of concern. Accordingly,

> the critic is not the one who debunks, but the one who assembles. The critic is not the one who lifts the rugs from under the feet of the naïve believers, but the one who offers the participants arenas in which to gather. The critic is . . . the one for whom, if something is constructed, then it means it is fragile and thus in great need of care and caution." (Latour 2004b, 246)

In view of the heterogeneity, multiplicity, and ubiquity of plastics and the ensuing complexity of their assemblages that Dey encountered, "matters of concern" serve as an apt foregrounding for the aesthetic, ethico-(thing) political, and affective dimensions of these heterogeneous hybrid entities, though only partially.


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With Latour's mention of care and caution, we move to another dimension of our approach to plastics. Although we might trace the complexity that leads to plastics as multiple matters of concern, we must also ask how we and others can do so "carefully": that is, address these issues as "matters of care," mindful especially of the many mischiefs of plastics. Here we draw on Puig de la Bellacasa's important discussion, whose "emphasis on care signifies . . . an affective state, a material vital doing, and an ethico-political obligation" (2011, 90). For Puig de la Bellacasa, the thing that is the object of care is multiply emergent through a variety of practices, including one's own care(s) and the care(s) of others who care in different ways. Thus, to care for the environmental impacts of SUVs also means to be careful of/caring for those who enact alternative cares for the SUV (e.g., as means of conspicuous consumption). There is, from the perspective of Puig de la Bellacasa, an ethico-political injunction to be careful about caring, to be sensitive to the questions "who is doing the caring?" and "who is being harmed or excluded by this caring?" and "what are the observer's (researcher's) own cares?" (91–92). This entails a recursivity that can address the drawbacks of care, for instance where it is exploitative, denigrating, or moralistic. At base, to engage with "matters of care" is to keep open the possibility of dialogue or, more radically, to co-become in the sense that all who care for a particular entity or event are co-carers despite their antagonism or opposition. That is, they might mutually shape one another in the process of pursuing their intersecting, tangential, or contrasting cares. Of course, this is highly optimistic, though a first step is that one is committed to the "knowledge and curiosity about the other" (98; see also Puig de la Bellacasa 2012).

However, one also needs to exercise judgment here. As Martin, Myers, and Viseu (2015, 635–36) argue,

> holding onto critique as a way of unsettling care may itself be an expression of care. Given the asymmetrical power relations that care can set in motion, it must be enacted carefully: care's partialities, limits, and effects must be located, situated, and questioned. . . . As the contexts in which we work become seemingly more urgent, that is, more critical, we must become even more cautious about how we enact our care (as Science and Technology Studies [STS] researchers).



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As the authors go on to discuss, to pursue care "critically" in this respect might mean looking at how care is attached to privileged and powerful actors, not least when it becomes a formulaic element in neoliberal practices of management and consumption (e.g., bottled water [Hawkins, Potter, and Race 2015]) or, as in one of our cases, a means of reasserting a specific sort of social ranking. This applies no less to STS researchers. How is their care reflective of their own positionality? What is obscured or rendered partial—or uncaring—in the process of engaging in matters of concern?

In the following section, we address these questions in detail as we apply the perspective of "matters of care" to the empirical material presented above. Key, here, is the question what are the complexities of caring for plastics? But also, what does it mean to treat plastic's multiplicity and ubiquity as a matter of care?

## On the Complex Cares of Plastics

In returning to the encounters with plastics, we see a range of cares enacted by our ethnographic "participants." In the case of the Bishnoi men, there is care for the environment, but it is folded into care for certain forms of class, caste, and gender identity, religiosity, and regional politics (we see parallel enactments of care in relation to the suffering and death of animals, specifically cows). This is especially evident in the care taken to limit care: to pick up plastic debris is to be careless with one's caste status (and the hierarchical corporeality of the social system per se). Plastic here is enacted in terms of a complex, variegated ontology (Mol 2002) in which care of plastics is patterned in ways that reinforce particular types of identities. In the case of the engineer, Dey, care was played out in other ways. His efforts to encourage the participants on the marches to collect plastics carefully—for recycling—were met with a certain degree of hostility. His status as both insider and outsider meant that his attempts to care for the caring practices of the marchers were not appreciated. Here we see how care is multiple in the sense that it is always already embroiled. To practise care for plastics is inevitably to practise care for a series of other relations, entities, and events that in some ways might compromise that environmental care (additionally, we can point to the Bishnoi men's use


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of their mobile phones to take celebratory photographs of their careful actions), at least from the perspective of an insider-outsider such as Dey. To have that care challenged is thus to have these multiple other cares also challenged. Moreover, they are challenged by those (the engineers) whose legitimacy (that is, the right to care about others' care) is not altogether established, to say the least.

In his subsequent travels around the region (and country), Dey encountered many more forms of recovering and reusing plastics. Again, the variegation of care was evident: the use of plastics as road-building materials and for insulation marks both professional care and the politico-cultural aesthetics of environmental care (reducing urban landfills). In this respect, one can ask whether these innovations and the broader agendas/policies that enabled them were negotiated carefully with other relevant constituencies.[2] Indeed, one can ask whether building better roads as part of a development strategy actually ends up being environmentally uncareful in a more systemic sense. In contrast to these more "infrastructural" uses of plastics, the local domestic inventive redeployments of, say, PET bottles (as buckets, planters, air-conditioners, water sprinklers, lighting enhancers, and so on) similarly reflected an environmentalist care for plastics not only as materials to be taken out of circulation but also as materials that enabled forms of economic or household care. Here the care of plastics is set within a context of material lack and all the cares that follow in the wake of it. On this score, we might ask whether there is an environmental care of plastics or whether plastics are incidental to a range of more immediate cares.

Economic cares of plastics find expression in the collective craft enterprise by the Delhi women or in Dey's mother's use of plastic artifacts (reusing plastic containers for storage, buying plastic plates in bulk). But these cares are nestled within a series of other cares, including care of the domestic space (keeping the house tidy), care of one's reputation (giving quality bags as presents, using polystyrene plates to ensure better hospitality for guests), care of hygiene (replacing insect-attracting leaf-based plates), care of dignity (the plastic bag as a means of socially managing infirmity and privacy), and care of the body (the plastic bag as a means of minimizing painful movements). Needless to say, as hinted in Dey's account, these cares do not go uncontested. Thus, Dey and his father


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urged Dey's mother into getting rid of some of her collected plastic artifacts when the house became too full of them. And his father was not much pleased with getting rid of the many polystyrene foam plates that are impossible to compress and fit into the trash bin (unlike the more compliant leaf plates).

In this section, we have simply listed a few of the ways in which practices in relation to plastics—including collecting them by the roadside and integrating them into new roads, deploying them out of social nicety, and redeploying them out of economic necessity—manifest complex and contrary forms of care. But in the process, we hope, we have also begun to explore what it means for the ethnographer/observer to care for caring. By unpicking the complexities of care, and the interdigitations of multiple cares, we hope that we have shown that to focus on and valorize one particular care (environmental) risks neglecting the nexus of cares within which this particular care is likely to be embedded. This, as Dey found to his cost with regard to the Bishnoi men, might turn out to be counterproductive. In light of care's variegation and multifariousness, perhaps what is needed is a caring for multiplicity or, as Bensaude-Vincent (2007) might put it, plasticity. We turn to this in the next section.

## Caring for Plasticity and the "Plasticity of Care"

In Bensaude-Vincent's (2007, 2013) now classic account, "plastic" is marked by the quality of plasticity. Within the context of the shifting borders between the inflexibility of the natural and the pliability of the artificial, plastic is characterized by a pronounced plasticity: this artificial polymeric class of materials has enabled a proliferation of artifacts and components. With this multiplicity also comes ubiquity: it is difficult to imagine any aspect of life untouched by the presence of plastic. In contrast, Michael (2013) argued that this plasticity, in fact, is constrained insofar as its multiplicity can be realized only at the production stage. Subject to highly industrialized processes of production, plastics offer limited possibilities for the local or everyday manufacture of objects. Inventive uses of plastics have been matters of bricolage, reuse, or adaptation rather than production. Michael further argued that the promises attached to the then novel technology of 3-D plastic printing enabled, potentially at least, the manufacture of plastic goods within the domestic sphere.


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Now, in the context of this chapter, we need to revisit the notions of plasticity and multiplicity as applied to plastics. Of course, plasticity is derived partly from the chemical compositions of plastics, and realized through industrialized manufacturing and particular techno-natural parameters such as temperature, pressure, other chemicals and so on that this process entails. However, we can also conceptualize plastics as complex matters of care: here we would need to address the local forms of invention that constitute and reflect those situated and multi-layered cares. Put another way, the informedness of molecular plastic objects (Barry 2005; Bensaude-Vincent and Stengers 1996), multiple though it might be (function, commerce, consumer aesthetics, legal and environmental responsibilities, and so on), is not determined—that is, inscribed into the molecular configuration and object character—at the point of industrial manufacture alone. Informedness is also elaborated at the point(s) of use (read as subsequent interventions within the adventurous trajectories of the polymers). For us, informedness is interwoven with carefulness, not least when those uses involve reuses and repurposings that inflect environmental matters of concern. The point is that plastics accrete informedness and carefulness, and they shift and change as the plastics are used, discarded, collected, reused, reconditioned, and reconfigured. The plasticity of plastics that Bensaude-Vincent identifies is thus ongoing.

However, lest we forget, sometimes this carefulness and informedness aim at decelerating or halting this plasticity, as in the case of fixing plastic materials within the matrix of a road surface or the cavity of a wall. Ironically, then, in caring for plasticity, one might also need to respect and care for stability and uniformity. In other words, we need to treat care itself in terms of plasticity: to engage with the "care of plasticity" is also to be attuned to the "plasticity of care."

But there is another issue to address here. To exercise care, as noted above, is also to exercise response-ability in the sense of opening oneself up to the suffering other in which the complexities of instrumentalization and care, humans and non-humans, means and ends, subjectivity and objectivity are attended to. Yet we might ask if there is a hint of the individualistic in the notion of response-ability. Is there a moralization of the individual responsible self that does not quite capture the "ability to respond" when it is embedded within a complexly stratified economy?


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In the cases that we have described, we cannot help but note that ability, in the sense of capacity to enact responsible action, takes on a political character problematized by class, caste, gender, religion, bodily capacity, and so on. How, then, do these varying abilities problematize care and the politics of caring? Put more broadly, how might particular forms of postcolonial politics (re-)enact the cosmopolitical?

## Concluding Remarks

This is a co-authored chapter entailing shared anecdotes, exchanged ideas, and negotiated analyses that have shaped both of us and our writing (and our caring for) the chapter together. If Dey—in the third person—appears in the foregoing to be the central narrative figure, then this is a figure composed of joint work that speaks in a voice that embodies—or so we hope—some of the commonalities and differences between us.

In addition, it is important to reflect on the fact that co-authorship itself is entangled in the processes of the plasticity of plastic care and response-ability across a range of socio-material levels. This process is variously manifested in (re)making and electronically exchanging drafts, for example. Co-authoring is also part of broader processes of navigating and making interconnected life worlds and their political economies. Travelling back and forth between countries and continents, family, work, and multiple homes (yet no home at all), looking through the window of the airplane, made fuel efficient by a lighter plastic build, Dey gazes at the ocean below. The gyres must be thickly populated with plastics of all forms, mediated by marine life, transformed forever, and transforming, he thinks. The bottled water served by the caring flight attendant might also contain microplastics: "Sir, you all right?"

Paddling a plastic canoe down the Exe, in our university backyard, we see birds, fishes, insects feeding and breeding amid plastic debris. The beaches along the coast are covered with plastic objects of different shapes, sizes, colours, and textures, washed in by the waves, cleaned up by concerned citizens who organize, act, and voice opinions. We thus see dedicated care. "Writing" into a white Word document on HDPE/Bakelite keys, editing, (re)formulating words—sustained by plastics, we are exercising another sort of care, emergent with idioms of inclusion and


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exclusion embedded in its formulation and practice. One day this laptop will be disassembled, its components perhaps buried somewhere deep or reconfigured, reused to prevent them from doing harm. Yet, through some form of careful mediation (degradation, transformation), this might empower some life form yet choke another to premature death—the care of plastics is nothing if not *plastic*.

## NOTES

1. Writers such as Chakrabarty (1992), Doron and Raja (2015), Kaviraj (1997), Mukhopadhyay (2006), and Phadke, Khan, and Ranade (2011), among others, offer compelling reflections on the messy contention for space in India. Whereas space assumes a central character in the discussion of postcolonial political economy in India and the many forms of negotiation and assertion of subaltern agency, the fluid over-runnings of "public" and "private" are also discussed within historical and socio-political contexts.
2. In November 2015, the Indian government stipulated that plastic debris (e.g., from urban landfills) be made a component of urban road building. Thus road network (re)development, as part of nation building, sits together with the current prime minister's much-debated pet project, the Clean India Mission. Parallel narratives on the safety and environmental impacts (degradation, leaching, etc.) of such a massive project near highly populated sites animate public debate, together with subjects such as the politics of vision, urban planning, religiosity, caste, gender, and so on.

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# 8

# On Becoming a Massively Distributed Thing

## Hedgehogs, Plastics, and the Bearable Lightness of Becoming

*Laura McLauchlan*

Extracting oneself from the proliferation of plastics, it seems, is next to impossible. As theorists have similarly noted with respect to global warming, in finding ourselves part of such a massively distributed problem, our every action seems both to implicate us deeply in the trouble and to be so minuscule individually as to be next to meaningless (Garrard 2013; Morton 2016). For many people working to reverse the decline in hedgehog numbers in the United Kingdom, the realization of such implicatedness led to widespread sadness at and disenchantment with contemporary individualist-consumer modes of conservation practice. In this chapter, following eighteen months of participant observation and interviews with hedgehog rehabilitators and urban conservationists largely in and around Bristol in the southwest of the United Kingdom, I attend to both this sadness and small instances of successful multi-agential mobilizations for hedgehogs. Although the widespread use of plastics might seem at times to be unstoppably ubiquitous, attending to successful antiplastic mobilizations suggests the possibility of recognizing that our



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harmful relationships with plastics are by no means the only massively distributed things of which we are part.

## Background

A largely beloved and once common critter in nighttime gardens, hedgehogs are now a rare sight in many parts of the United Kingdom. Studies of road deaths of hedgehogs suggest that the British population of *Erinaceous europaeus* has declined from a mid-1950s estimate of more than 30 million to perhaps less than 1 million today (Wilson and Wembridge 2018). Cars, poisons, impermeable fencing, gardening preferences for deathly tidiness, and the reduction of habitat through industrialization of farming practices, urban concreting, and construction of new buildings and roads seem to be key elements in this multi-factorial decline. Hedgehogs or "hogs," as they are fondly called by many hedgehog lovers in the United Kingdom, typically roam up to two kilometres a night in order to forage and find mates. Thus, a landscape can quickly become segmented for them beyond livability. Badgers might also play a part in this decline, though why they should be such a worry now, when the two species have long survived together, raises further questions about the extent and effect of habitat loss on badgers as well as hedgehogs (Warwick 2014).

Litter is a vital element of the decline of hedgehogs. Their physiology means that apparently innocuous rubbish can become deadly. An empty crisp packet can be enough to entrap a hedgehog fatally since its spikes can stick fast in these everyday foil pockets, stopping the hog from moving backward. In a famous case from Somerset town, Weston-Super-Mare, it took six people to extract a hedgehog from a crisp packet (SWNS Reporter 2012). Despite the charm of such tales of bumbling hogs and human eccentricities, hedgehogs *do* regularly suffer greatly and die from contact with rubbish. This is a matter to which rehabilitators—who often end up treating litter-wounded hogs—readily attest. Common rubbish-induced deaths involve suffocation, starvation, or strangulation in various forms of plastics, such as cups, bottles, nets, and six-pack rings. Becoming entangled in such rubbish can also cause the loss of limbs or the gradual wearing away of flesh,


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leading to the formation of open wounds that can cause death by fly strike. Even with first-hand knowledge of the danger of many plastic products for hogs, it can be difficult to extract oneself from the use of these flexible, everyday threats. Like roads and cars—other common hedgehog killers—plastics and other potentially harmful forms of rubbish are large parts of hedgehog-rehabilitation practices, with syringes, rubbish bags, and plastic packaging forming major parts of hog care. Even greater amounts of plastics enter the everyday lives of carers through the commercial plastic encasings of products from food to bedding to Christmas cards.

When it comes to hedgehogs, many people in Bristol have yet to see one. My street in St. Agnes, Bristol, was decidedly hedgehogless. Like many streets in the country, our rows of terraced houses sported paved front yards that offered little to nothing to support hogs and back gardens almost entirely closed in by hog-impenetrable concrete walls (Low and Heyden 2015).

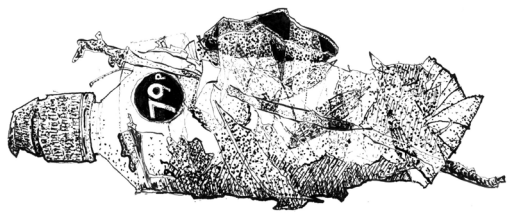


**Figure 8.1.** The St. Agnes hedgehog (courtesy of Laura McLauchlan).

One group of children who lived on the street had never seen a live hedgehog. From both Somali and Caribbean backgrounds, my young neighbours explained that they had learned about them in school and pointed out that all the cars and the lack of bushes and trees along our street meant that we probably would not have any hogs around. However, they still hoped that one day they might find a hedgehog in our neighbourhood. Indeed, before I met these children (or told any neighbours about my hedgehog project), I had heard some of them yelling excitedly "Hedgehog! Look, a hedgehog!" Elated that maybe there was


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an *Erinaceous europaeus* presence in the street, I ran straight downstairs from where I had been working in my two-storey terraced flat. However, by the time I reached the source of the hog-related excitement, the kids had realized that their hog was in fact my next-door neighbour's bristly shoe cleaner. After discovering our shared interest in hogs, from time to time this little team of children left offerings of hedgehog nesting material at my front door and once even a plastic bottle hedgehog (figure 8.1). This plastic and wrapping-tape hog is likely to be the only hedgehog in St. Agnes unless we somehow find a way to become part of an hedgehog-welcoming infrastructural paradigm shift.

## Inextricability

Thinking about one's individual implications is tricky in light of the apparently minuscule role of our own actions in the overall trouble. This is the sort of global warming micro-total culpability that Timothy Morton (2016, 8) explains in terms of turning the ignition of your car and realizing, despite the tiny nature of your act, that you are part of a "massively distributed thing." As Morton argues, in the scaling up of our car startings and coal shovellings to the billions, since they happen all over (and unequally) around the world, we come to see that we are directly responsible for global warming, albeit in such small ways. Similarly, in "The Unbearable Lightness of Green," Greg Garrard (2013) riffs on novelist Milan Kundera's consideration of the insignificance of individual lives in *The Unbearable Lightness of Being* (1984). Kundera considers Nietzsche's notion of the "eternal return," a concept that—among other things—potentially lends weight to one's actions and existence through the promise or threat that one might return to relive such actions throughout eternity. Thus, considering the troubles of apparent insignificance and the need to find a way to give weight to one's actions, Garrard (2013) wonders about the challenges of climate change, in which the massively distributed nature of the problem renders one's actions simply too light to bear. Yet Garrard notes that this lightness is simultaneously overwhelming in that everything one does—"switching lights off, eating air-freighted green beans and accepting a pay rise"—becomes heavily weighted morally (185). Simultaneously, one's every act matters, and none of one's acts matter.



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Despite the micronature of our individual guilt in such massively distributed problems, extracting ourselves from these systems of environmental degradation can be almost impossible. When it comes to hedgehogs, for example, the more you know, it seems, the more you come to realize just how hard it is to make safe urban spaces. To avoid using plastics, cans, crisp packets, rubber bands, not to eat anything that has involved the use of poisons, or to live without daily contact with roads and drains seems to be next to impossible, as much as we might wish not to be implicated in the demise of hogs.[1]

Bristolian hedgehog rehabilitator Yvonne Cox is often asked to give informative talks to children in primary schools about what can be done to help the hogs. Several times now I have seen Yvonne's engaging talk, which never fails to hold children spellbound as she explains the habits of hogs, what they need, and why they are struggling. At one point in the talk, using small soft toy hogs to demonstrate, Yvonne explains many of the ways that humans accidentally kill or harm hedgehogs (figure 8.2). Once two children grabbed each another's arms, clinging to one another as Yvonne told the tales of how hedgehogs get stuck and stabbed and squashed. In each talk, she explains everything that needs to be done to one's rubbish in order to make it hedgehog friendly. Yogurt containers need to be cut in half, as do crisp packets. Cans need to be washed and crushed so that hogs cannot get into them and get stuck. Drink cans are never okay since hedgehogs push their noses into them and get cut. And recycling or putting things into bins does not mean that hedgehogs will not find them—hedgehogs go to the dump and can clamber into recycling crates. In Bristol, they even get stuck in the netting used to cover such crates. Yvonne has been petitioning Bristol City Council on just this matter but, as yet, to no avail.

One day back at Yvonne's house after we had finished just such a talk to primary school children, Yvonne was busy as ever with the work of rehabilitating poisoned, injured, and emaciated hogs. As usual, there were cages to clean out, medications to administer, releases to organize, funds to raise, and twice-daily feedings to oversee. And there was rubbish to process. As Yvonne and I carried her recycling bins out to the curb, she acknowledged sadly that, at times, she just cannot keep up with all the processing needed to make rubbish safe for hogs. Although, when she


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can, Yvonne still crushes cans and cuts chip packets and yogurt containers in half, she explained that it is just not possible to do all the processing in addition to looking after all the hedgehogs in her care as well as her business and family responsibilities. Sometimes something has to give. Together we took the recycling out, but rubbish remained on our minds. Musing on the amount of plastics pollution everywhere, not only injuring hedgehogs that get caught up in it but also getting into waterways and becoming part of all sorts of aquatic life (and death), Yvonne added, "I just wonder how they will ever survive."


**Figure 8.2.** Props for Yvonne's talk on threats to hedgehogs (courtesy of Laura McLauchlan).

Systems geared to disposability are remarkably difficult to avoid. In a mode similar to the tendency of many hospitals to generate high levels of plastic waste (along with other pollutants), within hedgehog rehabilitation the prioritization of the immediate needs of suffering hogs leads to potential environmental harms for other hedgehogs. Although I was cognizant of these potential harms during my fieldwork as an assistant at several rehabilitation centres, the needs of the hedgehogs in front of me always called most strongly, and I would find myself throwing out syringes and


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plastic swabs and piling plastic bags full of the waste of caring into skips. In this way, hedgehog rehabilitation finds itself deeply and unintentionally tied to sustaining the infrastructures that harm hogs. Rehabilitation practices commonly make use of the cars that not only kill but also deliver supplies and transport needy hogs as well as the rubbish and chemicals that poison yet offer vital support for cleaning their cages. Industrial farming systems supply the commercial cat foods purchased for hogs, even while such modern farming has made many rural areas largely uninhabitable for hedgehogs (figure 8.3).


**Figure 8.3.** Some of the many entanglements of hedgehog rehabilitation worlds (courtesy of Laura McLauchlan).

It can seem to be impossible to escape this cycle. Consumerist modes of taking action emphasize one's ability to "choose" to opt out of purchasing such products. As noted in the introduction to this volume, even when one finds oneself able to choose not to support the proliferation of plastics, the hope that such choices will add up to something sufficient is slim. In my fieldwork, I regularly found myself humming Ani DiFranco's "Your


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Next Bold Move," drawn to the themes of inextricability from damage at the core of this song:

> . . . The mighty multinationals
> Have monopolized the oxygen
> So it's as easy as breathing
> For us all to participate
> Yes they're buying and selling off shares of air
> And you know it's all around you but it's hard to point and say "there"
> So you just sit on your hands
> And quietly contemplate
> Your next bold move.

Not participating in the use of plastics does feel like a long-term holding of breath. There are occasional tales, however, of people who live without—or with greatly reduced—amounts of plastic. A housemate whom I lived with in the Blue Mountains of Australia told me a story of a woman who lived somewhere in the mountains who would tie any plastic that she used onto her belt. She had pledged to continue wearing such plastic for the rest of her life or as long as the plastic lasted. By living with such a physical reminder of the persistence of plastics, she intended to sustain her motivation to avoid them. Although I never saw her, this woman apparently still lives in the mountains, and her belt is not yet full. When I was living in New Zealand, the story of a woman called Merren Tait—who went a year without using plastic—was highlighted in several newspapers as part of the Plastic Free July campaign. Tait cited her lack of children as a helpful factor in this difficult achievement and warned that it was not practical for everyone, noting that people thinking about shifting to plastic-free living should "prepare to be inconvenienced" (cited in Tiddy 2016, para. 20). The default flows of many of our lives mean that it takes extreme consideration and commitment—as well as resources of time and energy—to avoid the use of plastics as individual consumers. The demands of caring and budgeting raise the question of the extent to which avoiding plastics is ever a simple matter of choice (Shotwell 2016).



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## The Sadness of Lonely Action

Despite the impossibility of individual decisions adding up to the sorts of change that hedgehogs need, British hedgehog conservation campaigns have largely targeted individuals, encouraging volunteers (sometimes referred to as "champions") to negotiate with neighbours to put hog-friendly holes in fences, to avoid the use of poisons, to be careful with bonfires and whipper snippers, and to minimize rubbish. Capturing something of this approach, the British Hedgehog Preservation Society (BHPS) has stated that "small individual actions can have a huge impact when there are many people involved" (cited in Coles 2015, para. 11). Here, in line with the sorts of ABC, or "actions, beliefs, choices" models common to neoliberal modes of conservation, individuals are encouraged to choose environmentally-friendly products and actions (Shove 2010). Such approaches neglect the infrastructural, technological, regulatory, habitual, and meaning-based aspects of societal transformation (Elzen, Geels, and Green 2004). Such ABC thinking is in accord with what Nikolas Rose (1996) defines as the ideal neoliberal citizen: the skilled, (ostensibly) self-reliant, individual chooser-consumer. This emphasis on individual choice and freedom, however, makes hedgehogs' need for humans to connect their gardens en masse and for city-wide (or even nation-wide) avoidance of harmful waste seem to be almost impossible. In relying on consumption-based approaches, individuals are left hoping that their choices add up to something more for hedgehogs than just a scattering of isolated, inaccessible, would-be havens.

During interviews, many hedgehog champions privately acknowledged feelings of sadness about the ultimate usefulness of their actions. Despite upbeat public proclamations of the possibilities of conservation, participants often expressed a sense of hopelessness, seeing that their individual actions in the face of massively distributed things—whether plastics or roads or the lack of permeable fencing—were not sufficient to make the changes needed. Given the vastness of these problems, however, the issue is not necessarily that the actions are individually small—it is that they are lonely. Yet, though many hedgehog champions are well aware that individual actions are not enough and that a collective response (and responsibility) are needed, in the current conservation paradigm there is


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little means to create them. Speaking of hedgehog conservation more generally, hedgehog ecologist and author Hugh Warwick (Interview, 2014) saw larger social systems as the fundamental cause of hedgehog decline. In an interview, he commented that, in his "more depressed, melancholy state," he saw that "we're just tinkering with the problem because we can't deal with the real issue, and maybe it's that we keep tinkering long enough that we keep things from going down, but it's unlikely." A similar sense of disheartened sadness emerged in interviews with hedgehog champions from a range of political backgrounds who noted that they couldn't see what could be done in response to pervasive development, greed, and the "disposable" lifestyles of many people in the United Kingdom.

The sorts of dismay and sadness experienced by champions are given little public space. There is a political impact of these omissions: recognizing sadness is potentially recognizing that the strategy of individualistic hedgehog conservation is not doing all that is needed. As Sarah Ahmed (2010, 246) notes, rather than leading to despair, or inaction, the sadness of recognizing the hopelessness of the path that one is on might mean instead being "prepared to be undone." In this, unlike the regime-strengthening nature of compulsory optimism (Ehrenreich 2010), sadness and other "negative" emotions might be key for changing direction. Several clinical psychological tests have suggested that "with sadness comes accuracy" (Storbeck and Clore 2005). For example, people who have become sad from being exposed to sad films or music tend to become more detail oriented and make fewer mistakes in recall (Bonanno 2009). People with low moods also put greater time and effort into tasks (Melton 1995) and are more resistant to stereotypes of others than people who report feeling either angry or happy (Storbeck and Clore 2005). Indeed, clinical studies have suggested that sadness leads to increased creativity in problem-solving strategies (Gerrards-Hesse, Spies, and Hesse 1994). George Bonanno (2009, 31) argues that, in its purest form, sadness "is essentially about resignation" and that, as painful and vulnerable as sadness might be, it has a vital role to play in helping us to pay attention to our lives as it "turns our attention inward so that we can take stock and adjust."

Morton (2012) argues for the importance of such sadness—a mood that he sees in ecological awareness. He argues that, in addressing our current



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ecological situation, we must move from the guilt of recognizing how we are implicated to the sadness of greater acceptance of the ecological realities in which we find ourselves. He frames sadness as the psychic space in which we need to be in to accept the great troubles facing our planet without sliding into denial and self-protection, blame, shame, or guilt. It is the sense of impossible responsibility and of the depth of our interconnection. In hedgehog conservation efforts, though such sadness does not offer a direct solution, it does hold the painful truth of both desire for coexistence with hedgehogs and awareness of our role in making the world unlivable for them.

Perhaps curiously, other aspects of sadness might point toward—and even help to encourage—the sorts of greater connectivity and responsiveness that such situations need. Sadness suggests where our cares and desires lie, reminding us that meaning lies in connectivity. As Judith Butler (2014, 22) argues, it is in the loss of others—be they beings, places, or things—and the mourning of them that "something about who we are is revealed." As Butler notes, through experiencing the loss of another as a loss of part of ourselves, we come to see that we are composed of our attachments to others, that we are our relationalities. Sadness can also be helpful in countering the isolation in which we find ourselves. Per Stoknes (2015, 176) argues that more than personal sadness might help to forge community among those touched by it and that such pain can "open the heart to reach out to all things still living." Sadness tends to draw others to us, eliciting their caring responses (Riker 1991). In this way, the powerful pull of another's sadness can feel at times almost manipulative—or, at least, inconvenient—particularly when we wish to maintain fictions of individualism.

Although sadness potentially signals a necessary change in direction and might steer people toward connectivity, this is not to say that sadness is enough. Despite the many hedgehog champions who have expressed such sadness, little else has happened. In feeling and tending to sadness, we may recognise ourselves as implicated and interdependent, but then what? Response in the face of the realities of connectivity is not as simple as deciding to act boldly and singularly. Morton (2009) points out that the imperative to "act now" overlooks the impossibly interconnected realities of the problems that we face. We cannot, as the individualistic


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hero-actors whom we are encouraged to be, *make* what needs to happen actually happen (Lee 2013; Summers-Effler 2010). So what is a hedgehog champion to do?

## The Bearable Lightness of Becoming

Despite emphasizing interconnection, something remains curiously individualistic about Morton's (2012) notion of the sadness of ecological coexistence. His figure of ecological awareness, the noir detective, see themselves as *implicated*: that is, as both the detective and the criminal. As Morton notes, "the particular kind of guilt with which ecological awareness is associated strongly resembles the realization at the heart of a noir detective story: the detective himself is the guilty party" (16). He suggests that those of us who feel such guilt might sink into shame and then into sadness. My research with hedgehog conservationists has convinced me of the potential power of sadness—as opposed to guilt or blame or shame—to allow one to face the negative ecological realities of our entangled impacts on the world around us. It is, I argue, also necessary that we recognize our radical connectivity as also entangling us in the maintenance of lives and in possible responses to harm. Yet this potential can be hard to see. Just as our particular contribution to the massively distributed forces that we would rather not be part of is micro-total, with our individual actions seeming to be impossibly both light and heavy, so too is our potential "positive" participation in diffuse and multi-agential forms of power. We need to attend to the multiple ways in which we already are and might become active together in aid of the worlds we wish to be a part of.

Some distributed actions include the sorts of intentional campaigns on which much environmental activism is based. Yet such collective actions can also be based on quiet, everyday actions. One small anti-plastics success in the world of British hedgehog conservation was based on remarkably non-spectacular yet effective collective action. The McFlurry—a sweet frozen dessert—comes in a plastic cup with a fitted lid. A regular McFlurry lid has a wide opening to accommodate a large spoon, and the size of the opening is just right to trap the head of a hedgehog (BHPS 2006). This new form of plastic litter, it turned out, was unfortunately a perfect hedgehog trap. Smelling the sweet leftovers in discarded McFlurry containers,


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hogs would squeeze their heads through the lids only to find that, because of their spikes, they could not pull their heads back out of the hole. Such hogs often died of dehydration. The BHPS quietly mobilized. The organization's newsletter and supporting websites sent out instructions to the 12,000-strong group: they were to write letters to McDonald's en masse, complaining politely without foul language, threats, or sarcasm (Lean 2006). The campaign was not particularly speedy: letter writers worked for five years. However, finally in 2006, McDonald's relented, invested an undisclosed sum in design tests, and soon released the new McFlurry container, designed with a reduced hole in the lid, which meant that the majority of hedgehogs would not be able to push their heads into the cup.

Such a victory is by no stretch spectacular: all this letter writing resulted in a small change to the lid of a disposable ice cream container. Furthermore, that change has not been perfect. The cups are still plastic, and presumably many are still thrown into landfills. Small hogs still get caught in the cups: the new McFlurry lid needs to have a hole big enough for a spoon, which means that, even with the smallest hole possible, the gap is still big enough for baby hedgehogs to get stuck. However, many hogs have been saved by this quiet mobilization of BHPS members. It also offers new ways of thinking about power and effectiveness. In what Geoffrey Lean (2006), environment writer for the *Independent*, called "one of the most genteel campaigns in conservation history," a small but life-saving change emerged from this mass letter-writing campaign.

In this, we find a massively distributed thing playing out in a different way. In joining with others, in finding oneself within distributed agencies, one's actions are part of an immense contribution even while, individually, seeming to have been too small to be helpful. Within such activism, the action of one person is almost impossibly light: which letter or call to McDonald's over those five years finally led the company to change its packaging? Such agency is not heroic in the sense that any individual is *the* agent of change. Rather, it is the power of being one of many ants, working separately but together to make a remarkable thing, the magic of being part of a massively distributed thing.

As Elizabeth Lee (2013) notes, the actors in activist work are radically more than human. In this instance, there are felled trees for paper and envelopes, sunlight and soil and water and roads and working humans


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connecting all of them, phone lines and pens of metals and plastics and maintenance crews, BHPS offices and newsletters, and supportive grandchildren and the foods that maintain bodies and their ability to feel affection for hedgehogs and a culture inculcating a high degree of respect for particular forms of politeness. There are also forces and actors and vital accidents of which we might not be aware. Although one person alone cannot *will* such collective happenings, one can find oneself acting as part of the energies of actors that add up to something. Returning to DiFranco (2001), it is indeed hard to point and say "there," but that does not mean that one needs to sit on one's hands: rather, one might find oneself part of a radically bold move if one can take part in the collective work of collaborating within what Alexis Shotwell (2016) refers to as distributed ethicality.

Not all roles in distributed mobilizations are micro, of course. The letter writing campaign rested on a huge amount of work carried out over many years to create the infrastructures to support the community of humans and hogs who come together as the BHPS. The society was set up in 1982 to encourage respect for hedgehogs, to support research on and education about them and their needs, as well as to offer support and guidance to hog rehabilitators. In the years since then, this potential has been maintained through the work of volunteers and employees who tend to the mailing lists, fundraising, interpersonal matters, and the planning of events needed to keep people feeling a sense—and reality—of togetherness. While it might seem obvious that the BHPS campaign couldn't have happened without the existence of the BHPS—it is the creation of such collectives that holds the potential for action. Yet, despite forming an indispensable hub of action, for anyone who has been at the apparent helm of organizing an action, there is the immense frustration of realizing that you are not in control in an easy way. Although huge amounts of individual time and effort are invested in creating the potential for such mobilizations, one ultimately finds oneself acting in *concert with* many other forces rather than directing them. Even as the apparent 'organiser'—being part of such actions still has the curious feeling of being only part of a massively distributed thing.

Other campaigns that have made helpful—if small—shifts for the lived realities of hedgehogs have also tended to be strategies aimed at building



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and working with larger collectives. Again, these do not necessarily look like typical activist mobilisations. One such example is a woman living in a small Somerset village whose educational hedgehog-themed neighbourhood coffee and cake parties raised money for Prickle's Hedgehog Rescue; during such afternoons, she was also doing the transformative work of both connecting neighbours and educating them about the needs of hedgehogs. Such work quietly changes the configuration of a neighbourhood as neighbours are pulled in and mobilized. Recently, Hedgehog Street has also begun working directly with developers, and it is exciting to see what might emerge from such relationships. In targeting infrastructural barriers and pollutants, it is vital to look at the power that might be available in wide multi-species assemblages of stories and hogs and meaning and policy and the materialities of connection and communication.

How multiple forces come together successfully (and successfully for *whom*), however, is difficult to chart. As Jane Bennett (2010, 34) notes, the question of precisely what agency is—whether human or otherwise—is deeply mysterious. It is also hard, Bennett suggests, to know precisely how events come about, for stories of change are often told backward, from the events to the potentials that allowed for them, a mode of storytelling that can allow the teller to emphasise her or his most favoured explanations. Who exactly the agents are—and whether we will ever fully know—are also in question. Yet a range of affective, human, and infrastructural "conditions" allowing for mobilization can be identified (Ahmed 2010; Lee 2013). In particular, the McFlurry campaign was well suited to the tendency of many British people to love hedgehogs and, in particular, to frame them as gentle and somewhat quaintly eccentric. Such imagery is also at play in enabling successful neighbourhood-activating tea parties. Here, in place of the typical translation of "assemblage," returning to the French original of *agencement*, referring not just to a collective of things but also to an arrangement that creates a particular agency, is potentially helpful (Müller 2015, 28). This was not merely a collective but also a collaboration of tendencies and materialities that, in this right mood and moment, allowed for a small shift that matters.

Seeing that we are inherently implicated—for apparent good or ill—destroys fantasies that we might be able to extract ourselves from what


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is emerging around us. In seeing ourselves as connected—for better or worse—we reject the possibility of purity. Such ideologies of purity of looking after one's own backyard are ultimately, Shotwell (2016, 9) argues, "a decollectivizing, de-mobilizing, paradoxical politics of despair." Acting within implication—indeed the only way that we can act (or be)—we find ourselves necessarily compromised and making compromises. There are few guarantees. However, in seeing such connection, we might also see everyday potentials. How might one connect and with whom? Which infrastructures, organizations, collectives, or teachings might end up mattering? It is hard to tell, and it is surely a matter of experimentation, of connecting with others and seeing what happens. There is the necessity, however, of connecting with other agents in order to create new *potentials* for action. "We"—and who we are becoming—are never separate from such co-constitution. As opposed to Kundera's use of Nietzsche's eternal return to lament the insignificance of being, when one shifts outside of an individualistic frame, a new possibility of significance emerges. In attending to the desires and realities of connection, Rosi Braidotti (2006, 191) celebrates "the bearable lightness of becoming." In this, she argues, the challenge of the ethical is to transform negative passions into positive passions "through encounters and minglings with other bodies, entities, beings and forces" (163). It is faithfulness to this "desire to become" with others that guides such connections (163). In this, we become aware that we ourselves are always part of, and actively creating, massively distributed things.

Becoming is always a case of becoming with another: atomistic individualism is a fantasy. Such connections, creations of new instances of *agencement*, of mobilizations and possible becomings, also have implications for the sad loneliness of our times, marked as they are by the experience of a lack of meaningful connection. Such loneliness overlooks the reality that we are always in connection, always working in concert with others.[2] The vital question, however, is with which forces and actors are we connected? Many people do not belong to intentional care-oriented organizations such as the BHPS. However, we are always participating in massively distributed collaborations. Thus, rather than a question of individualism versus collectivism, the vital matter is to attend to which collectivities we are a part of: with which others we are joining and how?



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Many of the collaborations that currently create our lives connect us with infrastructures and technologies that support the proliferation of plastics but not of hedgehog-connected gardens. We might have relationships with neighbours, for example, that tend to emphasize "polite" distance. Such modes of relating can make it awkward to begin a conversation about how to knock a hole in a fence so that hedgehogs can get through. Yet such modes of relating might shift through a good neighbourly tea party. Shifts in our relationalities, by forming bicycle collectives, engaging in campaigns for carless streets, lobbying local councils and governments for hedgehog-friendly building design or on banning plastic bags, for example, all offer possible reconfigurations of relationships that could have benefits for hogs. All such collaborations, however, also mean subtle changes in ourselves as we become-together in new relationships with others. There are never any guarantees of course—with which actants (human? other than human animals? architectures? forces unknown?) might we come to work with and to what ends? And, indeed, as with our implication in greater harms, it might not feel like we are ever doing much. Yet our becomings might well be bearably—even joyfully—light. What might we become through actively—though never with full control—recognizing and attending to our participation in massively distributed things?

## NOTES

1. Although the sorts of human-made motorway crossing structures first implemented in the Netherlands are increasingly being built to assist critters in crossing British motorways, such "green bridges" are not currently being implemented in British cities (Natural England 2015).
2. Indeed, much of the conclusion of this chapter emerged from the thoughtful critique of the editors of this volume, who pointed out that I was imagining the archetypal neoliberal consumer as actually isolated. This is the sort of generous collaboration that can help us all to escape from the confines of imagined individualism and its many lonely, insanity-creating effects. It is also a reminder of the strangeness of authorship within paradigms of fantastical sole authorship. I find myself thinking of the provocative observation from Astrida Neimanis (2017, 9) that "no one ever thinks alone, and that gratitude is worth deliberately, even meticulously, cultivating."


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PART III

# POLITICS

# 9

# Communicative Capitalism, Technological Solutionism, and The Ocean Cleanup

*Sy Taffel*

Plastics are essential for contemporaneous networked digital technologies and telecommunications. From the plastic keyboard beneath my fingers, to the plastic motherboard inside my computer, to the plastic-coated fibre optic cables that carry digital data across the oceans to and from data centres filled with more plastic-laden machines, petrochemical-derived synthetic polymers comprise key components of the material assemblages of networked societies. There is growing awareness, however, that the production of over 300 million tonnes of plastics each year (Gourmelon 2015) produces a range of deleterious impacts on human and non-human life. From the contribution to anthropogenic climate change associated with the use of 8 percent of global oil required to produce this volume of plastics (Thompson et al. 2009b), to disruptions to the human endocrine system (Thompson et al. 2009a), to alarming images of seabirds that starve to death with digestive tracts filled with plastics, to the knowledge that microplastics are present in the overwhelming majority of drinking water (Carrington 2017) and marine environments across the globe ( Jamieson et al. 2017), plastics are increasingly recognized as ecologically problematic materials. This awareness, predominantly generated through digital media, is therefore communicated through plastic-laden technologies.



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Telecommunication, in combination with surveillance and targeted advertising, has become the dominant economic model for digital platforms (Srnicek 2016; Zuboff 2019). One notable consequence of the speed and scale of digitally mediated telecommunications is that human attention becomes a scarce resource, and in turn this deficit leads to further dependence on digital technologies that claim to "save time" and attention. Within this context, political action does not follow logically from raising awareness among rational-critical consumers by communicating accurate knowledge about the ecological impacts of plastics. In this chapter, I argue that the logic of convenient (hyper)consumerism that underpins the digital attention economy is equally pivotal to the proliferation of plastics. Furthermore, the attention economy's fixation on consumption dissociates the broader life-cycle implications of material culture—particularly the ecological costs associated with production and waste—from acts of consumption (Taffel 2012). Consequently, we find that solutions are limited to ethical consumerism combined with an unwarranted faith in technological solutionism: the belief that technological fixes can enact ideologically neutral remedies for complex ecological issues such as the global plastics crisis.

After introducing the concepts of technological solutionism, communicative capitalism, and the attention economy, I focus on a discursive analysis of The Ocean Cleanup (TOC), a solutionist project whose promotional literature makes grandiose claims about the project's ability to rid the world's oceans of plastics by using autonomous, scalable, and energy-neutral advanced technology. Analyzing these claims reveals the technocratic ideology guiding TOC that offers voluntary industrial and corporate actions as solutions to ecological crises. In the conclusion, I contrast this solutionist epistemology with the need for a politically engaged strategy that emphasizes the necessity of mandatory regulatory frameworks and legislative action in reducing the production of plastics.

## Communicating about Plastics in Communicative Capitalism

Digitally mediated communication has rapidly become integral to societies, cultures, identities, and economies. As of 2017, there were about



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4.3 billion internet users (ITU 2017). Although enormous discrepancies remain in terms of geographies of digital access, with inhabitants of the most developed countries being four times more likely to have access than those from the least developed countries, this should be understood within the context that twenty years ago there were only 120 million internet users, primarily located in the United States and Europe.[1] The overall trend indicates a huge increase in the number of people using digital communication tools over a fairly short period of time. The newfound hegemony of digital communication technologies can be grasped by examining the market valuations of the world's most valuable corporations (see figure 9.1). In 2006, the six most valuable corporations according to market capitalization were primarily oil/energy companies with some diversity with valuations ranging from US$204 billion to US$363 billion; by 2021 this list featured five digital technology corporations: Apple, Alphabet (Google), Microsoft, Amazon, and Tencent, individually valued at between US$2170 billion and US$780 billion.

Consequently, it has become common to hear claims that society has left the age of industrial capitalism and entered what has been referred to as the information age, network society, postindustrial age, age of tech, platform capitalism, or communicative capitalism. Although there are nuanced differences among these overlapping terms, not least the latter pair's focus on the contemporary moment as a period of capitalist development, a common thread advocates that digital information and communication technologies have become central to the present moment. In this context, it is perhaps unsurprising that media and communications are frequently proclaimed to be central to mobilizing social and political change. As the Spanish sociologist Manual Castells (2010, 369) argues, electronic media "have become the privileged space of politics." This does not mean that politics is entirely captured by media or can be reduced to images, sounds, and signs; rather, communicative action occurring exclusively outside digital media is marginal and therefore unlikely to impact significantly socio-ecological crises.

The centrality of digital media to contemporary society has led, perhaps unsurprisingly, numerous academic commentators on the global plastics crisis to call for communicative action designed to address the current situation. In many cases, this is based on a strategy of raising


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awareness of the issues among the public (e.g., Jacobs et al. 2015; Vegter et al. 2014; Veiga et al. 2016). In such cases, the problem is approached through a prism whereby informing individual consumers of issues of toxicity and accumulation will necessarily alter their behaviours. This approach is problematic insofar as it both reduces the scope of activity to the domain of individual consumption (see the introduction to this volume) and incorrectly assumes a linear causal relationship between information and action.

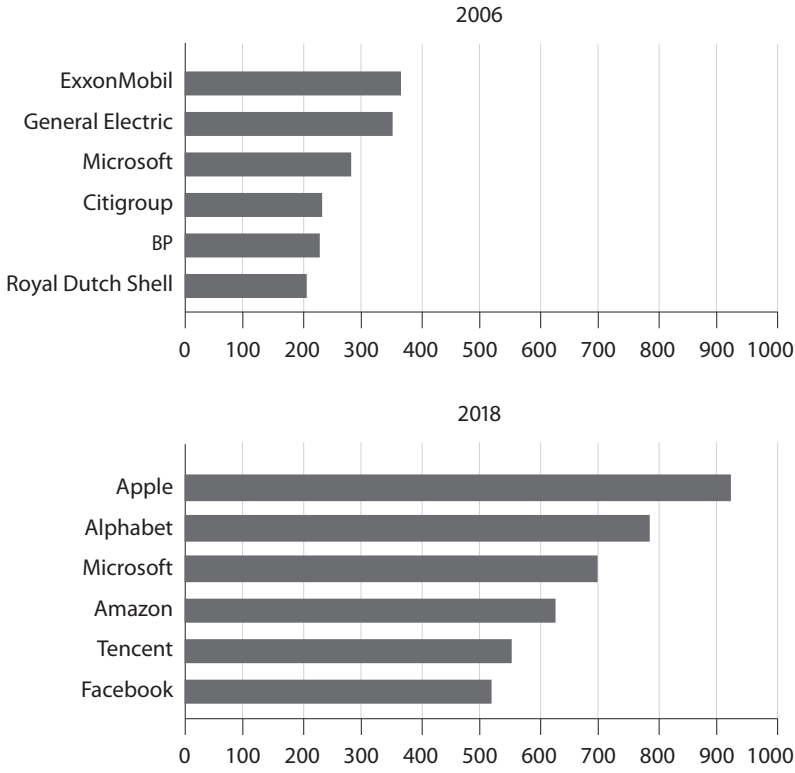


**Figure 9.1.** Largest corporations by market cap 2006 and 2018 in billions of dollars US (source: NASDAQ).

Networked digital technologies have transformed the economic value of information. Whereas until the late twentieth century information was a relatively scarce and therefore valuable commodity, today information is


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abundant, and the volume of information being produced is still expanding at a breakneck speed (Andrejevic 2013). As a result, what has become scarce and therefore valuable is human attention (Crogan and Kinsley 2012). Within this context, described as an attention economy (Beller 2006; Goldhaber 1997), there is not a deficit of information on ecological or social crises. That is, there is no shortage of rigorously researched details pertaining to the global plastics crisis; climate change; deforestation; reductions in biodiversity; oceanic acidification; conflicts in Syria, Yemen, Afghanistan, Libya, Palestine, Myanmar, Somalia, and South Sudan; starvation; epidemics of eminently treatable diseases; and countless other problems. The endurance of these crises attests not to a lack of information or awareness but to the distinction between awareness and effective action. Reading an article, watching video reportage, sharing a story on Twitter, and liking a post on Facebook are not actions that necessarily have any discernible impacts on these crises.

Indeed, enormous volumes of digital telecommunications are a central feature of the contemporary socio-economic system, leading political theorist Jodi Dean to describe these conditions as "communicative capitalism." Within this framework, corporate digital communication platforms are critiqued as systems that effectively capture and commodify attempts at political organizing. Through this process of commodification, they reinforce rather than meaningfully challenge hegemonic neoliberal social relations. For Dean, within the cacophony of online communication, "messages get lost. They become mere contributions to the circulation of images, pinion, and information, to the billions of nuggets of information and affect trying to catch and hold attention, to push or sway opinion, taste, and trends in one direction rather than another. What in one context enhances the potential of political change, in another submerges politics in a deluge of circulating, disintegrated spectacles and opinions" (2009, 24). Within this torrent of content, disinformation, hyperbole, clickbait, and cunningly disguised advertising frequently become disproportionately visible as they effectively game social media trending algorithms. Meanwhile, respectful, reasonable, and detailed analyses are often rendered invisible. The point is not that all mediated communications about plastics are already commodified and captured by neoliberalism, and therefore ultimately doomed to reinscribe existing social relations, but


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that activist telecommunications must be oriented toward mobilizing actions and enacting tangible changes rather than merely participating in the commodified circulation of digital content. This marks a departure, therefore, from the strategy of raising consumer awareness prominently advocated in the case of plastics.

## Convenience and Technological Solutionism

Digital platforms are designed to promote convenience; remotely storing information in the cloud (i.e., a corporate data centre) rather than requiring local backups, recommendation algorithms that suggest new areas of consumption, and allowing people to contribute to political campaigns by signing digital petitions, liking, sharing, or retweeting social media content are all designed to be user-friendly and convenient. They are designed to save time at a historical moment when the deluge of digital content means that attention is being pulled in many directions at once. In 2013, Jonathan Crary described this situation as 24/7 capitalism, whereby commercial pressures are exerted during every wakeful moment, with sleep being the only frontier not yet colonized by quantification and commodification. Since then, the rise of sleep-tracking wearable computing devices means that even sleep provides valuable data for digital platforms. As Crary and other theorists of technology and time have argued, there is a significant discrepancy between the rhythms of embodied human action that evolved under slower technocultural assemblages and those under the near-lightspeed flows of big data (Berardi 2009; Stiegler 2017). This temporal disjuncture subsequently results in a further drive for and dependence on automated digital systems that provide convenience in order to conserve human attention and cognitive load.

A homologous logic of convenience is equally central to the enduring arguments for single-use plastics. They are emblematic of an ecologically unsustainable throwaway culture in which petrochemical-derived synthetic polymers—the fossilized remnants of prehistoric life—are cracked and moulded into objects such as single-use bags, straws, and coffee cup lids whose usage times are commonly measured in minutes yet whose ecological effects persist for millennia. Far from being necessary or ecologically desirable entities, single-use plastics allow people to engage


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unconsciously in a multitude of minor acts of environmental destruction for the sake of convenience. The time required to preserve, clean, maintain, and reuse materials could be employed otherwise, so it's easier and often more economically efficient to just throw them away and forget about their ecological impacts.

Not all plastics are the problem from this perspective. There are many (relatively) long-lasting uses of plastics in which the specific properties of lightweight, malleable materials that act as thermal and electrical insulators are beneficial and whose chemical properties allow relatively straightforward reuse or recycling. However, particular plastics that are toxic because of their material composition (often related to the use of flame retardants, phthalates, and other plasticizers) or those that are designed to be almost instantly discarded are problematic materials whose ecological harms significantly outweigh their social benefits. Convenience, then, underlies the social case for using both single-use plastics and digital corporate platforms. Convenience is a tactic for dealing with a poverty of time and attention but frequently has disastrous longer-term impacts that exist at temporal scales obscured by the information overload and short-term economic focus of communicative capitalism.

The operational logics of the networked computational technologies that play a central part in contemporary life do not simply reside in machines; rather, they pervade how humans perceive the world and structure their engagements with it. Following the French philosopher of technology Bernard Stiegler, technologies are not external, neutral agents employed by autonomous human beings; indeed, the dynamic process of being human is and always has been fundamentally entangled with technology (1998, 2016). Technologies alter our collective capacities for storing memories and communicating cultures within and across generations. The digital, networked technologies that underpin communicative capitalism remotely store elements of our memories and selves. These electronic prostheses are owned and monetized by corporations that collate vast quantities of data in order to predict and shape behaviours. This economic model, predominantly involving forms of highly targeted advertising, is inextricably bound up with ecologically unsustainable overconsumption. Advertising might try to sell you an


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organic, more ethically designed product, but it does not try to curb consumptive behaviours; in fact, its raison d'être is to manufacture desire in order to fuel consumption.

The logics of convenience and calculability associated with digital technologies are reflected in how various complex social and ecological problems today are increasingly approached through an ideology of "technological solutionism" (Morozov 2014; Taffel 2018). The answer to just about every conceivable problem is allegedly located in the application of "innovative," "smart," and "disruptive" digital technologies underpinned by big data and machine learning. This is to suggest not that digital technologies cannot or do not have important roles to play in tackling contemporary social, political, and ecological crises but that the particular model of Silicon Valley–styled solutionism—which combines the fetishism of technological innovation, quantifiable data, and markets[2] with a distrust of centralized government, regulation, and formal politics—is itself an ideological construct that presents a particular form of technocratic cyberutopian libertarianism as common sense. If we follow Marx's (1968, 32) famous statement that "the ideas of the ruling class are in every epoch the ruling ideas"—that is, the ruling material force of society is its ruling ideological force—then technological solutionism is arguably one of the dominant ideological models of the early twenty-first century.

## The Ocean Cleanup

Technological solutionism is exemplified by The Ocean Cleanup, a project that seeks to employ "advanced technologies to rid the world's oceans of plastic" (The Ocean Cleanup 2018). TOC was founded in 2013 by Boyan Slat, a Dutch inventor and entrepreneur who, at age nineteen, dropped out of an undergraduate engineering program to work full time on the project. TOC originally sought to construct and deploy the world's largest floating structure, a 100-kilometre-wide, high-density polyethylene (a fossil fuel–derived thermoplastic), u-shaped floating array that moves with the currents in oceanic gyres to catch and concentrate plastics at a central point from which they would be collected by ship and transported to shore for recycling. Following a TEDx talk entitled "How the Oceans Can Clean Themselves" that went viral,[3] Slat launched a crowdfunding


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campaign that raised over $2 million US. Since then, the project has seen major investors come on board, including right-wing venture capitalist Peter Thiel and Dutch pharmaceutical corporation Royal DSM, supplying funding for the project of more than $31.7 million US.

TOC published a feasibility report in 2014 that was heavily criticized for containing a range of design issues and paying insufficient attention to the environmental issues that the array would cause (Martini 2014). In 2016, TOC tested a 100-metre prototype in the North Sea; however, after just two months, the shackles that connect the array to the mooring failed (Stokstad 2017). This led to a redesign, and in 2017 TOC announced that, rather than a 100-kilometre-wide array, it would deploy numerous one-kilometre-wide booms that would not be anchored to the seabed but have suspended sea anchors. After five years of testing, in September 2018, TOC deployed "Wilson," its first array in the North Pacific Subtropical Gyre, colloquially known as the Great Pacific Garbage Patch. However, by December, it was widely reported that the array was unable to retain the plastics initially collected, so further changes had to be implemented (Summers 2018).

TOC's website home page (www.theoceancleanup.com) features a headline describing the venture as "the largest cleanup in history." Beneath it is a statement that "over five trillion pieces of plastic currently litter the oceans," a figure drawn from Eriksen and colleagues (2014). The subsequent section of the home page, which has the subheading "Technology," declares that "The Ocean Cleanup develops advanced technologies to rid the world's oceans of plastic. A full-scale deployment of our systems is estimated to clean up 50% of the Great Pacific Garbage Patch in five years." This section is misleading in two ways.

First, the claim that the project's technological solution will "rid the world's oceans of plastic" wildly exaggerates the potential efficacy of the project. TOC's floating barriers are designed to catch macroplastics, so they are unable to collect plastics smaller than two centimetres in diameter (Slat et al. 2014, 177). About 92 percent of the 5.25 trillion pieces of plastic in the oceans is microplastic (under five millimetres in diameter) (Eriksen et al. 2014). Consequently, TOC's proposed solution will do nothing to remove the vast majority of plastic pieces from the oceans. However, we should note that, though the majority of oceanic plastics by


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count are microplastics, the majority by weight are macroplastics; plastics over 200 millimetres in diameter comprise about 0.2 percent of the total count but contain 75 percent of the mass of oceanic plastics (Eriksen et al. 2014). Put simply, a single lost fishing net might weigh hundreds of kilograms, whereas microplastics typically weigh fractions of a gram. TOC has the potential to reduce the volume of macroplastics in the oceans, and these macroplastics degrade over time into microplastics. The website is misleading insofar as it suggests that TOC will entirely remove (rid) rather than reduce oceanic plastics and cites count rather than weight immediately before discussing a 50 percent reduction within five years, logically leading readers to assume erroneously that this applies to the previous statistic.

Second, TOC's array removes plastics only from the uppermost 1.5 metres of the ocean. Plastics and the persistent organic pollutants that they attract in marine environments have been found in deep-sea organisms, including crustaceans that dwell between 7,000 and 10,000 metres below sea level in the Kermadec and Mariana Trenches ( Jamieson et al. 2017). Capturing macroplastics at the surface has no impact on the plastics already present in deep-sea environments. Although TOC conducted research concluding that oceanic microplastic concentrations decrease exponentially with depth, and approach zero at a depth of five metres (Kooi et al. 2016), other research indicates that plastics are present at significantly greater depths and mixed throughout a deep surface layer in a way affected by numerous factors, including wind speed (Kukulka et al. 2012). Indeed, TOC's study was criticized by oceanographers as advancing invalid conclusions because no samples were taken below five metres (Martini 2014).

The key point here is not the suggestion that passive floating arrays cannot assist with reducing the volume of macroplastics in oceanic gyres. If this limited and nuanced claim was advanced by TOC, then it would have presented one potentially useful strategy to be employed in tackling the problem of oceanic plastics. On the contrary, TOC exemplifies technological solutionism because it presents itself as a single, straightforward fix for the entire problem, as denoted by the erroneous claim that the project will rid the oceans of plastics. Presenting a partial and limited technical project as a magic bullet to eliminate entirely the complex problems of


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oceanic plastics is not just a fantasy that posits a convenient technical remedy for an issue caused by convenience-based overconsumption but also suggests that there is no need for regulation, legislation, or democratic debate since advanced technology will simply resolve the problem.

## Autonomous, Scalable, Energy Neutral

TOC's website home page further elaborates the project's technological orientation with three headings that align with key ideological markers of technological solutionism, arguing that the project is autonomous, energy neutral, and scalable (see figure 9.2).


**Figure 9.2.** Graphic that appears on The Ocean Cleanup website (www.theoceancleanup.com).

The first of these tropes, that TOC is autonomous, speaks to the fact that the arrays are designed as passive floating structures able to move after deployment with the oceanic currents that transport plastic debris into the North Pacific Subtropical Gyre (NPSG). The website claims that "algorithms help specify the optimal deployment locations, after which the systems roam the gyres autonomously. Real-time telemetry will allow us to monitor the condition, performance and trajectory of each system." Here we see TOC deploy terms commonly associated with digital systems—"algorithms," "automation," and "real-time feedback"—in order to establish the technological sophistication of the project. The ability of digital systems to automate processes so that they do not require human oversight is frequently cited as a key departure from previous technologies (Kitchin and Dodge 2011; Manovich 2000). Networked digital computers exhibit novel forms of non-human agency, they can make decisions based


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on the execution of algorithms in response to streams of "real-time" data (Mackenzie 2006), and they operate at speeds that exceed human reactions and can do so continuously, without the need for breaks imposed by human bodies. Autonomy therefore signifies both how digital assemblages exceed the speeds of previous technocultural ensembles and how they can operate with minimal human intervention once in place.

In practice, however, such rhetoric is somewhat dubious. TOC's arrays—the extraction of their raw materials and the manufacturing processes—are not autonomous, and their deployment requires ships to tow them to the desired locations. Once in place, these systems do not have the capability to repair themselves, with any such work again requiring boats to be sent with the requisite engineers and materials to undertake work that would be economically costly and technically complex because of the remoteness and size of the arrays. Also, the process of extracting and removing the plastic debris caught by the arrays is not automatic; rather, it requires a vessel to travel to the array and gather up the plastic items before returning to shore, where the material can be unloaded and recycled. Furthermore, the claim that "algorithms help specify the optimal deployment location" for the TOC arrays has been questioned, for the project has sought only to explore deployment within the NPSG. TOC claims that its proposed deployment of twenty-nine arrays in the NPSG can remove 42 percent of the mass of plastic currently located there (Slat et al. 2014), which amounts to 17 percentof global marine plastics pollution. Sherman and Van Sebille (2016) argue that deploying the same number of arrays at different locations could capture 31 percent of marine plastics by mass, with a key finding that placing arrays nearer to the coastlines of East Asia would capture a larger volume of plastic before it enters the gyre. Van Sebille, England, and Froyland (2012) found that it takes up to fifty years for some plastic debris to travel from shores to centres of oceanic gyres, so—in addition to the benefit of capturing a greater mass of debris—locating arrays closer to sources of pollution has the benefit of capturing materials earlier, before macroplastic debris further degrades into microplastics and nanoplastics, which the arrays cannot capture.

The second claim, that TOC will be energy neutral, resonates with the popular notion that digital technologies and the solutions that they offer are technologically complex but have minimal environmental impacts,


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that information technologies are smart, green, and act primarily at an immaterial level. The reality, however, is that digital technologies are complex assemblages of matter dependent on a diverse range of materials, many of which are relatively scarce in terms of their geological and geographical distribution, associated with significant issues in terms of the ecological impacts of their extraction, manufacture, and end-of-life disposal (Cubitt 2016; Gabrys 2013; Rossiter 2016), and often contain materials toxic to human and non-human life forms, notably including plastics, plasticizers (e.g., phthalates), and other additives (e.g., brominated flame retardants) (Taffel 2016).

It is common for the vast majority of the life-cycle energy requirements of digital devices to amass during the extraction and manufacturing stages, with in-use energy consumption being a small fraction (between 10 percent and 20 percent) of lifetime emissions. Although TOC's promotional materials focus on the fact that its arrays will not require an external energy source to manoeuvre through the gyre once in situ, this definition of being energy neutral excludes the requisite energy for extracting raw materials, manufacturing the arrays, towing them to the gyre, sending ships to the arrays for maintenance, or ferrying plastic debris back to shore for recycling (itself a process that requires significant amounts of energy to melt thermoplastics). Although the in-use stage of TOC's array is predicated on harnessing the power of the oceans, this claim neglects the huge energy costs associated with production, deployment, collection, and maintenance.

The final claim of this promotional material declares TOC to be a scalable project. This relates to one of the key shifts in the evolution of the array design, the move away from a singular gargantuan (100-kilometre) device to numerous one-kilometre arrays. This change enables TOC to deploy arrays gradually, scaling up over time, with the opportunity to innovate iteratively on the design in order to rectify problems. Iterative design and the accompanying notion of permanent innovation—whereby a platform or product is never finished but can be improved and refined constantly—originate from software development, in which the malleability of code entails that updates can occur as and when changes are made. This approach contrasts with mid-twentieth-century manufacturing processes that relied on standardization, which made alterations costly and


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consequently relatively infrequent. Scalability also speaks to the ability of digital platforms to traverse scales in an apparently seamless manner, allowing start-up enterprises to gain millions of users rapidly without altering the underlying characteristics of the project.[4] Anna Tsing (2015) argues that the logic of scalability is inherently bound to the colonial fantasy of conquering the natural world and invokes a reductionism that tends to obscure externalities. Whereas living entities comprise dynamic assemblages constantly modulated and contaminated by collaboration with others, scalability assumes a mode of immutability fundamentally at odds with ecological complexity. This assumption allows a reductionist model predicated on mathematics[5] to supplant historical and qualitative approaches that pay attention to the diverse specificities that arise from the evolution of assemblages in particular places and ecologies.

TOC has been criticized for espousing precisely this lack of specificity with regard to the ecological impacts of its array and the ability of biotic systems to affect the array itself. Its feasibility report has been criticized for discussing the potential impacts on species of zooplankton that dwell in the boreal and temperate North Pacific but are not found in the NPSG while failing to discuss the probable consequences for species that are found there (Martini 2014). Additionally, the feasibility report fails to discuss the by-catch that will likely occur from passive floating organisms such as the hydrozoan *Velella velella*, rafting barnacles of the *Lepas* genus, and the violet sea snail *Janthina janthina*. Tens of millions of these and other organisms are unlikely to be able to escape the array (Eriksen 2017, 125; 5 Gyres Institute 2015). Furthermore, the arrays are likely to act as biotic aggregating devices, not only accumulating plastics and floating organisms but also attracting fish and other marine life that feed on these organisms, in turn enticing the aquatic species that feed on them (Thaler 2015). Since the arrays are designed to spend a decade at sea, the structures are likely to form semi-permanent oceanic ecosystems, which—because of the high concentration of plastics caught by the arrays—can have severely deleterious impacts on the lives of these organisms. Both the 5 Gyres Institute and Thaler argue that these ecological impacts should be addressed in a formal environmental impact assessment conducted by an external organization, but thus far this has not been undertaken for TOC.


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In addition to these issues, TOC's feasibility report fails to address the issue of biofouling, the process whereby communities of micro-organisms attach themselves to floating structures. The NPSG has a significant community of such rafting species, which tend to be found on larger floating entities as opposed to microplastics (Goldstein, Carson, and Eriksen 2014). TOC accepts that the accumulation of such organisms presents a potential issue in terms of additional weight and drag (Slat et al. 2014), but no feasible solution has been presented, leading Martini (2014) to conclude that "The Ocean Cleanup cannot be said to be feasible unless it develops a realistic plan to address this fundamental ocean deployment issue." The lack of attention paid by TOC to both how the arrays will affect the specific taxa of the NPSG and how biofouling will affect the arrays themselves exemplifies Tsing's (2015) critique of how the supposed scalability of digital projects fails to address the complexity and specificity of ecological communities. Effectively, local concerns about by-catch, biofouling, and ecological alteration are rendered invisible by the global-scale solutionist rhetoric of TOC.

## Conclusion

Rejecting the idea that digital technologies produce simple solutions to complex ecological crises, and foregrounding how the global rhetoric of scalability often masks a range of local harms, do not mean that employing technology cannot help to alleviate issues such as the global plastics crisis. Indeed, finding thoughtful ways of employing technologies for particular tasks in particular places must be part of the strategy for addressing contemporary ecological issues. However, the real risk present in the technological solutionism illustrated by TOC is that people believe nonsensical claims that it is an autonomous, scalable, and energy-neutral way of eliminating plastics from the Earth's oceans. Succumbing to this seductive but fallacious narrative entails that there is no need for any form of collective political action since advanced technology—with the aid of a few visionary entrepreneurs and engineers—has provided an unequivocal solution. There would be no need, accordingly, for any further expenditure of precious attention on such non-problems. Put simply, the discourse of technological solutionism suggests that technology will fix the global


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plastics crisis for us. Herein lies the peril of technological solutionism: it inhibits the forms of messy, difficult, and contested political activity desperately needed to enact substantive changes to deeply destructive consumer cultures based on the fetishization of competitive individualism, choice, and convenience.

In place of the fantasy that technology will single-handedly ameliorate the ecological impacts of consumerism through downstream solutions such as TOC, which only retrieves plastics that have been discarded and entered oceanic gyres, there must be concerted political action to "turn off the tap" that sees an estimated 4.8–12.7 million tonnes of plastics enter the Earth's oceans each year (Jambeck et al. 2015). Indeed, even TOC's feasibility report finds that, without reducing plastic inputs into the oceans, the organization's arrays will not be able to reduce the overall volume (by mass or count) of oceanic plastics, let alone fulfill its claim of ridding the oceans of plastics entirely (Slat et al. 2014). The complete removal of oceanic microplastics is an unattainable dream that derives from the fantasy of total anthropocentric control over ecological systems.

Significantly reducing marine plastics pollution is possible, but achieving this reduction requires legislative action to regulate the use of single-use plastics and prohibit the use of toxic monomers and plasticizers. Here we can find prominent examples in which enacting legislation has led to significant reductions in plastic-related harm. Where legislation has banned particular goods, such as plastic bags in France, California, and South Australia, or the use of particularly toxic materials in products, such as the European Union's Reduction of Hazardous Substances (RoHS) directive, which removed the use of lead, mercury, hexavalent chromium, cadmium, polybrominated biphenyls, polybrominated diphenyl ether, and four phthalates[6] from microelectronics, the end-of-life harms from these substances are avoided entirely. Alternatively, the more than 80 percent reductions in the use of single-use plastic bags following the introduction of legislation mandating small levies in England, Scotland, and Ireland (BBC 2015; McNeily 2013; Smithers 2016) denote that action short of a ban can still significantly reduce consumption predicated on convenience. Tackling the global plastics crisis requires far more than simply banning single-use plastic bags, though. We need a reappraisal of how much of the 300 million tonnes of plastic used each year is really


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necessary or beneficial. Ultimately, legislative activity must be designed to reduce significantly the overall volume of plastics produced, with an initial focus on dramatically reducing single-use and particularly toxic plastics.

Legislative efforts are the results of years of campaigning from NGOs and activists and require the complex, contested, and often painstakingly slow process of formal politics. Far from the elegant, simple fix offered by technological solutionism, legislative efforts involve conflict and collaboration and require collectives to mobilize against economically powerful industry groups and lobbyists. At a time when formal politics is often decried as corrupt and incompetent, it is perhaps unsurprising that the reductionist narrative of technological solutionism presents a seductive alternative, but as in the case of TOC unilateral, voluntarist fixes are fantasies that cannot replace large-scale collective action. Legislative action frequently requires citizens to employ digital telecommunications to mobilize support; however, the key departure from raising awareness here is that such activity is not limited to informing individual consumers within the context of communicative capitalism but explicitly attempts to enact forms of collective change supported by mandatory legal frameworks. Dealing with Anthropocenic ecological disasters such as the global plastics crisis requires the use of digital technologies, but they do not provide magic bullets, as is typically proclaimed by technological solutionism. Technologies can assist with the difficult, conflict-based processes of political and cultural change, but they cannot entirely replace them.

## NOTES

1. There are also notable discrepancies in terms of gender, with more male internet users, and age, with younger citizens more likely to have internet access.
2. Typically, this involves venture capital–funded technology startups expected to lose significant sums of money for several years before becoming profitable. Indeed, most startups fail, but investors require only a fraction of those companies to become the next Facebook, Dropbox, or Snapchat for the overall model to be profitable.
3. As of 2018, the video had almost 3 million views.
4. Typically, this involves using platforms such as Amazon Web Services that grant projects access to vast technological infrastructures, with access scaling


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based on usage and demand. If demand surges, then the project can scale up because it is allocated more computational power, bandwidth, and storage by the Amazon Web Services system.

5. The move from media technologies predicated on chemistry and physics to mathematics is one of the key changes associated with the shift to digital technologies that employ numerical representation (binary code) as a universal format that can be manipulated algorithmically.
6. The four phthalates banned under RoHS are bis(2-ethylhexyl) phthalate (DEHP), butyl benzyl phthalate (BBP), dibutyl phthalate (DBP), and diisobutyl phthalate (DIPB).

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10

# Toward Large-Scale Social Change and Plastic Politics

## An Anthropological Perspective on the Practices of a Danish Environmental Organization

*Johanne Tarpgaard*

In 2014, plastics pollution was not an issue of concern in Denmark, garnering almost no public or political attention. Yet, by 2018, it was considered one of the most pressing environmental issues in the Scandinavian country, appointed the environmental case of the year by the Danish newspaper *Politiken* (Grundtvig 2018). In February 2019, all of the Danish parliamentary parties entered into an agreement to reduce plastics pollution and promote circular economies (Redder and Christensen 2019), and today Danish environmental organizations have partnerships with the Danish plastics industry (see, e.g., WWF 2021). But how was such rapid change possible? This question runs through this chapter, in which I use the case of Denmark to offer insights into the specific practices and processes through which large-scale social and legislative changes begin to occur. As the introduction to this volume makes clear, individual modifications of behaviour are not sufficient to address problems of plastics pollution: structural changes—including new policies, laws, and infrastructural systems—are certainly needed. It is thus important to probe how the momentum necessary for such changes comes into being.



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Denmark is a useful location from which to examine building awareness of plastics pollution. Like many countries in Northern Europe, Denmark is a high-trash society relatively good at "hiding" its plastics problem. In 2017, Denmark was the country in Europe that generated the most trash per capita at 781 kilograms. However, visible plastics pollution is relatively low in everyday life. This is because of highly effective municipal waste management systems that collect trash, clean streets, and incinerate waste, with almost 60 percent of Denmark's discarded plastics burned and converted into electricity and district heating (Eurostat Statistics Explained 2019; Innovation Fund Denmark and McKinsey and Company 2019). Although Danish waters, coastlines, nature reserves, and cities are neither plastic free nor shielded from its effects, in Denmark, people have generally been unaware of how their lives and lifestyles are connected to plastics and their waste. This situation—in which the consumption of plastics is high but the visibility of their waste is low—resembles that of many wealthy countries. But how can the people producing a disproportionate amount of plastics waste learn to see its effects and begin to view it as a problem and even crisis that must be addressed?

In this chapter, I trace the activist efforts of the Danish-based NGO Plastic Change, which has played a crucial role in transforming plastics pollution into a top public and governmental issue in Denmark at a rapid pace. The goal is to "stay with the trouble," to borrow a phrase from Donna Haraway (2016), and describe the messy, on-the-ground processes and practices of how Plastic Change has successfully put plastics pollution on the agenda with the public, industry, and politicians, generating substantial social, structural, and legislative changes. My goal here not to offer specific prescriptions for how to generate change but to foster wider analytical attention to the messy and contradictory processes. I do so because I see better and more nuanced understandings of how social movements work in grounded everyday practices as an essential component of larger efforts to confront plastics pollution.

My approach is inspired by the work of science and technology studies (STS) scholars, who call for attention to the processes and practices through which knowledge is made. In his early work, Bruno Latour (Latour 1988; Latour and Woolgar 1986) pioneered the study of knowledge making as a set of social and material practices. Rather than seeing


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scientific knowledge making as acts of "discovery," Latour presented them as social processes that could be understood best by following their translations, drifts, and diversions (1988,7). Within this STS tradition, Steven Shapin and Simon Schaffer (1985) similarly argued for attentiveness to the concrete practices through which knowledge is made in their seminal work on experiments and performative acts. Such attention to *practices* rather than to ideals or mental logics has become a characteristic of STS scholarship (Law 2008, 2019; Mol 2002). For example, John Law (2019) has repeatedly argued that to understand science one needs to pay attention not only to what scientists *say* but also to what they *do*. These everyday practices, he argues, reveal that science is a much more complicated, conflicted, and contradictory process than it appears if one examines only its stated principles and scholarly commitments. Law thus calls for social science research methods that draw from case studies and ethnographic methods such as participant observation and interviews to observe knowledge-making practices and the social world as they are enacted.

I wish to extend this practice-focused approach from its original scientific contexts to broader questions of public knowledge making in order to more closely examine the everyday processes and pragmatics that create social and legislative change. To do so, I examine the concrete practices of Plastic Change, one of the key players in increasing attention to plastics pollution in Denmark. Established in April 2014 with almost no funding, the organization nonetheless took on the ambitious mission of creating action on national and international levels so that future generations can live in an environment without plastics pollution (Plastic Change 2019). My analysis of Plastic Change is informed by ethnographic research that I carried out with it in the spring of 2016. As a volunteer with Expedition Plastic, the first project that Plastic Change launched, I sailed with members of the organization and other volunteers from Colombia to the Galapagos Islands and Los Angeles. In addition to participant observation onboard Plastic Change's expedition ship, I attended meetings and conferences and conducted interviews with the organization's employees in order to explore how Plastic Change has worked to create social and legislative change regarding plastics pollution. This ethnographic fieldwork, together with related media content from Denmark and elsewhere, forms the empirical basis for this chapter.


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I want to be clear that, in focusing on Plastic Change, I am not holding it up as a model initiative for others to copy. This chapter illustrates how the practices of Plastic Change sometimes fail to conform to standards of scientific practice as well as expectations of antiliberal political activism. Yet, rather than critiquing these aspects of the organization's work, I ask how Plastic Change might have been successful not despite but because of them. In the following sections, I offer three cases of the complicated and conflicting practices through which Plastic Change generated novel attention to plastics pollution in Denmark: witnessing the sampling of microplastics from Plastic Change's expedition ship in the Pacific Ocean, entangled stories about entangled animals, and the Danish dishcloth made from plastic fibres. The first case might make scientists uncomfortable because of its failure to measure up to sampling standards, the second highlights the sometimes troubling structures of care, and the third appears to reinscribe liberal market-based logics, running counter to the desire for more substantial structural change. Through these examples, I want to push us to rethink what "good" plastics activism might be. Might it be that the very practices that initially appear to be flawed scientific practices and neoliberal solutions are actually the very practices that help us to achieve the systematic and legislative changes that we need? Overall, I call for closer scholarly attention to how messy, complicated, and compromised processes might be, paradoxically, essential components of successful initiatives for wider structural and legislative changes.

## Witnessing the Sampling of Microplastics

When Plastic Change began its efforts to create awareness of plastics pollution and prompt social, structural, and legislative changes to mitigate it, the first project that it launched was Expedition Plastic, a two-year expedition from Denmark to Hawaii, through two of the world's oceanic gyres. The founder of Plastic Change saw the expedition as the obvious starting project for the organization, as he saw it as a way to create a platform for talking about plastics pollution in a way that would connect Denmark to the global plastics pollution crisis and give the organization a "more powerful platform to speak from," as the main skipper of Expedition Plastic expressed it.



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**Figure 10.1.** The expedition ship S/Y Christianshavn (copyright: Lisbeth Engbo, Expedition Plastic).

At that time, Plastic Change saw its documentation of the diffusion of plastic in the ocean and its effects as a cornerstone of its work or as a stepping stone from which to engage in conversations with policy makers as well as the public. Therefore, the sampling of microplastics was central to the expedition. The organization wanted to have its own body of scientific knowledge about plastics pollution in the world's oceans and with it contribute to the 5 Gyres Institute's modelling of how plastics pollution develops in the oceans in terms of volume and distribution (Plastic Change 2018). Surface trawling with nets is currently the most prevalent form of sampling, and the sampling of microplastics during Expedition Plastic was conducted with a manta trawl: a metal rectangular box with an opening of fifteen centimetres by forty-five centimetres on which a long net ending in a small tube was fastened. The manta trawl is designed to scoop approximately ten centimetres of the surface water. This is where a large portion of marine microplastics is situated because plastics are less dense than water and are thus naturally buoyant (Eriksen et al. 2014).

Before I started my fieldwork, I therefore expected to find scientific knowledge production constituted predominantly by comprehensive scientific datasets and that, by building scientific knowledge, Plastic Change was communicating a deeper understanding of the issue to the Danish


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public. Taking samples in the eastern part of the Pacific Ocean, I was thus surprised to find that the sampling procedure was not the rigorous scientific practice that I had imagined. The levels of experience and equipment varied from leg to leg, and this part of the expedition was not highly prioritized. Some of the samples taken during my part of the expedition were affected by contaminates such as plastic fibres from the rope holding the manta trawl. Some were even characterized as bad samples by my informants because of large amounts of phytoplankton in the water, longer time in the water than calculated, and a leak in the pontoon, which affected the balance of the trawl. Additionally, shortly after arriving in Colombia, where our leg started, we came to realize that there was no money for analyzing the samples. This was not a conscious decision by the organization's leading figures but a result of its small size and very limited funding at that time. No one had the time to apply for funding for lab equipment, lab time or to hire a biologist to analyze the good samples when we arrived back home. The process of creating scientific knowledge was thereby affected by contextual and multifaceted perspectives (Latour and Woolgar 1986, 23).

Given the many uncertainties and the fact that we were not producing any technical and scientific data on the amounts of plastic pieces in the areas in which we sailed, one of the biologists was especially frustrated, since she felt that her professional reputation as a biologist was at stake. Before volunteering for Plastic Change, she had carried out oceanographic research but had never worked with plastics and their pollution. Nonetheless, she was the most experienced person onboard during our part of the expedition. One evening, somewhere between Panama and the Galapagos Islands, she said in a mixture of frustration and despair "We are just a PR stunt!" At that time, neither of us understood that being "a PR stunt" was not as bad as we thought.

The sampling process in the eye of a scientist might look like a rather questionable data collection and a flawed scientific practice[1]. Still, when we look at the translation and diversion present (Latour 1988,7), we see that also these knowledge practices are performative (Haraway 1988; Law 2019, 8). The sampling process became an effective performance and a broader project of witnessing.



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**Figure 10.2.** Sorting the content from the surface trawl (courtesy of Johanne Tarpgaard).

In *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*, professors of history and philosophy of science Steven Shapin and Simon Schaffer (1985) argue, based on the debate between Robert Boyle and Thomas Hobbes about air-pump experiments in the 1660s, that the validity of experimental findings depend on the scientific culture in which they are made. Witnessing is key in the co-production of knowledge. Central to their work is to seek answers to how and why certain scientific practices, such as the air-pump experiments in seventeenth-century science, were considered as factual and proper in their entanglements with the cultural, political, and scientific paradigms of the time (Shapin and Schaffer 1985, 14). To answer these questions, Shapin and Schaffer identify three ways to multiply scientific authority by multiplying witnesses: eyewitnessing, facilitating the replication, and virtual witnessing. Even though their framework explores processes of creating scientific knowledge in the 1660s, their theory remains useful in looking at the practices of environmental organizations since it turns our focus on processes that would often be overlooked. Using Shapin and Schaffer's framework, I will now focus on these different modes of multiplying witnesses to the sampling of microplastics, with witnessing as the framework through which it became an effective performance.


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As crew members, we were eyewitnesses of the sampling, just like previous crew members. Because the sampling was considered an acceptable method of knowledge production about microplastics in the ocean and thereby a proper practice, even with the errors and uncertainties, we as crew members attested to and confirmed the sampling. In the social space of the other crew members, we saw that microplastics were collected and that visible pieces were found in every sample even though the samples were not analyzed onboard. For this reason, *we* believed that there were microplastics floating in the surface waters. Shapin and Schaffer (1985, 56–58) draw attention to the credibility of witnesses and how the profession of the eyewitness has great importance for his or her reliability. During the part of the expedition in which I participated, the marine biologist was in charge of the sampling. She was considered a reliable witness due to her expertise. Through different Danish media, Plastic Change portrayed her as an expert, and having her as a reliable eyewitness contributed to the validation of the multiplication of witnessing.

Additionally, Expedition Plastic was replicating the sampling procedure. Central to this way of witnessing is how protocols of a given procedure enable people to perform the practice themselves (Shapin and Schaffer 1985, 59). Protocols for the sampling procedure by the 5 Gyres Institute (2017) in California, a recognized organization working with plastics pollution, were followed. Thereby, Plastic Change was replicating a sampling method that had been used since 2007 (Eriksen et al. 2014). Even though the sampling was carried out with errors and uncertainties, most elements of the protocol were followed. The crew was directed to do the best with what was available at that time and on that leg. To replicate the sampling process further, Plastic Change made a smaller expedition around Denmark in June 2016 in which the crown prince of Denmark and the environment minister at the time took part (Plastic Change 2016). From this short expedition, Plastic Change replicated the sampling protocol once again, thereby ensuring direct witnessing (Shapin and Schaffer 1985, 59) and strengthening the trustworthiness of Expedition Plastic and its own credibility as an organization.

The most important practice of witnessing that Shapin and Schaffer identify is virtual witnessing, which "involves the production in a reader's mind of such an image of an experimental scene as obviates the necessity


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for either direct witness or replication" (1985 60). Plastic Change ensured virtual witnessing through many different platforms. During the expedition, it uploaded pictures, videos, and stories on its Facebook page. While we were away, various press releases about the expedition were published in different Danish media (see, e.g., DR 2016), and when we arrived home the biologist was interviewed by Danish radio and television about the expedition. This ensured that Expedition Plastic and the sampling process produced a strong image of plastics pollution in the ocean and meant that Plastic Change gained acceptance as a reliable witness of the amounts and effects of marine plastics pollution.

At present the "good" samples have been analyzed, but as the case highlights it was not the quality of the samples that made the activism good at the time. The processes and practices used to gather the samples were complicated and messy, but when we pay attention to them they show us how social movements can contribute toward wider structural and legislative changes in Denmark and Europe.

## Entangled Stories of Entangled Animals

Besides taking samples, Expedition Plastic was a platform for telling stories about the effects of plastics pollution that crew members encountered, and, as one of them stated one day, the voyage was indeed one big process of storytelling. The other crew members shared her point of view. "In some ways, it becomes more personal when we are on this little sailing ship rather than a big research vessel," one stated. They all agreed that being on a sailing ship was important for the forms and kinds of stories that could be told about plastics pollution. The S/Y *Christianshavn* was Plastic Change's platform and starting point for telling stories;not its office—which at that time was located in a basement.

Aligned with STS scholars such as Law and Haraway, in terms of his attention to materiality and practice, environmental humanity scholar Thom van Dooren argues that storytelling is one of the great arts and key forms of witnessing (Van Dooren 2014; Van Dooren and Rose 2016, 91). Focusing on environmental ethics and understandings of care in his work on extinction, he highlights how stories can give rise to proximity, ethical encounters and entanglements, care, and concern (Van Dooren 2016). Looking empirically at how Plastic Change does the work of storytelling


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as an explicit form of witnessing, I focus here on the sometimes troubling structures of caring, by which the effectiveness of Danish witnessing reduces the distance to the effects of plastics pollution, thereby creating a stronger sense of responsibility than if it were a non-Danish witness.

As sociologist John Hannigan (2006, 70) reminds us, visual images, then, are important to underline the central imagery. To underline the central imagery of plastics pollution in the world's oceans, according to Plastic Change's communications consultant, it was important to post images of the crews' first-hand experiences on Facebook and other social media. In addition, for her, telling stories had to involve a tangible element that could spark an emotional response and engage people. The following was, in her eyes, a good example of such a story.

**Figure 10.3.** The entangled sea turtle (copyright: Lisbeth Engbo, Expedition Plastic).

On the trip from the Galapagos Islands to Baja, California, some of the crew members saw something faintly in the distance. When they got closer, they could see that it was a sea turtle entangled in rope, fishing line, and plastic bottles. The pictures and story of how they encountered and freed the sea turtle were uploaded on Facebook, and within a few days



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shared by more than 200 people and viewed by a few thousand in total. At that time, in April 2016, Plastic Change's Facebook page had about 15,000 followers, and the viewing of the pictures and sharing of the story were therefore overwhelming, according to Plastic Change.

Internationally, the imagery of species affected by entanglement and ingestion of plastics has been very popular and especially strong in the United States. Photographer Chris Jordan's photo series Midway: Message from the Gyre (2009), showing the skeletons of dead Laysan albatrosses at Midway Atoll in the middle of the North Pacific plastic gyre, is one example of imagery that has travelled the world. Trying to draw emotional reactions from those who see the images, Jordan wanted to create a bridge between the global and the personal and make the invisible visible (Bennett 2013). Pictures and videos of entangled sea turtles and other marine animals have also been shared widely online in recent years (Butterworth, Clegg, and Bass 2012; NOAA 2014; Ruiz-Grossman and Dahlen 2017). One example is the picture of the sea turtle named "Peanut" found in 1993 in the St. Louis area of Missouri. Since her early years, she had had a plastic six-pack ring around her body, which meant that she had grown into an abnormal shape, hence her name (Zarlenga 2012).

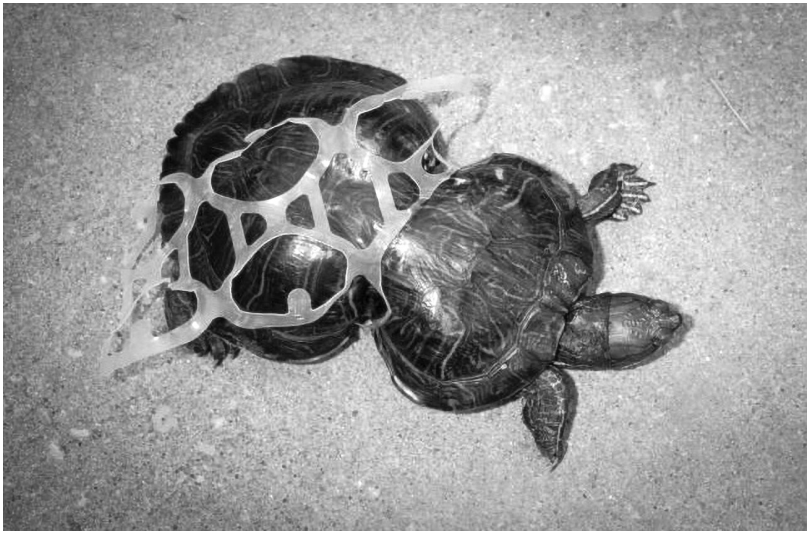

**Figure 10.4.** The red-eared slider Peanut (copyright: Missouri Department of Conservation).



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Given this existing online international trend, it was easy for Plastic Change to tell the story of the entangled sea turtle that crew members freed; the organization had an international narrative into which it could tap, thereby making use of visual images and existing stories seen in international media. According to the communications consultant, images and stories of entangled animals such as seabirds, sea turtles, and sea mammals are popular because these animals are "likable." As a former employee at DanChurchAid, she knew that it was easy for people to relate to animals and children. "They are vulnerable since they cannot help themselves in the same way as adults," she explained in an interview. They catalyze a powerful set of emotive responses such as grief, loss, and love.

Even though a part of the Danish population had already seen images such as Jordan's albatrosses or Peanut, I argue that a desensitization did not take place. Instead, a new story was added to the body of stories about plastics pollution entanglements with marine animals and seabirds and created an echo between the different stories and pictures. Since the story dealt with an entangled animal, the imagery of the entangled sea turtle was already familiar to people interested in the problem of plastics pollution. However, the sensational impact of the images of Peanut, the albatrosses, and Plastic Change's entangled sea turtle was not enough in itself to create responsibility; it had to be made personal and close through a witness to be able to foster a sense of familiarity and intimacy.

As Laura McLauchlan argues in Chapter 8 of this volume, questions of care become complicated by the multiplicity of spatial and temporal scales at which plastic operates. Even though the object of love and grief was thousands of kilometres away in Jordan's images or Plastic Change's image, the scale of connection to the Danish population was different. The narrative of the entangled sea turtle was presented shortly after it was freed, and it was told by a Danish witness. In that way, plastics pollution in the world's oceans became very close, and the effectiveness of the Danish witnesses eliminated the great distance between the Danish viewers and the entangled sea turtle. For a moment, the Danes who saw the picture and heard the story became emotionally and ethically entangled in stories of entangled animals. In Van Dooren's words, "to care for another, to care for a possible world, is to become emotionally and ethically entangled" (2016, 13).


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Around the world, we see that many environmental organizations that work with plastics pollution have expedition ships (see By the Ocean We Unite 2019; Exxpedition 2019), for they all want to be close to plastics pollution in the ocean so that they and their crew members can tell intimate and relatable stories. This highlights the troubling structures of caring in which the feeling of intimacy—of caring about something thousands of kilometres away—sometimes has to be cultivated by kin and kind to be able to reduce the distance and create a stronger sense of responsibility (Haraway 2008, 88). But are stories and pictures together with processes of witnessing enough to change larger structural and legislative matters regarding plastics pollution and make people use less plastic in their everyday lives?

## The Danish Dishcloth Made of Plastic Fibres

Even though neoliberal approaches frequently manifest as individual consumer responsibility, of which this book forms a substantial critique, I will in this last section present a slightly different argument: That we should not discount the roles of things that appear to reinscribe liberal market-based logics, for they might actually have an important effect on large-scale social change. To support this argument, I will present the Danish dishcloth made of plastic fibres.

Besides showing the distant impact of our waste, Plastic Change wanted to get people to relate to plastics pollution in their everyday lives. Therefore, the organization told other stories in an attempt to generate changes in behaviour and to encourage people to use less plastic. One of these stories was about how most people in Denmark for a long time have been using plastic-based disposable dishcloths without being aware that they release plastic fibres. The disposable dishcloth is one of the most common household cleaning items in Denmark and is known by Danes for its pastel colours. The average Dane uses it several times a day, and it is therefore an item to which most Danes can easily relate.

In the spring of 2015, the founder of Plastic Change was in the majority of the Danish media showing and describing how Danes release microplastics into the environment by using those dishcloths over and over (see, e.g., Sommer 2015). When we use dishcloths, they eventually wear out and release microfibres down kitchen sinks and into wastewater


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systems and rivers until they find their way into marine ecosystems. The story spread like ripples in a pond, followed by the story that it was easy to knit your own dishcloths or buy cotton cloths instead of microplastic ones (Tuxen 2016). At that time, in 2015, it was not easy to buy natural fibre dishcloths since they were not a standard item in supermarkets. Elderly women who volunteered in second-hand shops started to knit and sell cotton dishcloths, and in the largest cities in Denmark environmental organizations invited the public to attend knitting events in 2015 and 2016. A "Knit the Microplastic Out of the Ocean with the Danish Society for Nature Conservation's Youth Group" event, hosted in Aalborg in April 2016, was just one example of an event that brought attention to ocean plastics pollution while at the same time knitting a material, small-scale solution.

What we see with the dishcloth is how stories are not only verbal and visual but can also be inscribed in the materialities and practices of things. Drawing on Law's notion of a material semiotic, both the disposable plastic dishcloth and the knitted cotton dishcloth have material and semiotic elements (Law 2008, 2019). Through its materiality, the dishcloth comes to bear semiotics (signs and symbols). The dishcloth, earlier just a dishcloth, became a story for the people who used it or, more importantly, for the people who changed their dishcloths to home-knitted ones. The dishcloth story caught their attention and made people feel responsible and believe that they could actually do something. Today the story of the dishcloth is known by a large part of the Danish population, the media still refer to it, and it is considered by many to be the main story by which Danes became aware of plastics pollution (Frese 2017). But is changing your dishcloth an adequate solution to the scale of the global plastics crisis?

An important perspective raised by one of the crew members was whether the dishcloth story would be the only story and not one of many and thereby overshadow other sources of plastics pollution. In 2017, this problem was discussed in debate pieces in a Danish newspaper (Engbo 2017; Frese 2017). The head of environment at Coop, a large Danish retail business, stated that, instead of sharing knitting patterns, knitters should make demands for real change in our consumption of plastics within the political realm and the plastics industry. The response from Plastic Change


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was that the world cannot be saved from plastics pollution by knitting dishcloths alone but that people who become aware of such pollution from dishcloths have a heightened awareness of the problem, and that awareness is spread one dishcloth at a time (Engbo 2017).

Today you can buy alternative dishcloths without plastic fibres in all supermarkets in Denmark, and a few retail businesses have stopped selling the original plastic-based dishcloths. The same is true for other household cleaning items. Recent research from the Danish Environmental Protection Agency states that 99.7 percent of the microplastics that make their way into sewage systems are caught by Danish wastewater treatment plants (Vollertsen and Hansen 2017). The report thereby highlights that changing your dishcloth does not significantly change the emission of microplastics.

The dishcloth by itself neither shows the scale of the crisis nor gives a deep understanding of the effects of plastics pollution, but it has connected people with the unintended consequences of their daily lives, thereby widening their attention to such pollution. The dishcloth was a simple item to start with, for it was easy for most people to change and paved the way for talking about other sources of plastics pollution, such as the use of single-use plastic items, plastic fibres in clothes, the release of plastic pellets from the plastics industry, and so on. Issues that today are being taken seriously by the industry. When we look at the dishcloth with a material-semiotic approach, we see the weaving of materiality and narrative and thereby the web and the practices that carry them (Law 2008, 2019). We find that the practices that look like neoliberal solutions manifested as individual consumer responsibility might actually be the practices that will carry the wider structural and legislative changes for which we are calling.

## Toward Large-Scale Social Change and the Politics of Plastics

Today the global plastics crisis is a central and highly visible environmental issue. It is now an important topic not only within environmental organizations but also within political and industrial institutions in Denmark. Although not widely discussed as a catalyst of this emerging concern, Plastic Change has nonetheless played a key role in terms of the structural and legislative changes that we see today toward mitigating plastics pollution.


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Its work drew fresh attention to plastics, and the movement that its work generated continues to grow.

By carefully tracing some of Plastic Change's work during the first three years of its advocacy efforts, with a specific focus on Expedition Plastic, I have highlighted that successful social movements are not necessarily perfect or uncompromised endeavours. I agree with Napper and colleagues in Chapter 1 of this volume that public education alone is unlikely to achieve the substantial change required to address the plastics pollution crisis. However, the cases in my chapter illustrate that raising awareness among the public is indeed a crucial part of movements toward larger structural and legislative changes.

In only a few years, Plastic Change managed to turn plastics pollution from an unknown topic into one of widespread interest. In other words, it went from an environmental problem known and discussed primarily by scientists to one debated by members of the public, politicians, and industry representatives. In an interview in 2016, one of the skippers of Expedition Plastic explained how Plastic Change aimed to accomplish something that scientific researchers could not do. As he had discussed with their main allied researcher from Roskilde University,

> those who already know the issue are the only ones who read his research articles, and then it becomes a scientific problem and an analytical problem more than a real environmental problem that has to be dealt with. What is important is that someone takes [a scientist's] research and argues that it is not just statistics and data. That it is a real problem! It is a real environmental issue that has far-reaching consequences for nature and ultimately ourselves.

This quotation highlights that the work of organizations such as Plastic Change is not the dissemination of established scientific facts. Instead, it is a creative practice of generating concern by scaling and weaving stories. Often these stories do not offer a comprehensive understanding of the scientific details of plastics pollution. Instead, organizations such as Plastic Change engage in different kinds of practices and processes, telling stories that work together to create broader conversations. Equally important, they bind stories to everyday life such that they must be iteratively engaged and retold. This significant practice is at the heart


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of Plastic Change's dishcloth initiatives, which tend to be read as trivial at first glance.

Plastic Change is no longer a small, marginal, environmental organization (Engbo 2019; Tuborgfondet 2017). During the past number of years, the organization has worked with a range of projects, from the development of teaching materials for primary school and high school levels to collaborations with local citizens, municipalities, and industries. Plastic Change was nominated for The Nordic Council Environment Prize 2018; and it won the national Energy Globe Award 2018 and the Danish Svend Auken prize given to people or organizations that have made an extraordinary environmental effort (Altinget 2018; Engbo 2018; The Nordic Council 2018). In November 2018, Plastic Change achieved accreditation by the United Nations Environment Programme, which means, among other things, that Plastic Change has observer status at the United Nations Environment Assembly (Plastic Change 2019).

Plastic Change has also helped to amplify additional NGO engagement with plastics pollution (see e.g., DN 2019; WWF 2021. The World Wildlife Fund (WWF) in Denmark has, in the past few years, similarly made a significant effort to address plastics pollution. In 2018, it employed a full-time plastics-focused staff member. This means that it now has a range of initiatives, partnerships, and advisory services. For example, in the fall of 2018, based on counselling from Plastic Change and the WWF, the beer giant Carlsberg decided to eliminate its use of plastic six-pack rings of the kind that entrapped Peanut, the sea turtle. Instead, a re-think of the six-pack ring has been launched in which the six beer cans are glued together—an initiative which, according to the company, reduces plastic use by 150 metric tons per annum (Knudsen 2018). It is one of many signs that industries in Denmark are beginning to become responsive to calls to reduce plastics use and waste.

As this case study shows, highly successful social movements often work through practices and tropes that are compromised, reifying, and problematic. But Plastic Change alerts and reminds scholars that practices of which we are highly critical might also be tools for projects about which we care. Plastic Change's actions, which initially appear to have been flawed scientific practices or neoliberal solutions, might actually be the very practices that can help us to move toward the systematic and


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legislative changes that we know are needed. This chapter thus constitutes a call for academics to pay closer analytical attention to the pragmatic challenges of action and direct more scholarly attention to the role of messy, complicated, and compromised practices as essential components of larger efforts to confront the plastics pollution crisis rather than as sites for simple critique.

## NOTES

1. In her analysis of the travels of creatures through attempts to disentangle them from plastics in the pursuit of scientific knowledge, De Wolff (2017, 44n3) brings forward an interesting perspective in a footnote: University-based marine debris researchers have described the famous environmental organization Algalita's work as 'citizen science' or even as 'not science.'

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11

# Plastics Talk/Talking Plastics

## The Communicative Power of Plasticity

*Deirdre McKay, Padmapani Perez, and Lei Xiaoyu*

Facing a plastics crisis, the world needs not only better science communication and more engaging activist campaigns but also to grasp what plastics themselves have been saying. The material qualities of plastics have enabled people around the world to use plastic "stuff" to say things about themselves and shape their senses of selves-in-the world. Plastics speak not just about the material politics of industry and development (Gabrys, Hawkins, and Michael 2013) but also about people's everyday concerns and conflicts. Plastics are intimately connected with context-particular ideas of progress, comfort, abundance, convenience, and potential. Any intervention that academics, activists, science communicators, concerned citizens, campaigners, or curators might make necessarily speaks into a series of conversations already in progress.

Because they are durable, lightweight, brightly coloured, and cheap, plastics have already been appropriated to a wide variety of social and cultural ends. Many people are attached, if not to their materiality itself, to their convenience, abundance, and disposability and thus the forms of social status that they represent. Replacing, reusing, recycling, reducing, or refusing plastics of various kinds, then, has repercussions for the kinds of messages that plastics are already communicating. When researchers attempt to convey the scope, scale, and urgency of the plastics crisis, they



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compete with the ideas and hierarchies at stake in ongoing conversations about important themes: development for the poor who need cheap furniture and small sachets of consumer products; equitable opportunity for those with disabilities who need ready-to-eat meals and plastic straws; and convenience for the time poor and harried whose lives rely on easy-care fabrics and packaged foods. When academics and activists understand how plastics are already engaged in shaping alternative political and economic possibilities for these groups, and see how they are already carrying potent cultural meanings, they can work effectively across the diversity of people using them, buying them, disposing of them, or campaigning to ban them.

In this chapter, we show not only how plastics are just handy, useful stuff, clutter, or unwanted packaging but also how they act as indices of social issues and political conflicts. The ways in which plastics convey messages about key aspects of personal identities and political categories teach us important lessons about how to shape careful and creative communication on the theme of plastics waste. We ask here, if plastics can be said to "talk," then how might people best be able to listen? We answer that question by reflecting on lessons learned in a participatory and exhibition-based project in the Philippines and how we are trying to apply those lessons to work recently started in the United Kingdom. By beginning with the materials themselves, these projects explore how engaged research can help people innovatively and responsibly to reuse, reduce, or replace plastics in their everyday lives. In more academic terms, what these exhibition projects seek to create are encounters with materials that generate a new version of what Barbara Kirshenblatt-Gimblett (1998, 50) calls a "turn of the head." This "turn" is the encounter that "bifurcates the viewer's gaze between the exotic display [of the museum exhibition] and her own, everyday world." Thus, the methodology that we deploy is a curatorial one. This is an approach in which workshops lead to an exhibition event designed by the workshop participants and research team to challenge received knowledge and create new ways of understanding the world for exhibition visitors (Puwar and Sharma 2012).

This curatorial methodology relies on a central concept that is a property of plastics themselves: these materials have "patiency." Patiency describes a form of agency usually attached to artworks. It was coined



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by anthropologist of art Alfred Gell (1992, 1996, 1998) to describe how artworks captivate and thus exert this kind of secondary agency on people. Patiency, in Gell's theorization, is an agency that lies in the physical properties and cultural histories of an art object. Through patiency, the engagements of people with objects shift their self-understandings and conceptions of the world around them. It is in this work of shifting selves that we find the power of art. Deirdre McKay and colleagues (2015) extend the theory of patiency by showing that, in the case of plastic replica trade beads, materials have a patiency separable from that of the form of the object that they make. The plasticity of plastics gives these materials powerful patiency—the mere fact that they are made of plastic can transcend and reshape the other meanings that people attach to the form of an object. Thus, telling a story about what an object is made of can be a political act just as much as speaking about what the object is used for symbolizes.

We learned about objects' stories and plastics through publicly engaged research that deployed participatory action methodologies. Our first project, Everyday Objects (see figure 11.1), was an exhibition-based project on upcycled plastics craft. It was conducted in the northern Philippines in 2012 by geographer Deirdre McKay and anthropologist Padmapani Perez (McKay and colleagues 2015; McKay and Perez 2018). Our experiences there inform our current project, which offers community arts workshops on plastics in the United Kingdom's West Midlands. We hold workshops in collaboration with the UK arts charity B arts (see https://www.b-arts.org.uk), which specializes in pop-up and street-based events that foster social inclusion and cultural democracy. These UK workshops also culminate in exhibitions put together by a UK team that includes Deirdre McKay, media studies scholar Eva Giraud, and artist-advocate/PhD student Lei Xiaoyu. This chapter condenses the lessons learned from our Philippines research that inform our current UK work.

In the first section of this chapter, we describe how plastics talk about identities in the Philippines. This section sets out how plastics' messages are conveyed through the collecting, reworking, displaying, manipulating, and circulating of craft objects made by upcycling the material in Everyday Objects. In the second section, we reflect on the underlying messages in this work. In the third section, we suggest how our lessons from the


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Philippines could shape our approach in the United Kingdom. We then conclude the chapter by suggesting ways to develop more effective communication and public education programs on plastics.

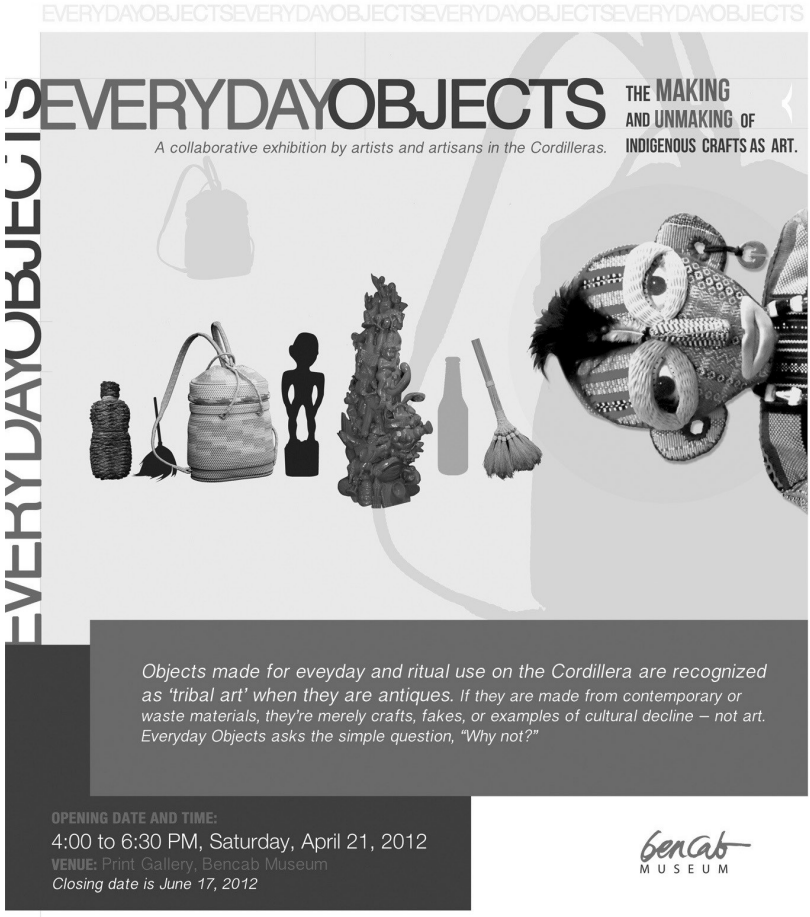


**Figure 11.1.** Everyday Objects exhibition poster, Baguio City, 2012 (courtesy of Deirdre McKay, Padmapani Perez, and Lei Xiaoyu).



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## Plastics' Messages

The malleability of plastics enables people to use these materials to subvert cultural categories and do the vital political work of mapping out inequalities and alternative futures. As Adam Drazin (2015) argues, the essential malleability of plastics calls into question what stuff is, its authenticity and history, and thus class and individual identities that people attach to materials. This insight applies to the situation in the Philippines, where Perez (McKay and Perez 2018) and McKay and colleagues (2015) worked with Indigenous Igorot artisans and artists to explore craft items and artworks made of upcycled plastics. Padma and Deirdre led a participatory research process to produce an exhibition, Everyday Objects, staged in Baguio City in 2012. The research methods included participant observations with artisans and artists, formal interviews with dealers and collectors, and audience responses to the plastic artifacts that their team exhibited. As we recount here, the malleability of plastics enabled artisans to comment on Indigenous people's identities, desired futures, social mobilities, and political allegiances.

In the Philippines, making artifacts in plastics emphasized the adaptability of people's cultural traditions and highlighted how the people could envision how their culture could be otherwise (McKay and Perez 2018, after Povinelli 2012). By working in plastics, Indigenous Filipino artisans were making a powerful political statement. They were choosing to take a material widely denigrated as waste—and considered to be opposed to art, authenticity, and depth—and elevating it into traditional forms. By doing so, these artisans were also redeeming aspects of themselves, their culture, and their history. In their experience, they saw that the cultural mainstream considered their Indigenous culture, like plastics, to be a kind of waste—something once useful that now had no further purpose (McKay and Perez 2018). Examining the political messages that plastics carried in the Everyday Objects exhibition reveals three major themes. These themes are the three political concerns that, on the Philippine Cordillera Central, art or craft in plastics is already talking to people about.


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### *Plastics Are Already Talking about Class*

Plastics carry stories with them, whether in their diverse types or as the more generic, catch-all category of plastic stuff. In the Philippines, that generic version of plastics might convey an even stronger message about social class and distinction than in many more developed countries (Bensaude-Vincent 2013; Fisher 2015; Wilkes 2015). For wealthy Filipinos, plastics are the detritus of colonial globalization and the toxic materiality of deprivation. In the public discourse on plastics, people tend to reduce diverse and ubiquitous plastic materials to a single category of plastic that contains predominantly the single-use plastics consumed by the poor. Plastics become a site of moral panic about the behaviours and living conditions of poorer Filipinos. Poor people who cannot access solid waste disposal services fill the air with toxins when they burn these plastics in their garbage piles and block the waterways with them, creating flooding. The poor fill the streets with this waste, too, when they discard packaging purchased from sidewalk vendors or throw it out of windows of public buses onto roadsides after they have eaten their snacks. Discarded moulded plastic items such as garden chairs and buckets that do not easily burn make their way into canals and rivers. Metaphorically, all of these plastics—mostly single use but also broken durables—are the stuff that blocks national progress. Plastics mark a kitschy and tacky—in Filipino *baduy*—popular aesthetic associated with the lower classes. Most of the highly educated elites in the Philippines are reluctant to buy plastics and unlikely to decorate with them, preferring authentic Filipino natural materials such as rattan and bamboo, ceramic and wood, where they can find them.

Poorer households, in contrast, embrace plastics. The poor tend to collect cheerful, colourful, and inexpensive plastic items. The accumulation of things made possible by inexpensive plastics gives poor people a sense of abundance and thus material security. Plastics give them what they need to get by, store food and water, keep themselves relatively dry and comfortable, and inject colour into often dank and grey dwellings made from wood, concrete, and galvanized iron.

There is far more to the problem of plastics in the Philippines than the propensity of people to throw them away, ruin the landscape aesthetic,


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and introduce them into water systems, oceans, and food chains. The word *plastic* itself—in Filipino *plastik*—indexes Filipino critiques of character and social relations with a collective noun. *Plastik* carries a set of social critiques that revolve around class, solidarity, and ideals for charity. Making craft items or artworks in plastics then makes these critiques material. Because poor people often already have craft skills and are frequently underemployed, their free time is easily put into adapting these skills to repurpose discarded plastics. So the poor often make, remake, or purchase plastic items that are distinctively kitsch and not considered "proper" items but cheap alternatives. Indeed, that is the connotation of the word *plastik*.

An anonymous Filipino blogger explains that the word "connotes something cheap: plastics slippers, plastics shoes, plastics watch bands, etc. It used to have that meaning too in Filipino: *'Naku, mura lang 'yang platong iyan. Plastics kasi.'* ['Oh, that plate is only cheap. Because it's only plastic']. It was a cheap substitute for breakable drinking glasses, leather shoes, leather watch bands and the like" (2008, 1). As in other parts of the world, the word *plastik* does not just identify the material but also acts as a metaphor for the cheap, fake, and undesirable in human relationships. The word is also used as an adjective meaning hypocritical or fake. The blogger goes on to explain that "*plastik* in Filipino now captures that behavior (thought, act, feeling) which is quite the opposite of what one truly feels. It carries more than the sense of being not just 'not really,' but more—it also signifies 'not truly.'"

Thus, in the Philippines, the word *plastik* carries a sense of falsity or lack of genuine intent, as the insult "plastic" did in the American counterculture of the 1960s (Bensaude-Vincent 2013, 240). People say "*Hoy, hindi ako plastik, ha!*" (Hey, I'm not plastik, eh?) to assert their sincerity in interactions with others. Such interpretations of plastics are common across the world. In the Philippines, too, *plastik* is often associated with the hypocrisy that the rich display in their everyday encounters with the poor. As Bensaude-Vincent (2013, 19) argues, "the alliance between one material and one function—still visible in common language within phrases such as 'a glass of wine'—was seen as a mark of superiority" in the West, and this remains true in the Philippines. However, as more plastics have come into circulation, there are more and better fakes and tricksters. These


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materials mean that the poor can afford to have items that are just as nice or useful as those of the rich. They mean, too, that the ability to distinguish between the "real" and the "fake" on which the rich pride themselves is called into question. The rich are thus not that much more capable than, or different from, the poor. By extension, craft or art objects made from plastics can misrepresent the social position of their creator or somehow make a fool of the viewer or purchaser. Using plastic items is thus a way of speaking not only about class but also about inauthenticity and resistance in relations between classes. Plastics are not neutral substrates. Rather, they are "doing politics" as active co-producers of socio-economic and cultural categories. In this way, plastics can be said to talk.

### *Plastics Are Already Talking about Authenticity*

If plastics are the key materials of the new global world, then it is a world where stuff is increasingly not what it seems to be (Barry 2015). The Filipino word *plastik* is closely aligned with the idea of *peyk* (fake) as opposed to *jinwayn* (genuine). Many fake items, indeed, are made from plastics, including beads that replicate originals made from ceramic, semi-precious stones, or glass and acquired through long-distance trade (McKay and colleagues 2015). When it comes to these heirloom trade beads, Indigenous Filipinos consider that it is vulnerable or foolish people who cannot distinguish between the real and the fake. People who lack the hands-on experience from handling materials themselves are the ones most likely to be "taken in" by fakes made from plastics. The expert artisans who make plastic crafts, conversely, can play with the ideas of authenticity attached to plastics as a metaphor for Indigeneity and progress. Their first-hand knowledge of materials, old and new, gives them a kind of political power.

Plastic replica trade beads comprised one of the most engaging "fake" craft items that our team collected for Everyday Objects (figure 11.2). These beads were made from repurposed plastics extracted from waste and melted down to create replicas of the antique trade beads that entered the islands in the colonial era. People from the Igorot ethnic groups of the northern Cordillera region of the Philippine island of Luzon have been making replica beads from old toothbrushes since the 1950s. More


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recently, they have begun to experiment with materials gleaned from a variety of other forms of plastic waste, including CD cases, coat hangers, and fast-food spoons.

**Figure 11.2.** Plastic replica trade beads made from domestic waste in Kalinga, the Philippines (courtesy of Deirdre McKay, Padmapani Perez, and Lei Xiaoyu).

Strands of these plastic replica beads made from domestic waste plastics are for sale in Baguio City. Their intended market is Igorot high school and college students who, as part of their education, are expected to take part in cultural performances. Strung according to Kalinga traditional patterns but used by other ethnic groups to express broader Igorot identities, these beads replicate strands of glass and stone heirloom trade beads. The trade beads themselves are a definitive aspect of the material culture of the Kalinga ethnic group of northern Luzon and serve specific ritual purposes in life-cycle events (Abellera 1981). Brightly coloured trade beads made from stone, ceramic, and glass were used as a currency to exchange for goods and services during the colonial era (sixteenth to twentieth centuries). Among Igorots, the original beads still serve as a store of familial wealth since they are valuable heirlooms passed down to the next generation and worth thousands of dollars. The plastic replicas, however, are extremely useful for the expanding calendar of cultural presentations and ethnic events attached to education and local politics. Replica beads thus replicate what are important traditional


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markers of ethnic identity and social status, but sometimes, too, they fake them when they are worn by people who are not descendants of the traditional Igorot *kadangyan* elite.

Only elite families could give female performers a full set of authentic trade beads, worth several thousand dollars, but anyone can purchase several replica strands for a few tens of dollars. The abundance of beads made possible by plastics has made Kalinga dance performances both more colourful and more equitable. Rather than only two or three performers with "complete" sets of beads, replicas mean that all dancers can appear in similar "full" ethnic costumes. As one of the dancers whom Deirdre interviewed explained, "We really dance our culture, not our class system. What fun would it be to dance as *nawotwot* [poor] when you can just buy beads like this? It's a representation only, sure, but it's good to see all the colours when all the girls move—it's so graceful. The beads, they really attract you to look. And it means we can all be there, the same, representing our place." Plastic replica beads thus talk about authentic Indigenous identity and femininity in ways that, politically, build Indigenous solidarity across classes. Poor people can dance as rich people with the replica beads, and rich people can leave their real beads in glass cases and dance with the replicas for reasons of comfort and security. Replica beads blur the class system through their materiality.

These plastic replica beads also travel around the world, accompanying migrants from the Cordillera region when they move for work or education. The beads carry with them messages about contemporary Igorot cultural potency. They also carry messages about solid waste management problems on the Igorot Ancestral Domain. Without a reliable domestic collection system or an incinerator, much of the domestic waste in the region goes into landfills along the Chico River. If broken CD cases do not become replica beads, then they are likely to enter the river and break up, with ever-smaller pieces eventually working their way north into the Pacific Ocean. So the beads also speak to the ways in which culture can reappropriate global waste. Culture is then used to deploy the symbolism of waste in Indigenous political struggles at both the local scale and the global scale.

In London, when Deirdre spoke with Igorot migrant dancers at cultural events, she saw that they were mixing their real trade beads and


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plastic replicas with abandon to create luxuriant displays (McKay 2016). Here migrants were concerned about material authenticity—which were the real beads and traditional patterns? Deirdre learned that telling the real beads from the fake beads created anxiety for those migrants who had grown up in families too poor to have retained their own inherited trade beads. The most common story was that the family had fallen on hard times and had sold the real beads in the 1960s or 1970s to fund education, medical expenses, or house building. But now people wanted their real beads back as a way of expressing pride in their culture, and they wanted to be sure that they got real ones.

Taking advantage of this desire, other migrants were selling plastic replica beads to their friends at prices closer to those for glass replicas or original ceramic or stone beads. In response to questions about why she was asking to photograph performers' beads (McKay and colleagues 2015), Deirdre explained that she was interested in the combination of real and fake on display. Later she showed migrants involved in these Igorot cultural performances what she had learned from plastic bead producers and bead-wearing Kalinga performers in the Philippines. Check the temperature of the bead on your skin, because plastics always feel warmer than glass, stone, or ceramic. When you rub the bead against your teeth, the reworked plastic feels rough against your enamel. In terms of weight, the plastic bead is light. When you look at how it reflects the light, a plastic bead is comparatively dull beside glass, stone, and ceramic beads. Then examine the bead for inclusions or irregularities. Should an inclusion look like soot, it is most likely a bead made from plastic that has been melted down over a fire.

Plastic fakes can fool people unfamiliar with the real materials of authentic beads. The ability to distinguish between fake and real was an acquired skill. Back in the Philippines, the bead makers whom Deirdre had interviewed were experimenting with different waste plastics all the time and attending traditional and contemporary ritual or performance events at which people wore these beads. Bead makers found it very easy to distinguish plastic, glass, stone, and ceramic beads. They were amazed that Deirdre found it difficult but taught her the distinctions. From their Igorot perspective, Westerners and urbanites taken in by fake beads seemed to be ill-educated materially. The daily familiarity among bead makers with


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plastic materials that they struggled to break up, incinerate, bury, or repurpose gave them a wealth of expertise from which to draw.

Plastics, in this context, were talking not only about class but also about street smarts, life experiences, intelligence, and materials nous. Bead makers, buyers, and wearers were usually women, and it was often a woman's task to sort the reworkable plastic materials from the general garbage. Many Igorot migrants either came from urban areas with waste collection systems or migrated while young. Either way they had not grown up with the materials nous required to sort and repurpose garbage plastics. They were anxious about being potentially fooled by fake beads, for that would suggest somehow that they lacked the requisite knowledge to locate themselves in the centre of Indigenous diasporic politics. Back in the Philippines, however, plastics were related to Igorot men's gender identities in more potently subversive ways.

### *Plastics Are Already Talking about Gender*

Another compelling set of plastic craft objects that our team collected for Everyday Objects was composed of plastic backpacks. They were woven basket-style bags in bright yellow plastics with pink and red trim. These basketry backpacks originated in the gold mines beyond Baguio City where they were woven from the discarded plastic wrappers of electric blasting caps, likely beginning in the 1960s. Their makers were artisans who worked as miners in nearby gold mines. They wove the backpacks on breaks from their work, sitting in the mine tunnels and repurposing waste created by the activities of global capital on the local landscape to their own cultural ends. Because the backpacks could not be produced on a commercial scale, they had no fixed market prices. Nevertheless, they were a key element of Baguio City's male Igorot "street style." Men who wore these backpacks were miners themselves, members of their extended families, and those who wished to show solidarity with miners and their Indigenous communities. The street-style plastic backpacks collected by the team usually had come to their eventual owners through barter or exchange.

These backpacks were extremely distinctive accessories. The pink and yellow plastics from the blasting cap wrappers stood out like beacons


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against an Igorot craft tradition that features the soft beiges and browns of rattan and bamboo. As plastic craft items made from material appropriated from mine sites, the backpacks spoke of the capacity and cultural potency of a group of male labourers doing dirty, dangerous, and poorly paid work. They also positioned these men as bearers of a proud Igorot culture that gave them the knowledge and skill to make something desirable out of the detritus of globalization. Garish compared with the "authentic" natural fibre versions, the plastic backpacks asserted an Indigenous identity in which other Indigenous people—particularly men—wanted to share. It was precisely because their plastic trim was eye-catching and "feminine"—pink, red, and yellow—that these items had become "cool" accessories for Indigenous men.

The thrill of queering the accepted version of masculine self-presentation turned up in our interviews with artisans and wearers. Hector, one of our interviewees, explained that he had styled his backpack with an all-black ensemble to show off its colours:

> Me, I like the way it looks. You know, it's the colours for a woman—pink, yellow—but made by men. And mining is a hard work, you know, earning money if you have it. . . . If not, then nothing. . . . You know, . . . they can make something like this from . . . just *basuro* [garbage]; it shows that they can really survive. They can survive just anything, you know. That's us, Igorot men. We can mine, we can work in the city, but we don't need somebody to pay us. We have the skills. We can go back to farming, build our own house, build our own . . . just anything. . . . Our skills let us make the things we need, without money, without shopping. That's us. And when you see that colourful backpack, you know, that guy—with him, you'll be just ok, whatever happens. He can live just anywhere. (McKay and Perez 2018, 181)

Using feminine-coloured plastics for men's accessories—rather than the blues, browns, and black more strongly associated with men—is subversive in a wider Filipino society. There material markers of success in sombre colours or precious metals are privileged in measuring men's accomplishments (Johnson 2017). Mainstream (non-Igorot) Filipinos tend to look to watches, clothing, cars, jewellery, housing, and the like to see how potent a man might be. They look for well-known brands


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and expensive, authentic, imported materials such as leather or steel. A yellow, pink, and red backpack resists this definition of success, staking a claim to cultural continuity and practical nous as a site of Indigenous male self-confidence. Displaying mastery of manual skills has long been a working-class approach to performing masculinity (Maynard 1989, cited in McKay 2011), but making plastic backpacks is about more than the usual Filipino *diskarte* (creativity) and know-how. Plastic backpacks subvert dominant Filipino masculinity with materiality and colour because they are both made of plastics—potentially fake—and read as feminine. Even elite visitors to our Everyday Objects exhibition puzzled over how their garish colours fit with the evident machismo displayed in the photographs of the men who wove and wore them. However, it was self-evident to all of the exhibition visitors that any man who traversed a cosmopolitan city like Baguio wearing a pink and yellow plastic backpack had to have enough self-control not to succumb to the provocations of others. He had to be ultramacho so that he could deal with any negative comments but with a soft side that he was happy to show.

By bringing waste plastics together with a traditional Igorot basket form, the plastic backpack problematized both masculinity and tradition. This plastic object held in productive tension the ideas of Indigenous tradition and global garbage. To this problematic, it added a second and parallel tension, one between dominant and alternative Igorot versions of Filipino masculinity. The plastic backpack positioned Igorot men at the intersection of two masculine modes of being, revealing masculinity to be likewise malleable and even suggesting that mainstream masculinity might be *plastik* or hypocritical. For men in a marginal cultural space, wearing plastic backpacks positions them as central to Indigenous resistance to a dominant culture that would marginalize the poor, unskilled, and left behind and as capable of making their way in a global world. Plastics carry this message for them.

## Lessons from an Exhibition

After Everyday Objects closed at the BenCab Museum, a selection of works and objects travelled to the University of the Philippines Baguio and the Yuchengco Museum in Manila (McKay and colleagues 2015).


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The Philippine press and comments from museum visitors spoke of it as an "important" and "ground-breaking" show (Lolarga 2012). This was because it had combined plastic crafts with text and the museum's tribal art collection. Mainstream Filipino audiences were surprised to discover that these plastic objects, presented in their historical contexts, were valuable, desirable, attractive, and even "cool." The materiality of plastics themselves communicated powerful questions of authenticity, gender, and class to exhibition visitors in surprising ways. That vibrant contemporary Indigenous cultures refigure waste plastics as valuable "not waste" suggests new ways of thinking about the entangled politics and histories of materials in the Philippines.

Here we see that what makes plastics politically potent is the patiency of the materials. Plastics act on the viewer or exhibition visitor in ways that subvert or contradict the messages of authenticity or tradition carried by art objects. Beads can thus "say" one thing about Indigenous history, ethnicity, class, and tradition while the materiality of the plastics from which they are made can carry a countervailing set of messages. It is in the tension between these two messages and the creation of problematic ("inauthentic") traditional objects that the patiency of plastics speaks for Indigenous people of their political resistance to assimilation and dispossession. Indigenous artisans and artists thus deploy the patiency of plastics to playful and subtle political ends. A plastic bead or backpack that is not traditional but obviously fake, by enacting a kind of "play on substance," is their way of speaking about the problematic construction of key social categories such as gender, ethnicity, and class. The government of the Philippines has been increasingly invested in a problematic process of formalizing Indigenous identities as either Indigenous peoples recognized as holding Ancestral Domain or non-Indigenous people—that is, as either "real" or "fake" Indigenes. In this context, using art and craft to subvert and question identities, and to pluralize and problematize histories through materials, reincorporates people who fear that this process will see them dispossessed in the discussion of lands and resources.

Given the ways that plastics talk about the identities outlined above, it is likely that the Philippine context is one in which plastics' patiency could become entangled with well-meaning attempts to introduce, for example, compostable plastics. Igorot bead makers will still want a


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supply of colourful, shiny, hard waste plastics, even after CD cases are obsolete, because there will be a demand for something to melt into replica beads. Basket weavers will seek thin polypropylene wrappers to weave into baskets and prefer those materials that can be "liberated" from sites of global capitalist production for the subversive messages that they carry. The symbolism, touch, and kitsch aesthetic of plastics will continue to be appropriated in new ways within everyday Philippine politics. Thus, waste management and materials planners who might wish to replace all plastics immediately with compostable alternatives need to look carefully at the ways in which plastics talk. Unless they consider the particular social and cultural meanings carried by plastics here, they could meet with resistance to their future plans or, more likely, new forms of innovation and appropriation to political ends that might seem, at first glance, to be far removed from the immediate concerns of disposal and waste reduction.

## Learning from Plastics: Exploring Storytelling

The big lesson that we learned from Everyday Objects was that the patiency of plastics as materials enabled people to tell their own alternative stories about their stuff, plastic objects and their makers. Our twenty-two audience encounter interviews at the BenCab Museum highlighted the importance of this storytelling. People who saw the exhibition wanted to share their own stories of similar objects seen or collected or of similar efforts to repurpose materials or to tell us where they had seen the same plastic materials accumulate as waste. These exhibition visitors were prompted to tell us their own stories by their hands-on examinations of the objects on display. When they touched the tools used to melt the broken plastics to make beads or handled a partially woven backpack, the haptic qualities of the materials spoke to them. Their interview transcripts told us about what they thought when they held these items and outlined their plans to acquire plastic craft items or to reduce their consumption of single-use plastics.

These comments suggested that the exhibition encounter had motivated people to think about plastics when they could understand the wider story of the bead or backpack maker, the sources and types of plastics


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used, and the eventual destination of the craft item made. The ethics of storytelling and audience making have thus become a focus for further research. By reflecting on the lesson that the patiency of materials created the desire to tell stories among exhibition visitors, and by considering what academics and activists need plastics communication to do more broadly, members of our team have begun to explore how this lesson can be applied elsewhere.

We are now experimenting with further events and exhibitions in the United Kingdom. Rather than telling people about the properties—and different degrees of recyclability—of varied plastics, we have decided to create spaces for these materials to engage people. We have designed hands-on workshop events that enable people to handle various waste plastics and make artworks from them. These events anticipate that, by allowing participants to develop a sense of plastics' affordances, the activity itself might create an encounter in which plastics, normally "silent" in their daily lives, can "speak back" to people. These workshops also facilitate imaginative exercises in telling the local stories of plastics—what people use them for, how people value them, how people discard them. These stories can give people ownership of the local aspects of the global plastics problem.

Here our preliminary observations suggest that participants find this strategy of artmaking and storytelling enabling. Because they can tell their own stories, they can move them to positive endings in which they remain in control. Telling their stories about plastics then lets them spot where changes can be made in their daily lives, without having someone preach to them. Some participants indeed told us "I recycle already" because "the council makes me" and suggested that they do not intend to do much more. Others, however, reported that they have made some significant changes. They have returned to our events or followed us on social media to let us know that they have "switched to beeswax wraps" or "now carry a water bottle" or "signed up for glass bottle milk deliveries" or lobbied to "replace Styrofoam cups with ceramic [cups] at work." Collecting and connecting these stories of personal change to participants' encounters with plastic art, and then linking them to class, gender, and more, comprise our next challenge.


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## Conclusion

Talking plastics—both talking about plastics and identifying the ways in which plastics talk to workshop participants or exhibition visitors—work when the conversation is framed within the local context and information is delivered through a collaborative exploration designed to empower people. What these creative and public engagement-based research activities seek to produce is the sense, in the viewer, that the plastics of the artwork on display are familiar, everyday materials. We want to turn people's heads to show that the problems and potentials of plastics might not yet be familiar to visitors or viewers but that plastics' patiency is there, in action, acting on them through the ways in which they value and interpret art and craft.

By deploying these creative and engaged methods, academics can help people to listen to the messages that plastics carry. We can then interrogate how these messages might—or might not—shape people's interactions with the materials and their own sense of responsibility in the plastics crisis. Our UK work suggests that plastics convey messages about expertise and permission to speak, about knowledge, class, and more. Although our UK project is barely under way, it seems likely that, by working with the materials, hands-on and engaged research can not only communicate the problematics of plastics and the urgency of the crisis but also deploy patiency to activate plastics' latent potential. This is the potential both of plastics as materials to be readapted and reworked and of individuals to take effective action to discern among them and thus unpack the collective idea of plastics as all bad or all good.

In the Philippines, the materials literacy of our participants meant that they were more informed, but they had much less access to appropriate recycling and disposal services. Supporting them is a lively set of civil society groups and artists extending the debates about plastics to reframe them in issues of corporate social responsibility, good governance, and class (GAIA 2019). In the United Kingdom, people seem to have too much generalized information and might lack the materials literacy to discern comfortably which plastic materials are—in their own assessments—better or worse or more or less necessary in the products that they encounter. Our results thus challenge the idea that regulation


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or taxation can work effectively by compelling people to change while underestimating what they are willing to learn and apply (see Chapter 1 of this volume). It is the plasticity of the materials themselves that give plastics their communicative power, and, as academics and activists, one of the most effective ways to communicate is to work with that power through hands-on learning. Building public materials literacy through creative and context-sensitive approaches should be just as important as taxes and regulations in transforming the roles of plastics in a global materials ecology.

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12

# Redressing the Faustian Bargains of Plastics Economies

*Trisia Farrelly, Ian Shaw, and John Holland*

Half a century ago plastics producers might have been excused for thinking that the benefits of their products outweighed their costs. In light of the biological, economic, cultural, and socio-ecological harms attested to by the contributors to this book, producers today can no longer claim innocence. In this chapter, we support the argument for more radical forms of transdisciplinary research that can lead to a paradigm shift in thinking about and acting with plastics. We acknowledge Andrew Stirling's (2015) "innovation democracy," in which future plastics pollution data will not only come from disciplinary and transdisciplinary experts but also require contributions from a broader civil society. As we show here, a current yet vital transdisciplinary lacuna is the intersection of marine litter studies and endocrinology. In addition to a more interdisciplinary and democratized approach to science, we propose a shift in global plastics pollution governance that holds petrochemical and plastics industries fully accountable for the negative externalities associated with their production activities.

National, regional, and international agreements relevant to the governance of plastics pollution have been described as "reactive, piecemeal and isolated, and with mixed success" (UNEP 2012, 170). Consequently, we advocate a policy approach that builds on the limited successes of pre-existing agreements to forge a single, integrated, stand-alone,



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international, binding plastics pollution treaty democratically formed by knowledgeable publics through the United Nations Environmental Assembly (UNEA) process. The treaty should acknowledge plastics production externalities and adopt a precautionary approach that accounts for the full life cycle of plastics production, namely extraction of fossil fuels, alternative polymer sources, production, manufacturing, recycling, incineration, pyrolysis, and legacy plastics. The treaty could also include caps on virgin plastics and the regulation of toxic additives in plastics production and recycling. Although it is currently unlikely or even undesirable to regulate all plastics, the treaty would regulate the most toxic, least recyclable, unnecessary, and avoidable single-use plastics until green chemistry (Schug et al. 2013) and other bio- and environmentally benign polymer innovations gradually replace fossil fuel–based plastics. Following Sheila Jasanoff's (2003) "technologies of humility," the proposed paradigm shift in the life cycle of plastics would be underpinned by a scientific and economic humility in which science does not claim to have all the answers and producers internalize the short-, medium-, and long-term negative externalities of their products.

Endocrine disrupting chemicals (EDCs) are found in plastics as monomers and additives and in persistent organic pollutants (POPs) that adsorb to plastic polymers and can be taken up in food chains. Although a lot is known about EDC impacts on endocrine systems, the nascent bodies of science on EDC-plastics-organism-ecosystem relationships are complex and require a speculative research approach.

Speculative research "responds to the pressing need to not only critically account for the role of calculative logics and rationalities in managing societal futures, but to develop alternative approaches and sensibilities that take futures seriously as possibilities and that demand new habits and practices of attention, invention, and experimentation" (Wilkie, Savransky, and Rosengarten 2017, 2). The proposed treaty will need to capture and respond appropriately to the speculative aspects of the science of plastics pollution and could be modelled on the Montréal Protocol, in which a precautionary approach resulted in the phasing out of chlorofluorocarbons (CFCs).

Faustian bargains have been made in which "Big Plastics" harvest the short-term profits of plastics and pass on the financial and economic costs



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to future generations. In other words, Big Plastics have traded long-term harms for short-term gains. In this chapter, we build on all of the chapters of this volume to offer a global solution to the various actual and potential harms identified by expert scientists and civil society. The various authors of this book have provided critical considerations of the ecological, geological, and biological implications of plastics pollution and how they might not be characterized easily as inherently good or bad; the liveliness of plastic long after its intended use; the unevenness of its harms and benefits; its deep-time implications; and the new technologies that they inspire. Perhaps audaciously, we assert that the democratic underpinnings of the proposed treaty will allow for debate and negotiation on all of the concerns presented and that ultimately it will serve to redress the Faustian bargains made by Big Plastics. Although the suggestions offered here might be ambitious and broad, we strongly believe that debates on such solutions are vital if global leaders are collectively and effectively to stem the tide of millions of tonnes of plastics flooding the planet's ecosystems every year.

## Microplastic Entanglements

Every plastic item ever made remains in existence in some form or another and will continue to act on environments for millennia. The history of the base ingredient of plastics (petroleum) stretches back to previous geological epochs, and its legacy will outlive us all. Scientific journals and the popular press continually reveal new places that have been invaded by microplastics, including the air that we breathe (Yurtsever, Kaya, and Bayraktar 2018); our tap water (Rochman et al. 2013); store-bought sea salt (Karami et al. 2017); bottled water (Mason, Welch, and Neratko 2018); soil (Hahladakis et al. 2017); earthworms (Lwanga et al. 2016); and the intestines and tissue of marine life throughout the food chain (Katsnelson 2015). Additionally, new research frequently reveals more unknown risks ("known unknowns"; Randall 2011) associated with plastics pollution. One of the least understood harms associated with microplastics involves their entanglements with EDCs.

Many consumer plastics contain EDCs that can migrate as residual monomers (e.g., bisphenol A) or additives (e.g., phthalates) that mimic


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hormones and can interfere with any system in the body controlled by hormones, including cardiovascular, developmental, metabolic, and reproductive systems (Schug et al. 2011). Some POPs are also EDCs and "toxic chemicals that adversely affect human health and the environment around the world. Because they can be transported by wind and water, most POPs generated in one country can and do affect people and wildlife far from where they are used and released. They persist for long periods of time in the environment and can accumulate and pass from one species to the next through the food chain" (EPA 2017).

EDCs leach from plastics, and the POPs that adsorb to micro- and nanoplastic fragments can be taken up into the food chain, where they can bioaccumulate in tissue and biomagnify up the chain (Bakir, Rowland, and Thompson 2014; Guerranti et al. 2017; Jamieson et al. 2017). According to Managing Director of the Food Packaging Forum Foundation, Jane Muncke (2013), the first two studies demonstrate clearly that microplastic contaminants are enriched in the human food chain were conducted by Chelsea Rochman and her team and Mark Browne and his colleagues in 2013.

Entanglements among plastics, EDCs, POPs, and organisms involve lesser-known risks because of the complex ways in which EDCs act. In 2012, the European Commission called for a "state of the art" assessment of EDCs that resulted in the Kortenkamp Report, which warned that "there is no such thing as a universal, ready-to-use detection kit for EDCs. The reason is that the hormonal system is extremely complex and EDCs can hijack it in many different—and largely unknown—ways" (Horel 2015, 5). This admission of the uncertainty of establishing safe limits to the harms associated with EDCs makes the growing volumes of nanoplastics in the environment extremely concerning. Microplastics and nanoplastics can be taken up by an organism's cells. Some researchers refer to nanoplastics as a Trojan horse:

> It is possible that nano-plastics pose a greater chemical risk than microplastics due to their larger surface-volume ratio. . . . Due to the absence of knowledge on nano-plastic exposure to humans, their potential chemical risk, especially after translocation into tissues and cells remains a "black box." It is possible that these internalized and/or encapsulated particles would deliver plastic-associated POPs and



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> additive chemicals to different tissue types and locations than those resulting from uptake from food and water (UNEP 2016, 105).

Despite the element of "known unknowns" associated with EDC science, a sharp spike in EDC studies over the past fifteen years has resulted in an overall weight of evidence that EDCs indisputably threaten life. In 2006, thirty specialists concluded that "BPA [bisphenol A] at concentrations found in the human body is associated with organizational changes in the prostate, breast, testis, mammary glands, body size, brain structure and chemistry, and behaviour of laboratory animals" (Vom Saal et al. 2007, 134; see also Shaw, Balakrishnan, and Mitchell 2009). The Environmental Working Group's list of over 100 peer-reviewed studies states that BPA, a common EDC used in the production of consumer plastics, is toxic at extremely low doses (Environment Working Group 2013).

An article and an editorial in *Endocrinology* highlight the need for more transdisciplinary research to explore the full extent of risks posed by EDCs: "This community of experts has formed a united front to state the undeniable: that EDCs pose a threat to human health and to the ecosystems of the earth" (Gore 2013, 3955). Since Louis Guillette Jr. and his colleagues (1994) first attributed EDC exposure to the decreasing sizes of alligator penises in some of Florida's lakes, numerous other studies have highlighted the impacts of EDC exposure on wildlife. Their findings include sexual disruption of fish, decreased fish populations (Ingre-Khans, Ågerstrand, and Rudén 2017; Kidd et al. 2007), and "reduced feeding and reproductive success, reduced survival, cellular-level toxicity, changes in immune function, changes in enzyme function, and gene expression" (Worm et al. 2017, 13).

## Post-Normal Science and the Precautionary Approach

Post-normal science (PNS) is the application of science in which "facts [are] uncertain, values in dispute, stakes high and decisions urgent" (Funtowicz and Ravetz 1992, 254). EDCs and climate change are two of the most frequently cited examples of PNS. Aspects of plastics-EDC entanglements represent similarly uncertain and contested bodies of knowledge. Because of the unpredictability of microplastics entanglements, we support a PNS approach that acknowledges the limits of our


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understandings of plastics production, consumption, and disposal and therefore requires the adoption of a precautionary approach. The principle asserts that, "when an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically" (Raffensperger and Tickner 1999, 354). The precautionary principle emerged out of criticisms of traditional risk assessments and presents justification for acting in the face of uncertain knowledge about the impacts of hazards (Callréus 2005).

Uncertainty and unpredictability are unavoidable aspects of any scientific endeavour and should provide impetus for action since uncertainty increases potential risks associated with the scientific subject (Lewandowsky, Ballard, and Pancost 2015). For example, EDCs were not incorporated into the accounting in the United Nations Environmental Programme's *Valuing Plastics* report, which captured the dollar values of a range of externalities caused by the plastics industry "due to its complexity and for lack of quantitative data" (UNEP 2014, 100). We propose that this is precisely why the precautionary principle should be applied in the proposed treaty.

Since the Rio Declaration on Environment and Development in 1992, the precautionary approach has been applied frequently in international conservation and protected area policy. According to Principle 15 of the Rio Declaration, "the precautionary approach shall be widely applied . . . where there are threats of serious or irreversible damage, [and the] lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation" (UN 1992). The 2016 UNEP report *Marine Plastic Debris and Microplastics* recommends the precautionary approach, particularly in relation to nanoplastics: "Significant knowledge gaps and uncertainties remain, particularly for nano-sized material, and this may justify a more precautionary approach" (105).

However, despite UNEP's approbation of the precautionary approach, and its declaration of manifest uncertainty associated with EDCs, no commitment to this approach has been forthcoming. Jasanoff (2003) suggests that a key flaw in conventional risk assessments is that they pre-empt political discussion. This means that plastic products and their associated chemicals on the market are assumed to be desirable. This is because


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basic science is limited to whether an innovation *can* be made rather than considering whether it *should* be made. Interrogating the latter exposes potential conflicts of interest and political and financial agendas such as policy-relevant science primarily funded and driven by the petrochemical industry (see UNEP 2016). A particularly startling example of a conflict of interest relevant to this topic is when a major EU public health initiative (the previously cited "State of the Art Assessment of Endocrine Disruptors" or the Kortenkamp Report) was hijacked by plastics and chemicals industry lobby groups in 2015 (Horel 2015). Scientists and regulatory agencies alone can determine neither what science should do nor what people want it to do. This involves democratic deliberation and transparency.

Another reason for democratizing the science and policy of plastics pollution is that the capacity for institutions to learn is often limited by the blind spots produced by their narrow framing of the problem (Jasanoff 2003, 242). For example, testing single toxins such as BPA and ignoring the cumulative or"cocktail" effects of multiple exposures in real-world scenarios will result in less than optimal management strategies (Shaw 2014). One way to correct this is to conduct context-specific, real-world science in transdisciplinary teams, including those living with the impacts of plastics pollution on a daily basis.

A shift of focus toward what new technologies should do in risk assessment is particularly salient in the case of the unqualified surprises inherent in PNS. Where scientific certainty is elusive, so is certainty regarding the safety of a product across the broadest of scenarios, temporalities, and territories.[1] This is also why a precautionary approach is necessary in such cases. Jasanoff's (2003) "distribution" as a "technology of humility" suggests that much legislation and policy is focused at "end of pipe"[2] and does not account for the distributive consequences of products. The lives and legacies of plastics comprise a case in point. What is needed are "sustained interactions between decision-makers, experts and citizens, starting at the upstream end of research and development . . . [to expose] the distributive implications of [scientific] innovation" (Jasanoff 2003, 242).

A review of the rhetoric surrounding scientific uncertainty in the media, *Making Sense of Uncertainty: Why Uncertainty Is Part of Science*, sheds some light on why the connection between EDCs and plastics pollution is largely absent from public awareness, discourse, and action in


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this field: "Scientific uncertainty is presented as a deficiency of research. We want (even expect) certainty—safety, effective public policies, useful public expenditure. Uncertainty is seen as worrying, and even a reason to be cynical about scientific research—particularly on subjects such as climate change, the threat of disease or the prediction of natural disasters" (Gibbs et al. 2013, 3). If it is suggested to civil society that scientific uncertainty is just poor science, then it is no wonder that policy seldom builds in mechanisms to deal with uncertainty. It will take a critical mass from civil society to challenge current plastics pollution policy and demand transparency and precaution in risk assessments where uncertainty or ambiguity presides.

## Weaknesses in Current Plastics Pollution Commitments

There are contradictions, disconnections, and gaps in current international agreements associated with toxicants and plastics pollution. For example, Mirex (a flame retardant) and polychlorinated biphenyls (PCBs) are two POPs (also known EDCs). Although they have been banned by the Stockholm and Basel Conventions, not all countries are signatories to these conventions, and some still use these chemicals in the production of plastics. Global trade flows of plastics mean that nations that are signatories to these conventions might continue to import plastic products from states where these toxicants are unregulated. In addition, plastics containing these additives flout international environmental policies when they cross state boundaries on trade winds, ocean currents, and transboundary rivers and lakes.

Despite the growing body of evidence to the contrary (Guo et al. 2017; Teuten et al. 2009; Wang et al. 2007), the Stockholm Convention does not recognize many EDCs commonly used in the production of plastics (e.g., phthalates) as having the capacity to bioaccumulate in fatty tissue or biomagnify up the food chain. Therefore, such EDCs are not classified as POPs under the convention. We also found a contradiction in the European Commission's REACH, Europe's key chemical control program responsible for the registration, evaluation, authorization, and restriction of chemicals manufactured in or imported into the European Union. Di(2-ethylhexyl) phthalate (DEHP) is a plasticizer used in the production


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of plastics. Although DEHP is strictly controlled under the REACH program, BPA (a recognized EDC) is allowed in the production of consumer plastics with the exception of polycarbonate baby bottles.

The effectiveness of international agreements committed to reducing marine plastics pollution, like the international agreements on toxicants noted above, is often diluted by a lack of attention to the global magnitude, interconnectivity, and cumulative impacts of plastics pollution and/or a lack of political will to address the problem meaningfully at source. The International Convention for the Prevention of Pollution from Ships (1973) (MARPOL 73/78) is the first international agreement aimed at reducing marine plastics "litter" and currently has 156 signatory states supporting it. However, though 80 percent of marine plastics pollution comes from land-based sources ( Jambeck et al. 2015), MARPOL is limited to the regulation of pollution of the marine environment by ships via routine operations or accidents. The United Nations Convention of the Law of the Sea Convention (UNCLOS) came into effect in 1994 and is supported by the Convention on Biological Diversity. UNCLOS has a mandate to protect and preserve the marine environment and prevent marine plastics "debris" on a global scale. It is the only regulatory instrument providing the mandate for the prevention of marine plastics debris. However, it does not deal adequately with points where pollution enters the sea (e.g., rivers and estuaries), and implementation and enforcement are weak because of its lack of standards and specific obligations.

The United Nations Washington Declaration on the Protection of the Marine Environment from Land-Based Activities was created in 1995 to address this gap. The declaration saw 108 governments committed to act to prevent marine pollution from terrestrial sources, including sewage, POPs, radioactive substances, heavy metals, oils (hydrocarbons), nutrients, sediment mobilization, litter, and physical alteration and destruction of habitat. However, as a non-binding agreement, it has had limited impact. Since the ratification of MARPOL in 1973, Rochman and her colleagues (2013) found that concentrations of microplastics had increased by two orders of magnitude in the North Pacific Ocean. The latest estimate of mismanaged plastic waste entering the world's rivers, lakes and oceans is between 24 and 34 million metric tonnes (Mt). This figure will increase to 36–90Mt y–1 by 2030 if no further action is taken (Borrelle, Ringma, Law,


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Monnahan, Lebreton et al. 2020). These examples illustrate the failure of existing agreements targeting marine plastics.

The United Nations Environmental Assembly (UNEA) is the world's highest-level decision-making body on the environment. At the third session of the UNEA in 2017, Resolution 10 on Marine Litter and Microplastics called for the convening of an Ad Hoc Open-Ended Expert Working Group, and 10 d (ii) tasked this expert group with identifying the range of current regional, national, and international response options to the plastics pollution crisis. Raubenheimer, Oral, and McIlgorm (2018) responded to this call and concluded that none of the initiatives (neither individually nor collectively) dealt with the full life cycle of plastics and that many lacked enforceable laws, specific targets, sound action plans, regular monitoring and evaluation, and reporting. In addition, these existing global policy instruments and bodies do not have the potential to provide an integrated approach to address the full life cycle of plastics pollution considering their individual mandates and funding mechanisms.

Although waste management (e.g., recycling) remains the focus of current international commitments, academic and other research institutes have recently called for multilateral plastics pollution governance that concentrates on prevention and reduction systems and strategies ("top of pipe" solutions) (e.g., Farrelly, Borrelle, and Fuller 2021, Haward 2018; Raubenheimer and McIlgorm 2017; Simon and Schulte 2017). Some of them recommend a treaty based on the successes of the Montréal Protocol (Haward 2018; Raubenheimer and McIlgorm 2017; Rochman et al. 2013). We are also of this opinion. Kofi Anan proclaimed the Montréal Protocol the most successful international agreement at the Millennium Assembly of the United Nations in September 2000 (UN 2000). Under the protocol, CFCs were reclassified as "hazardous," and today 98 percent of CFCs have been phased out (Rochman et al. 2013). Supported by 196 states and the European Union, the Montréal Protocol now has more signatories than any other international agreement or body, including the United Nations itself. Not only does the agreement bind countries, but also its adaptive management approach provides financial assistance for phase-outs in developing nations. If the proposed plastics pollution treaty is to realize the success of the Montréal Protocol, it will also need to emulate its somewhat revolutionary approach by adopting the following


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principles: common concern, precaution, and common but differentiated responsibilities (Green 2009).

## UNEA Ad Hoc Open-Ended Expert Working Group and Scientific Advisory Committee

The Ad Hoc Open-Ended Expert Working Group tasked with advising the UNEA on the Resolution on Marine Litter and Microplastics is an excellent example of the democratization of plastics pollution science and policy at the highest level of environmental governance. The resolution (UNEP 2019) reaffirms Sustainable Development Goal 14.1, which aims to "prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities." One of the resolutions to emerge from the third session of the UNEA was the formation of the Expert Group. It is represented by the following accredited civil society groups: farmers, women, scientific and technological community, children and youth, Indigenous peoples and their communities, workers and trade unions, business and industry, non-governmental organizations, and local authorities. These civil society organizations are crucial in providing expertise and scientific knowledge, informing governments of local needs and opinions, and presenting "at the coalface" realities of policy decisions. The Expert Group convened twice in Geneva between UNEA3 and UNEA4 and once online in 2020 in preparation for UNEA5 in 2021. The group provided recommendations to UNEA member states and the UNEP Secretariat for a multilateral governance structure, a legally binding treaty, and precautionary and preventative responses to the full life-cycle impacts of plastics pollution. The group proved to be particularly influential in the resolution negotiations at UNEA4 in Nairobi in March 2019. However, despite widespread agreement among the majority that urgent, ambitious, and global action is needed to address plastics pollution, a small minority heavily invested in plastics production led by the United States blocked ambitious text and delayed negotiations. Despite this disappointment, the mandate of the Expert Group was extended at UNEA4 at its 2020 meeting it identified technical and financial resources or mechanisms. The Expert Group will report on its progress in considering response options at UNEA5 in February 2021.


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In addition, at its fourth session in March 2019, the UNEA adopted a Resolution on Marine Plastic Litter and Microplastics, which included a request to the executive director to "strengthen scientific and technological knowledge with regard to marine litter including marine plastic litter and microplastics." This resulted in the formation of the Scientific Advisory Committee (SAC) in August 2019, tasked with supporting the preparation of the *Assessment on Sources, Pathways, and Hazards of Litter Including Plastic Litter and Microplastic Pollution* (the *Assessment*) for submission to UNEA5. The SAC is made up of natural and social scientists with expertise in plastics pollution from seventy developed and developing UN member states. The process by which SAC contributes to the *Assessment* is highly democratic and iterative. SAC members are provided with ample opportunities to offer country-specific narratives reflecting local and Indigenous knowledge systems and practices, cultural responses, and economic and political drivers of and barriers to assessments and solutions.

The extension of the Expert Group mandate means that plastics pollution remains on the international agenda and provides an opportunity for the consideration of a future legally binding agreement. However, this will depend on the level of support to those who suffer most immediately from plastics pollution: developing states and marginalized sectors of society. More resources will be needed to ensure that these states and communities (particularly developing countries and Indigenous communities) have the capacity to engage fully in the UNEA process.

## Enforcing the Treaty

Multilateral treaties have various enforcement mechanisms that set legal verification and compliance mechanisms. For example, the Nuclear Non-Proliferation Treaty has an International Atomic Energy Agency mandate to conduct fact-finding missions in state parties' nuclear energy facilities to ensure that these parties are not using them to make weapons. Often, though, treaties have voluntary compliance mechanisms based on transparency reporting and peer reviews whereby states monitor one other and bear the brunt of diplomatic rebukes for non-compliance. Whereas this might be more successful in some states than others, it does


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provide an effective form of moral compulsion. Once a state is a signatory to an international law, that state is bound by the obligations of that law in its national context. Sometimes states have to put in place national legislation to give effect to an international treaty to which it is a signatory, for example legislating specific penal sanctions. However, this depends on the treaty and the legal and constitutional nature of the state in question. Nevertheless, once a state has signed a piece of international law, it is bound by the Vienna Treaty on Treaties not to do anything contra to the spirit or letter of that legal instrument. On that basis, a legal challenge could be mounted under the national law of that state if its actions are in violation of the international law that it has signed. Therefore, a specific court is not needed to make legal challenges regarding international law, which can be enforced by courts in the country seen to break that law.

There is also a wider point here about the normative effect that setting clear legal boundaries can have on the policies and practices of states. The treaties prohibiting landmines and cluster munitions have no strict verification measures and are not even signed by states such as the United States, Russia, and China. Yet they have contributed to overhauling the policies and practices of those states. The production, trade, and use of landmines have been virtually eliminated since that treaty was signed in 1997. Thus, we argue that a specific multilateral legal instrument with strict provisions aimed at preventing plastics pollution is the most effective way to influence the policies and practices of all states. Such an instrument would be effective in terms both of its norm-setting power and of the actual implementation of provisions related to prohibiting certain types of plastics produced and the practices that allow plastics pollution to enter the environment.

## Redressing the Faustian Bargains

A growing impetus to action is being fuelled by increasing public debate and mounting evidence that plastics can carry EDCs, pathogens, POPs, and alien species across ecological territories and political boundaries (e.g., Chapters 1 and 4 of this volume; Viršek et al. 2017). The movement of plastics across global markets makes plastics pollution a "common concern" for all of humankind (Chavarro 2013). Silvio Funtowicz and Jerome


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Ravetz's (1992) "post-normal science," Sheila Jasanoff's (2003) "technologies of humility," and Andrew Stirling's (2015) "innovation democracy" all assert that speculative sciences and risk assessments underpinning regulatory policies must be democratized if they are to protect current and future life. This proposed radical shift in international plastics pollution policy will entail a reinstitutionalization of "knowledge-making within institutions that have worked for decades at keeping expert knowledge away from the vagaries of populism and politics" (Jasanoff 2003, 235).

Historically, there have been plenty of examples of science and industry producing innovations that later proved to be disastrous, including CFCs, thalidomide, tobacco, asbestos, POPs, and EDCs. As end users or innocent bystanders, citizens should have a key role in deciding which plastics and associated chemicals are needed, valued, hazardous, unnecessary, and so on. We argue that, where there is uncertainty regarding the persistent and polluting implications of a product, greater emphasis on precaution is needed. A precautionary approach is a powerful way "to moderate the powerful forces of closure and lock-in science and technology" prior to releases of products (Stirling 2015, 18). Because of the uncertainty and speculation surrounding EDC-plastics pollution science, a precautionary approach requiring international collaboration must be legally binding and enforceable to prevent ongoing global harms. The plastics pollution treaty proposed here is based on the success and sound principles of the Montréal Protocol, particularly "precaution" and "common concern." Another reason why the treaty must be legally binding is that voluntary commitments can mask vested interests in the fossil fuels and plastics industries.

Like climate change and clean water, the dynamic, persistent, unpredictable assemblages of plastics pollution are "a common concern of humankind" because they "inevitably transcend the boundaries of a single state and require collective action in response" (Shelton 2009, 83). The proposed treaty would respond to the urgency expressed by the global community to address the interdependent harms caused by plastics pollution to the biosphere and to humanity and to level the playing field. With political will from member states and further capacity building for civil society to lobby governments within the UNEA process, the Resolution on Marine Litter and Microplastics could culminate in such a treaty at


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UNEA5. A global, legally binding treaty with clear targets and standards is the most comprehensive way to redress the Faustian bargains made by Big Plastics.

## NOTES

1. For example, exclusive economic zones, species' territorial boundaries (feeding and breeding grounds), and national/state borders.
2. A waste management approach focused on pollution once it has entered the environment. "Top of pipe" solutions, conversely, focus on preproduction and prevention.

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# Conclusion

## Where There's a Will . . . Contesting Our Plastic Inheritance

*Trisia Farrelly*

The chapters of this book provide a series of interdisciplinary arguments, positions, provocations, and possibilities about the global plastics crisis and how to respond to it. They lay out the scientific evidence for such crises while adopting social science and humanities approaches to consider how we define and understand pollution, persistence, and a range of potential political responses. Many of the contributors to this volume have emphasized the need for a full life-cycle approach when offering solutions. This life cycle includes the extraction of fossil fuels/sourcing of alternative feedstocks, production, distribution, consumption, disposal/recycling/reuse/composting, and recovery of legacy plastics.

The new materialist chapters included in this book present plastics as a part of nature, outlining the often unpredictable ways in which human and non-human bodies, discourses, and materials become entangled and how this entanglement challenges lifeless and apolitical representations of plastics. They also illustrate the risks associated with viewing plastics as inert objects—not the least of which include the missed opportunity to see them as the lively, unpredictable materials that they really are; an important step toward recognizing how sustainable and ethical plastics economies might supplant the current situation. Plastics naturecultures are constantly on the move and in the process of forming new and unexpected ecologies with uncertain implications for humans and non-humans. Some plastics create novel ecologies where new life flourishes. Plastics can alleviate



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some aspects of poverty and give voice to political struggles at multiple scales. However, plastics also leach toxic additives, carry pathogens and species that can destroy ecosystems, and play a significant role in new syndemics (synergistically linked health problems). We are constantly discovering new, often unforeseen, effects of plastics. They might not be entirely good or altogether bad. However, plastics' ontological and moral ambiguities must not hinder political action. Indeed, it is entirely because of the level of uncertainty and speculation surrounding these lively naturecultures that some of the authors here recommend a precautionary approach at every phase of the life cycle of plastics.

The chapters in this book also foreground the multiple temporal and spatial scales at which plastics are operative. Contemporary solutions offered in response to the plastics crisis treat plastics not only as relatively inert objects but also as materials with a limited and linear life span. However, as some of the authors show, the origins of contemporary plastics can be traced back millennia to the fossil fuels produced from the demise of long-extinct organisms. Plastics manifest geologically, marking the Anthropocene from the Holocene, and will continue to determine ecological, biological, and socio-political outcomes for a long time to come. Yet solutions to the plastics pollution crisis are often deployed with short-term thinking and limited spatially to local, national, or regional responses. However, as the contributors to this volume emphasize, plastics do not respect territorial boundaries and are often found thousands of kilometres from their sources at macro-, meso-, micro-, and nanoscales. They float across geopolitical territories on tides and trade winds, they are carried in the bodies of organisms, and they move with global trade flows, migration, tourism, conflict, and humanitarian aid.

Because plastics are so mobile and do not respect culturally constructed boundaries, many contributors to this volume argue that meaningful and sustainable solutions to the plastics crisis can be realized only at a global scale by radically restructuring the global economic system. This would require a shift away from GDP (gross domestic product) fetishism and toward a new global system that balances social well-being with human activity, and that does not exceed planetary boundaries. This is a plastics economy in which nothing is produced unless it is responsibly sourced and manufactured, is non-toxic, and can be safely and ethically recycled,



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reused, or composted. Some of the authors also emphasize the need for education with the caveat that any education will have limited impact if current systemic weaknesses are not simultaneously addressed.

The authors across the volume consider how politics and communicative action are key to implementing the types of social, cultural, and economic changes urgently needed to meaningfully address the global plastics crisis. The authors' emphases on plastics' tendency to transgress geopolitical boundaries and surprise scientists in proliferating studies of plastics at multiple temporal and empirical scales lead to calls for multi-level governance solutions. Some authors also highlight the importance of collective civil society action, not only to assuage feelings of guilt and sadness that can come with plastics pollution–related work, but also to exert greater influence on policy and legislative responses from high-level governance bodies.

Many of the chapters also discuss the ways in which invisibility and nomenclature influence political and communicative action. Woven throughout is an agreement that proximity and visibility enhance responsiveness and that information conveyed to the public and policy makers about the actual and potential harms of plastics is often limited to their visible and measurable impacts. However, the contributors to this volume have emphasized that the most problematic plastics are not those visible to the naked eye. The focus on the visible and known impacts of plastics at their post-consumption (or "end of life") means that regulation of plastics pollution is usually enacted when the product is no longer of value to the consumer and defined as "litter" or "waste." In other words, responses to the global plastics crisis are almost always "waste management" focused. Where they are visible, plastics and their impacts offer a greater potential for strong emotional responses. Conversely, the less visible impacts of plastics pollution, for example the health impacts of plastics on lugworms or plankton, receive less care and responsibility from humans despite the potential to grievously affect entire food webs.

Waste management efforts are often promoted as technical "solutions" to what all of the contributors here have shown are extremely complex problems. Although technology might alleviate some aspects of the plastics crisis, it can also introduce additional harms. Furthermore, the technofixes offered, often by entrepreneurs,the plastics and petrochemical



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industries, and the states politically and economically dependent on them, mask the systematic social and economic flaws at the root of the proliferation of plastics pollution: globalized consumer capitalism. In short, all waste management efforts have failed to have any significant impact on the plastics crisis. Waste management technosolutions cannot replace the need for collective political action with the potential to significantly shift the deeply entrenched political, economic, and cultural structures and behaviours predicted to see a 33 to 36 percent increase in plastics production over the next few years.

How plastics are represented is important because it changes their material, social, and discursive dimensions. This, in turn, has significant implications for potential responses to the plastics pollution crisis. For example, defining plastics as "litter," "microplastics," "pollutants," "hazardous," or "hybrid" has a profound bearing on the urgency and form of response to plastics pollution. Some of the chapters highlight how plastics communicate an array of messages, including security, identity, belonging, comfort, affluence, convenience, modernity, safety, and progress. The authors of these chapters appeal to us to learn how to listen to the messages that plastics convey to different people. If we fail to listen carefully, we also miss the opportunity to understand which forms of action might compel people to live better with plastics and to understand which plastics we can or must learn to live without if we are all to live well.

Talking about the scope and scale of plastics emphasizes the limits to which consumers can turn the ship around and why we need to stop talking about littering, as if all responsibility should fall solely on the shoulders of consumers, and start talking about plastics as hazardous pollution. In this way, the vast majority of the responsibility can be directed back onto producers that have no right to manufacture such hazardous products for profit (particularly in the absence of social licence) and onto states complicit in allowing producers to skirt responsibility for their polluting practices.

*Plastic Legacies* also highlights how the effects of plastics are felt unevenly by different groups of humans and non-humans in different places. In some cases, plastics extraction, production, and disposal perpetuate colonial cycles of inequity that have been sustained for centuries. In other cases, a broad range of non-human species, from hedgehogs and



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albatrosses to the microscopic denizens of the plastisphere, is affected by plastics. The chapters in this volume emphasize that not all plastics are considered bad by all people. Indeed, some of these chapters illustrate the cultural benefits that plastics have afforded to certain social groups. It is important that we recognize this and that we listen to what plastics are communicating to us so that our responses to the plastics crisis are empowering ones.

The contributors to this volume talk about plastics at the scope and scale of the Anthropocene, remote responsibilities, endocrine disrupting chemicals, and persistent organic pollutants. They also draw our attention to the various moralities and cares attributed to different plastics. All of this emphasizes the limits of our ability to ask all the right questions and provide all the right solutions independently. Our research collaborations and collective societal responses will need to match the complexities of what we currently know about plastics. This will demand innovative and consciously transdisciplinary work that extends far beyond what we have achieved in this volume.



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**Sven Bergmann** is a cultural anthropologist currently working at the German Maritime Museum (DSM) in Bremerhaven. His research interests span from feminist technoscience, kinship, reproduction, and the body to political ecology, marine and environmental anthropology, and economies of waste. His postdoctoral research deals with the problematization of plastics in the ocean and other environments.

**Stephanie Borrelle** is a seabird conservation ecologist. Her research is at the intersection between conservation and policy, specifically in relation to plastics pollution and the impacts on seabirds and marine wildlife. Stephanie is from Ōtautahi, te Waipounamu, Aotearoa, and is a David H. Smith Fellow at the University of Georgia in the United States and the University of Toronto in Canada.

Trained initially in mathematics and the science of complex systems, **Tridibesh Dey** switched to (social) anthropology after a brief working career in engineering. He has co-created and been part of an international network of students in engineering, design, and social sciences to collaborate with marginalized communities in India on the problems of waste. Tridibesh is currently pursuing a PhD as a University of Exeter International Excellence Scholar.

**Trisia Farrelly** is a senior lecturer in environmental anthropology and an indefatigable optimist when it comes to solutions to plastics pollution.



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She is a member of the United Nations Environmental Programme's Ad Hoc Open-Ended Expert Working Group and Scientific Advisory Committee (Marine Litter and Microplastics). She is also a co-founder of the New Zealand Product Stewardship Council; a co-director of Massey University's Political Ecology Research Centre; and a co-founder of the Aotearoa Plastic Pollution Alliance. Trisia advises New Zealand's Ministry for the Environment, the Parliamentary Commissioner for the Environment, businesses, and non-governmental organizations on plastics pollution impacts and responses, including shaping New Zealand's national container deposit scheme. Her current focus is on the formation of an international coalition dedicated to developing novel, rights-based solutions to the plastics pollution crisis.

**Christina Gerhardt** is an associate professor of environmental humanities, film, and German at the University of Hawaii at Mānoa and a senior fellow at the University of California at Berkeley. She is the author of *Atlas of (Remote) Islands and Sea Level Rise* (University of California Press, 2021) and the editor of *Climate Change, Hawaii and the Pacific*. She is the editor of *ISLE: Interdisciplinary Studies of Literature and the Environment*, the quarterly of the Association for the Study of Literature and the Environment published by Oxford University Press. She is the founding director of the Environmental Humanities Initiative at the University of Hawaii. She has been awarded grants by the Fulbright Commission, the DAAD (German Academic Exchange Service), and the National Endowment for the Humanities. She has held visiting appointments at Harvard University, Free University Berlin, and Columbia University.

**John Holland** is a professor of environmental management at Massey University. His research interests include tourism, environmental economics, national parks, and wildlife tracking.

**Deirdre McKay** is a reader in geography at Keele University. Her research explores the material outcomes of global aspirations and people's shifting senses of future selves. Her book *An Archipelago of Care* (Indiana University Press, 2016) documents Filipino migrants' lives in London. Deirdre has worked with CIDA- and AusAID-funded projects in the Philippines and with Filipino migrant communities in Canada, Hong Kong,



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and London and online on arts and development projects. Her current work examines upcycled plastic arts and crafts, "private aid" after natural disasters, and the potential for migrants to document their development contributions through community arts.

**Laura McLauchlan** holds a PhD in anthropology from the Environmental Humanities program at the University of New South Wales. Her thesis work was based on fieldwork with hedgehogs, humans, and questions of conservation in urban Bristol (UK) and Wellington (NZ), with a particular focus on questions of care, obligation, collectives, affect, and uncertainty. Arising from this work, her ongoing interests as both a scholar and a human involve thinking about how to make and sustain helpful collectives as well as what taking emotions seriously might mean in teaching and environmental politics. Laura is currently convening courses in environmental justice at the University of New South Wales and ecocriticism at New York University Sydney.

**Mike Michael** is a sociologist of science and technology and a professor in the Department of Sociology, Philosophy and Anthropology at the University of Exeter. His research interests have touched on the relation of everyday life to technoscience, the role of culture in biomedicine, and the interplay of design and social scientific perspectives. His recent major publications include *Actor-Network Theory: Trials, Trails and Translations* (Sage, 2017) and *Energy Babble* (with Andy Boucher, Bill Gaver, Tobie Kerridge, Liliana Ovalle, Matthew Plummer-Fernandez, and Alex Wilkie, Mattering Press, 2018).

**Imogen Napper** recently completed a PhD at the University of Plymouth researching "The Sources and Fate of Plastic in the Marine Environment." Her work influenced the UK government's decision to introduce legislation on the use of microplastics in cosmetics. She is currently working on a National Geographic Early Career Grant, in partnership with Sky Ocean Rescue, to see how effective different inventions are at capturing fibres from clothing when it is laundered.

A Ngāti Porou wāhine and the mother of two children, **Tina Ngata** is involved in advocacy for environmental, Indigenous, and human rights.



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This work includes local, national, and international initiatives that highlight the role of settler colonialism in issues such as climate change and waste pollution, and it promotes Indigenous conservation as the best practice for a globally sustainable future.

**Sabine Pahl** is a social psychologist engaged in basic and applied research. Her applied work focuses on the human dimension in environmental issues. She investigates perceptions and behavioural changes, particularly in the area of protecting marine environments, marine litter, and microplastics.

**Padmapani L. Perez** is a research fellow at the Institute of Arts and Sciences, Far Eastern University, Manila. She held the Wenner-Gren Hunt Postdoctoral Fellowship at the University of the Philippines, Baguio City, in 2014–15. Her book *Green Entanglements: Indigenous Peoples' Rights and Nature Conservation in Indonesia and the Philippines* (University of the Philippines Press, 2017) is an ethnographic exploration of the relationships among Indigenous peoples, agents of biodiversity conservation, and their environments. Padma is a community-engaged researcher and serves on the Board of the Anthropological Association of the Philippines (UGAT) and is a founding partner of Mt. Cloud Bookshop, Baguio City.

**Jennifer Provencher** studies how seabirds are affected by human activities in collaboration with Inuit communities in northern Canada. Her research focuses primarily on contaminants and ingested plastics in seabirds. Jennifer is of settler heritage, a mother of one child, and a Weston Fellow of Northern Research and a Liber Ero Fellow at Acadia University, Nova Scotia, Canada.

**Ian Shaw** is an author, broadcaster, and academic. He has worked in government science, the pharmaceuticals industry, and several universities. He rose to the dizzy administrative height of pro vice-chancellor (science) at the University of Canterbury but then defected to the world of real science in 2009. He is now a professor of toxicology at the University of Canterbury. Ian is the author of three books on food and the environment, the editor of a major work on estrogen mimics in food, a feature writer for the *Press*, a regular on Radio NZ National's *This Way Up* and



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TV NZ (*What's Really in Our Food?*), and has published over 100 articles in scientific journals. His research interest for the past twenty years has been the cellular and human effects of estrogen mimics in food and the environment, with particular reference to environmental estrogens from plastics and their impacts on human and ecosystem health. Ian is a fellow of the Royal College of Pathologists and the Royal Society of Chemistry. He won the New Zealand Association of Scientists Science Communicator Award in 2009, and in 2020, he was awarded a Doctor of Science by the University of Bath for his contribution to toxicology and science communication. But Ian is most proud of being awarded Science Lecturer of the Year by the University of Canterbury Students' Association in 2009, 2013, 2014, and 2016.

**Elyse Stanes** is a cultural geographer in the School of Geography and Sustainable Communities at the University of Wollongong, Australia. Her research connects everyday cultures of consumption to wider politics of excess and waste.

**Sy Taffel** is co-director of the Massey University Political Ecology Research Centre and one of the centre's founding members. His research focusses on political ecologies of digital media, technological solutionism, and the social, cultural, and political impacts of digital technologies. Sy is the author of *Digital Media Ecologies*, and along with Nicholas Holm co-edited the anthology *Ecological Entanglements in the Anthropocene*. Sy's research has been published in many journals, including *Cultural Politics*, *Media, Culture & Society*, and *Convergence*. He also makes documentary/activist films, including for environmental groups such as the Environment Network Manawatu and Carrying Our Future.

**Johanne Tarpgaard** is a PhD candidate with Project BLUE at Aarhus University, Denmark where she also received her master's degree in anthropology. Throughout her master's degree, she was affiliated with Aarhus Research in the Anthropocene (AURA). Based on anthropological interest and work experience focusing on human relations to the ocean, she carried out her fieldwork on the expedition ship of an environmental organization working with plastics pollution.



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**Richard Thompson** has focused his research work over the past decade on marine debris. He was a co-author of the European Union Marine Strategy Framework Directive text on marine litter. He has been a member of numerous international working groups on marine litter, including GESAMP, NCEAS, UNEP, and UNIRP. Recent work by his team directly informed the UK government's decision to introduce legislation on the use of microplastics in cosmetics. Richard has been working recently with G7 nations on the monitoring of marine litter. In 2017, he received the Marsh Award for Marine and Freshwater Conservation for his work on plastics, and he was recognized in the New Year Honours List with an OBE for services to marine science. Richard leads the International Marine Litter Research Unit at the University of Plymouth.

**Lei Xiaoyu** is a member of the company at the Stoke-on-Trent arts charity, B arts, and a PhD candidate in the Human Geography programme at Keele University.



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