



Open Access  CC BY 4.0



## Anthropocene Ouroboros: Shimmying Plastics and the Contamination of Time

SASKIA ABRAHMS-KAVUNENKO 

## WORLDWIDE WASTE

Journal of Interdisciplinary Studies

Volume 8, Number 1, 2025

Published online 1 October 2025

Submitted 24 April 2025

Accepted 29 July 2025

The White Horse Press

The Old Vicarage, Main Street,  
Winwick, Cambridgeshire  
PE28 5PN, UK

### ABSTRACT

The ever-increasing abundance and expanding affordances of plastics have come to instantiate modernity through their successes and failures in usage and beyond. Materially, plastics have a capacity to stubbornly endure yet simultaneously to fracture. Grounded in ethnographic fieldwork on an Indian Ocean island, this article will explore the heritage of plastic objects in their shattering and dispersal. The novel presence and ubiquity of plastics have caused some scholars to propose that the presence of plastics could constitute a possible marker of the Anthropocene. Yet plastics won't stay in their own epoch. Microplastics can migrate and infuse sedimentary layers from previous eras, shimmying down to earlier stratigraphic layers and complicating the very knowability of the past. This paper will look at the temporal vertiginousness of the current epoch through the recalcitrance of human-made materials, arguing that, even in their material remnants, plastics radically complicate the delineation and understanding of geological time.

### CORRESPONDING AUTHOR:

**Saskia Abrahms-Kavunenko**

The Hakubi Center for Advanced Research, Graduate School of Human and Environmental Studies, Kyoto University, Kyoto 606-8501, Japan  
[s.abrahms.k@gmail.com](mailto:s.abrahms.k@gmail.com)

### KEYWORDS:

Plastics, time, heritage,  
Anthropocene, microplastics

### TO CITE THIS ARTICLE:

Abrahms-Kavunenko, S. 'Anthropocene Ouroboros: Shimmying Plastics and the Contamination of Time'. *Worldwide Waste* 8(1): 6, 1–10. <https://doi.org/10.3197/whpww.63857928646680>

## INTRODUCTION

Over the course of the twentieth and twenty-first centuries, the seemingly alchemical possibilities contained within plastics have supported increasingly rapid forms of consumption and discard. The shimmering nylons and polyesters that are sold in fast fashion outlets and outdoor markets seem to effortlessly appear and disappear without a trace. Household objects for tidying other household objects proliferate in homes, taking on new shapes, colours and forms. As Barthes describes the production process of the emerging wonder of plastics in the late 1950s:

An ideally-shaped machine, tabulated and oblong ... effortlessly draws, out of a heap of greenish crystals, shiny and fluted dressing-room tidies. At one end, raw, telluric matter, at the other, the finished, human object; and between these two extremes, nothing; nothing but a transit, hardly watched over by an attendant in a cloth cap, half-god, half-robot ([Barthes 1972 \[1957\]: 97](#)).

In the industrialised processes of production, the past of each plastic object is obscured. Their origin stories are unknown, and often unknowable, as industrial forms of manufacturing reduce each object's history to, at best, the mechanical extrusion and moulding of smaller constituent plastics into finished plastic products.

Although industrial processes provide the illusion that plastics are 'the first magical substance which consents to be prosaic' ([Barthes 1972 \[1957\]: 97](#)), plastics do not conform to the material expectations of their makers. They evade control at all their life stages: spilling fragments and toxic residues during extraction, manufacture, use and transportation, and after they have been discarded. They have pervasive material consequences that are carried through their fractious materiality, the chemical retinues that infiltrate sites of production, extraction, refinery and remoulding (where this occurs), and the climatic effects attendant to every part of their lifecycle ([Bauman 2019](#), [UNEP 2021](#), [UN Environment Report 2018a, 2018b](#)). Pieces and fragments of plastic – macro, meso, micro and nano – now cover the Earth ([Bergmann et al. 2022](#), [Chia et al. 2021](#), [O'Brien et al. 2023](#)). The very durability that makes them such desirable materials ensures that many outlive their makers, imposing themselves in unknown ways on the future. Resistant to many forms of biodegradation, they split apart, infuse and off-gas, spreading themselves and their attendant chemicals unevenly across the planet ([Bauer et al. 2019](#), [O'Brien et al. 2023](#), [Yang et al. 2011](#), [Zhang et al., 2020](#)).

The processes of transforming the fossilised remains of the past into capitalism's very own

wunderkind material<sup>1</sup> have changed social and ecological life on the planet. Some scholars have suggested that this change is so drastic that the presence of plastics in the stratigraphic record could be used as a reference to indicate the start of the Anthropocene ([Corcoran et al. 2014](#), [Rangel-Buitrago et al. 2022](#), [Zalasiewicz et al., 2016](#)). Complicating the suggestion that the stratigraphic presence of plastics could highlight this epochal shift, recent findings have noted that microplastics and nanoplastics can migrate and infuse sedimentary layers from previous eras ([Dimante-Deimantovica et al. 2024](#)), shimmying down to earlier stratigraphic layers and complicating the very knowability of the past. Even in their material remnants, plastics complicate the recording and understanding of geological time. By interrogating the difficulties of using plastics as a potential marker of the Anthropocene, this article will explore the unwillingness of plastics to follow the linear temporalities which we ascribe to them. As plastics emerge as a dominating material of the present and foist themselves in unknowable ways upon the future, the presence/present of plastics works to unmake the past.

## PLASTIC HERITAGE ON AN INDIAN OCEAN ISLAND

The coastlines of Christmas Island, a small island in the Indian Ocean with around 2,000 inhabitants, are intermittently overwhelmed with tremendous volumes of plastics that are carried to the island's beaches from the rivers and shorelines of Southeast Asia. Three hundred and fifty kilometres south of Java, the Australian external territory is visited by a vast flotilla of plastic waste that arrives seasonally, following the Indonesian Throughflow, that brings with it plastic detritus through the Lombok Strait, the Sunda Strait and the Timor Passage. The overwhelming majority of this armada sweeps on past the island, casting, if ever, ashore on distant sands such as those of the Seychelles ([Vogt-Vincent et al. 2023](#)). In amongst the tiny specks of plastics and larger broken up fragments that are characteristic of most of the plastics in the ocean ([Liboiron 2016](#), [Monsaingeon 2017](#)), some of the debris that makes its way to the island's beaches remains recognisable as specific items. These include flip flops, food packaging, items used for fishing, toothbrushes,

<sup>1</sup> It is important to note that it is not only capitalist societies that have made use of plastics. During socialism, plastics were a key material, for instance, in the German Democratic Republic (see [Rubin 2008](#) for a fascinating discussion of socialist plastics). In spite of this, with the exception of some notable nation states that still self-identify as socialist but are very much entwined in specific ways within global capitalism (such as Vietnam and China), the drastic increase in plastic production over the last thirty years can be connected to the kinds of rapacious consumption that are connected to late-stage capitalism.

single-use bottles and bottle tops, plastic bags, and single-use water cups. During the dry season these objects and other pieces of plastic visibly saturate the waves as they crash upon the small island's beaches.

Carrying out fieldwork on the island in 2022–2023 and again in 2024, I spent time with Jo Doble who had at the time been a resident on the island for around 27 years.<sup>2</sup> In early 2023 my husband and I spent some time in Jo's small art studio before travelling with her to visit one of the island's worst affected eastern beaches, Greta Beach. In her studio she stored collected charismatic plastic items, such as toys and other objects and materials that she had collected from decades of clearing plastics from the island's beaches. These items all stood out in some way, due to some material resonance or to the traces of stories acquired during or predating their journey at sea. She saw moments of beauty in the vast and exhausting plastic inundation that unceasingly arrives on the island's beaches. As an artist, Jo looked for materials that she could sand back to transform into artworks or other items such as baskets and jewellery. In her studio she had several large glass jars full of small toys that she had found on the beach, as well as other interesting and brightly coloured pieces.

Demonstrating a discerning eye for found plastics that she had cultivated from her years of beach cleaning, as well as her background in anthropology and visual art, Jo explained that she found novelty in the materials as well as the objects that she collected. Sometimes she collected items that have been repurposed, such as flip flops that have been repaired or engraved. Sometimes the materials demonstrated a novel transformation during their marine voyages. As Jo told me in a long interview in 2023:

The whole journey on the ocean has created these pieces and ... they can have all sorts of interesting marks on the surfaces ... this one piece ... revealed this beautiful colour underneath and then it had the texture of all of the cut marks ... the journey across the ocean kind of recreates it into something quite different sometimes ... occasionally I look at a thing and it looks like they have bite marks on them.

During our time on the beach together collecting large plastic items and plastic fragments amidst the crawling of hermit crabs, my husband found a flip flop covered in mollusc shells. Someone had placed

it on top of a boulder on the beach, likely unsure, as we were, about what to do with it. It seems, as De Wolff has written (2017), to be of the kinds of mixings of life and plastics that have been labelled the 'plastisphere' (Zettler et al. 2013). The plastisphere refers to places where novel ecologies have formed around plastics, sometimes generating complex ethical conundrums about whether or not to remove plastics from aquatic ecosystems when they are harbouring, for instance, reef fish in the open ocean (Davis 2022, De Wolff 2017).<sup>3</sup> Looking at the flip flop reminded me of the difficulties in separating life from plastic materials and the complexities surrounding what constitutes pollution and habitat. In this case we decided, not entirely convinced of our reasoning, that the inhabitants had likely left the shells and we took the flip flop off the beach.

Back in Jo's studio my husband noticed a piece of plastic that showed signs of being significantly weathered. It appeared as though it has been melted and had deteriorated during its time in the ocean in a way that caused it to resemble a fossil or part of the geological record, rather than something which had been deliberately industrially manufactured. The piece that my husband noticed in Jo's studio in many ways mimicked the appearance of a plastiglomerate, a term coined to describe the bonding of organic and/or mineral matter with plastics into geological or rock-like formations (Corcoran et al. 2014). The troubling appearance of plastiglomerate was first recognised by Charles J. Moore<sup>4</sup> on Kamilo Beach in 2006, one of Hawai'i's most plastic pollution-affected beaches. Following from Moore's findings, the term plastiglomerate was coined by a small research team containing sedimentary petrologist Patricia Corcoran, Moore and visual artist Kelly Jazvac (2014). Together they argue that the appearance of plastiglomerate could indicate a potential geographic marker to signal the start of the Anthropocene (Corcoran et al. 2014).

The plastiglomerates that Corcoran and colleagues (2014) found in their sampling of the Kamilo Beach area were formed anthropogenically. They were formed as a result not only of the industrial manufacturing that created the plastics, but also of the secondary burning of plastics (likely in camp fires) which created the plastiglomerate itself. Following from this initial discovery, different kinds of plastic-rock aggregates have been identified around the world, causing Rangel-Buitrago and colleagues (2022) to suggest a diverse

2 The fieldwork referred to in this article was conducted over the course of six months in 2022, 2023 and 2024. This fieldwork involved participant observation, media and social media engagement as well as formal and informal interviews. The project received a formal ethics approval from the University of Copenhagen and always meets the ethical standards of accepted guidance documents for anthropological research, specifically those highlighted by the *American Anthropological Association (AAA) Code of Ethics* (2012).

3 Similar ethical quandaries exist for the removal of plastics from vegetated soil (see Cyvin et al. 2021 for a discussion).

4 An oceanographer, Moore is known for having identified the Great Pacific Garbage Patch in 1997 (Gerhardt 2021). Unfortunately the idea of a 'patch', the size of which has been likened to a continent, has led to false understandings of the ways in which plastics are found and behave in the oceans, most erroneously in the idea that plastics can simply be 'cleaned' from the oceans (see Monsaingeon 2017).

nomenclature to distinguish between the various plastic-rock composites. In favour of the use of the Plasticene they write that the particular ways ‘that plastics interact with humans and the environment meets the minimum requirements for defining this “time of plastic” as a new geologic substage’ (Rangel-Buitrago et al. 2022: 7). The authors note that the appearance of plastics accords well with the International Commission on Stratigraphy’s definitions for a ‘global chronostratigraphic standard’ (Rangel-Buitrago et al. 2022: 7), contending that there are clearly identifiable plastic markers to indicate the ‘lower boundary of the Plasticene’ that are globally synchronic and can be ‘dated and compositionally described’ (Rangel-Buitrago et al. 2022: 7). They propose that, due to the recent appearance of plastics, the material markers of the Plasticene have not yet been disturbed by tectonic movements or other geological changes. Whilst they acknowledge that all geological classifications are ultimately constructs, they write that, given the volume of plastics that have been created, used and discarded, ‘this litter leaves its global marker for the beginning and definition of the Plasticene’ (Rangel-Buitrago et al. 2022: 8).

Generally perceived as distinct from plastics used in everyday life and those connected to infrastructural necessities on the island, the seasonal arrival of plastics on Christmas Island’s beaches caused a range of reactions from locals and visitors. Many friends told me that they avoided going to the eastern beaches during the dry season, as the sight of the beaches covered in plastics was too depressing. Whilst visiting Greta Beach in August 2024, friends explained to me that each day the tide completely covered the beach anew, bringing with each flow a fresh deluge of plastic waste. Greta Beach is a beautiful cove nestled between jagged limestone rock faces reached by clambering down a set of steep metal stairs. As I approached the beach in August 2024, from the top of the cliffside lookout I could already see that the ocean currents were saturated with large pieces of plastic detritus. I had been driven to the beach by my then housemate Ann-Marie who had been a resident of the island for around five years. Formerly a volunteer for Eco crabs, a small island enterprise that melts plastics to create small household objects, Ann-Marie regularly visited Greta Beach to gather plastic debris, driftwood and other materials to use in making art. In conversation my husband asked her how bad the plastics were on that particular day, relative to others. She replied:

A three [out of ten]. I was just saying, I’ve had it so deep you were walking on plastic, not on the beach. What you see here, and it’s no different to any other day, gets brought in on the tide. Anything you pick up is a bonus, the rest gets swept out on the tide. Sometimes it gets the best of you and you just wander around ... looking.

Ann-Marie explained the feeling of visiting the beaches: ‘It’s always different. Sometimes it’s overwhelming and I sit there and cry. Sometimes it’s manky [slang for dirty] and it makes me feel sick.’ She told me later: ‘I’m not doing anything; I’m not changing anything. The problem is too big. But there are all these materials that I can go and collect. Then I get to explore my art and what I can do.’ Beach cleanups are carried out by volunteers on the island, and local council workers pick up the collected debris left in re-used bags from the local phosphate mine near the beach’s car park. Aside from the localised efforts of people like Jo, Ann-Marie and other individuals and small volunteer groups such as Island Care, Ecocrabs, Tangaroa Blue and the local high school to re-utilise some of the found plastic waste, the plastics collected on the beaches end up in the island’s rubbish dump. Ann-Marie told me that the problem needed to be stopped in the water before it hits the island. She explained that one of the mainland-based NGOs, Tangaroa Blue, sends letters to companies when they find particular brands on the beaches. Matter-of-factly, she went on: ‘you know what they probably do when they get those letters?’ Then she brandished her middle finger.

Much of what arrives on the beaches of Christmas Island are single-use plastics, reflecting changes in the global use, dependence upon and speed of consumption of plastics. In an interview with Jo in early 2023, I asked her whether the plastic detritus on the island’s beaches had changed over the 27 years that she had been engaging with it?

I think it probably has increased. Because in 27 years there is now a lot more packaging of processed foods, and packaging related to processed foods and far, far more than there ever was in the past. And so you see a lot more ... I think the quality of plastics has changed also. If I think about the toys and the little figures and things I have found in the past, they were quite solid and quite beautiful but there is a lot more stuff now that is ... more flimsy and cheaply produced. And therefore breaks up more readily ... The rubbish, doesn’t have the same appeal in a lot of ways. This sounds like a terrible thing to say because I think it is all disgusting, but I also find lots of beauty in it. I think I used to find a lot of interesting pieces of timber and carved bits of timber ... I find a lot less of that now. You know I used to find maybe a piece, that you know might have come from the top of a chair ... there is so much more now that is produced in plastic ... the materials have changed over that time.

## THE PREVALENCE OF PLASTICS

Since the invention of the first completely synthetic plastic, Bakelite, in 1907, both the scale of production



and the diversity of plastics have rapidly increased. The early designs and applications of plastics were associated with conservation ([Meikle 1995](#)), with the first uses of the non-synthetic plastic celluloid replacing tortoise shell for making combs and ivory for making billiard balls ([Westmont 2020](#)). Distinct from the initial utopian expectations of overcoming material shortages and the overhunting of certain species, emerging relationships with plastics in the twentieth century turned increasingly ambivalent in the post-war period ([Meikle 1995](#)). As the affordances of plastics inspired new forms of modernity they also invited critique ([Meikle 1995](#)). Whilst the appearance of plastic flowers in middle-class American suburbia created a sense of stability and effortless utilitarian durability ([Gupta-Nigam 2020](#)), they also attracted sceptical commentary that people were no longer able to see beauty in the natural cycles of blossoming and decay ([Meikle 1995](#)).

Just as the plastic fittings and furnishing of homes in the German Democratic Republic enabled a new kind of living for the socialist citizen (Rubin 2008), plastics in capitalist contexts have been associated with modernity and an increase in economic success ([Pathak 2020](#), [Schlehe and Yulianto 2020](#)). The oft-scorned plastic bag can be a symbol of hospitality in convenience stores in Japan ([Steger 2021](#)) and is associated with the performance of modern citizenry in urban Java in Indonesia ([Schlehe and Yulianto 2020](#)). As key materials which carry out important 'social work' ([McKay et al. 2020](#): 312) plastics enable certain kinds of mobility and speed ([Hawkins 2018](#)). Due to their specific material affordances, plastics have co-arisen with the development of specific kinds of economic configurations and infrastructures ([Hawkins 2018](#)).

In many contexts plastics are exalted for their intended material affordances, whilst in others they are repurposed to be used for something new. In their design and aesthetics, plastic boba (bubble) tea containers are a key part of the huge growth in the popularity of boba tea and the mass mediation of its consumption across China and elsewhere ([Wu 2023](#)). In other contexts plastics are repurposed in novel and creative ways, such as the use of plastic bags to make footballs by young men in Tanzania ([Klocker et al. 2018](#)), using colourful plastic discards to weave backpacks ([McKay and Perez 2018](#)), the repurposing of large plastic containers for carrying all kinds of liquids in Madagascar ([Fache et al. 2023](#)) or for fermenting milk products in Mongolia ([Reichhardt and Abrahms-Kavunenko 2022](#)). Plastics intended for mundane usage can be incorporated into ritual contexts for containing offerings ([Abrahms-Kavunenko 2022](#), [Brox 2022](#), [Holmes-Tagchundarpa 2023](#)) and for conserving the memories and bodies of the dead ([Bredenbröker 2024a, 2024b](#)). In ritual life, their capacity to remain can be both a boon and a source of social and material problems. Plastic ritual remains from sacred

offerings can become ambivalent as the extended lifespan of offered items can make it difficult for them to receive correct treatment after use ([Abrahms-Kavunenko 2022](#), [Bhutia 2022](#), [Bredenbröker 2024a](#), [Brox 2022](#), [Holmes-Tagchundarpa 2023](#), [Wirtz 2009](#)).

In some places, plastics and their proliferation have come to stand in for the failures of modernity ([Abrahms-Kavunenko and Brox 2022](#), [Abrahms-Kavunenko 2023](#), [Chao 2019](#), [McKay et al. 2020](#), [Meiu 2020](#)). As an increase in plastic imports frequently co-arises with the import of foreign products and dependencies on non-local food (such as instant noodles and sweets, see [Chao 2019](#), [McDougall 2021](#), respectively) the appearance of plastics has been associated with colonial domination and the loss of local social and biological reproduction ([Chao 2019](#); see also [Meiu 2020](#)).

Following the infamous pronouncement of the editor of *Modern Packaging Magazine*, Lloyd Stouffer, in 1956 that the 'future of plastics is in the trash can', the design of plastics increasingly moved from durable objects towards single-use, creating a design paradox ([Hawkins 2013](#); [Liboiron 2016, 2018](#); [Meikle 1995](#)). As Gay Hawkins writes, single-use packaging needed to be 'both tough and expendable' ([Hawkins 2013](#): 74). Packaging such as polyethylene (PET) bottles used for containing liquids, needed to be durable enough to meet the expectations of stability during transportation and distribution, yet would be immediately thrown away after use ([Hawkins 2013](#)). Plastics, through their abilities to contain and to be light enough for efficient transport, ensured that products could travel. These new forms of mobility had enormous impacts on the ways in which products were viewed. As she writes:

Containing isn't a static function; it is an action in itself, a dynamic capacity to hold and re-source. This socio-material and technical effect enacts a distinct form of *presentism* or ontology of the present. Commodities are immediately present and available on the shelf before you; they appear to have no history or origin, their source *is* the package and they are endlessly replaceable and reproducible ([Hawkins 2018](#): 99).

In this way, as Barthes described above, the temporality of single-use plastics communicates only with the present. Brightly-coloured food branding printed on plastic packaging simultaneously obscures the origin stories of the products contained within and communicates the virtues of consumption directly with consumers as the products sit on supermarket shelves. The past and the future are obfuscated as the affordances of plastics illuminate a kind of presentism that urges the consumer to forget the actual labour and materials involved in the consumption of the products that they encase, replacing their identities with the communication tied to the imaginary of the brand ([Hawkins 2018](#)).

For many people in the twenty first century, plastics are connected to pollution either after their discard or before ([Pathak 2023](#)). In India campaigns which symbolically link plastics to pollution as a problem of waste management or an aesthetic disturbance ([Pathak 2023](#)) can lead to collection and small-scale open burning practices in an attempt to 'clean' spaces of unsightly rubbish ([Latkar and Pathak 2024](#)). The open burning of plastic waste, as a means of getting rid of waste and of providing low-income communities with a source of fuel or heat, can produce dangerous dioxins and other kinds of toxicants both during the course of burning and in the residues that remain ([Pathak et al. 2023](#)). The generation of plastiglomerates through burning transforms the chemical and physical properties of the 'parent' materials, meaning that the new agglomerates contain more organic pollutants than the waste from which they came ([Utami et al. 2023](#)).

The concatenating problems associated with plastics are expansive. In spite of attempts to increase recycling programmes and the introduction of plastic bans in places such as Uganda, according to reports by the United Nations Environment Program the current production of plastics is predicted to triple by 2050 ([UNEP 2021](#): 38). In 2015 around 60–99 million tonnes of discarded materials entered the environment and this figure is expected by 2050 to increase to 155–265 million tonnes per year ([UNEP 2021](#): 13). Of all the plastics that have been created, around nine per cent have been recycled and this recycling tends to happen just once, as the plastics degrade in the process of recycling, weakening the bonds between the polymers ([UN Environment Report 2018a, 2018b](#)). In 2017, the United Nations Environment Program (2021) estimated that half the virgin plastics ever produced at that time had been created since 2004 ([UNEP 2021](#)). Plastics have been found in every part of the planet from the depths of the Mariana Trench ([Peng et al. 2018](#)) to remote regions of the Arctic ([Bergmann et al. 2022](#)). Microplastics are now present in rainwater, aquatic environments, the soils in which we grow our food and the air we breathe ([Chia et al. 2021](#), [O'Brien et al. 2023](#), [Zhang et al. 2020](#)). They have become a part of human bodies, being found in lung tissue ([Amato-Lourenço et al. 2021](#)), the blood ([Leslie et al. 2022](#)) and the brain ([Nihart et al. 2025](#)).

## THE PLASTICENE THAT EATS ITS OWN TALE

As a term and a concept the Anthropocene, and its growing popularity, have been controversial since 2000. Initially used by biologist Eugene Stroemer ([Stager 2011](#)), the term was popularised when atmospheric chemist Paul Crutzen interjected the term into a debate during the International Geosphere-Biosphere Program assembly in early

2000. Frustrated by a lack of explanatory power in the usage of the Holocene, he suggested that the Holocene no longer had sufficient explanatory power due to the immense effects that human beings were having on the planet ([Irvine 2020](#)). The Anthropocene's capacity to stand in as a shorthand for widespread ecological destruction resulted in the term's growing popularity both within and outside the scientific community. In the sciences, humanities and social sciences the concept has been widely utilised and critiqued. Some scholars have suggested alternative namings, to highlight the unevenness of the actors that have created these vast global changes. Suggested terms have included the Capitalocene and the Plantationocene (see [Haraway 2015](#) for the genealogy of these terms) and, pertinent for this article, the Plasticene ([Haram et al. 2020](#)).

Other parts of the debate, particularly within stratigraphy itself, have centred around the appropriate timeline for demarking the Anthropocene. In order to identify whether or not it should be officially included as part of the International Chronostratigraphic Timechart, twelve geologists formed a panel tasked with considering the scientific data in 2009 ([Irvine 2020](#): 11–12). As the Timechart is a diagram, with illustrated dates, discussions have centred around the specific markers that could indicate the start of the epoch. Whilst some scholars have favoured dates such as the start of the industrial revolution ([Crutzen and Stoermer 2000](#)) or the colonisation of the Americas or a later ban on nuclear weapons testing (both suggested as potential markers by [Lewis and Maslin 2015](#)), 1952 was selected as the most promising of the dates. This was the moment when hydrogen bomb experiments left residual plutonium markers in the sediment of Crawford Lake in Ontario, Canada. Choosing the early 1950s also places the start of the Anthropocene at the beginning of a period of expanding ecological destruction characterised by the rapid increase in deforestation, pollution, biodiversity loss, climatic changes, urbanisation and consumption (labelled by some as the 'Great Acceleration': see [Morton 2013](#), [Steffen et al. 2015](#)).

In early 2024, the twelve geologists who were given the task of identifying the start of the epoch voted against 1952 as the definitive date to mark the commencement of the Anthropocene ([Witze 2024](#)). Following fifteen years of debate, the vote defeated efforts by some within the geological scientific community to agree on a specified date and marker that could pictorially be included in the Timechart. The very attempt to mark an epochal shift by a single year is indicative of the kinds of timelines that some scientists are working with (see [Irvine 2020](#)). Whilst accepting that markers in the stratigraphic record should play a role in the identification of the Anthropocene, some scientists have challenged the idea that a single date or marker should herald the

start of the new epoch. They argue that, rather than having arrived all at once in a clearly recorded stratigraphic moment, the Anthropocene epoch could be seen in diachronic rather than synchronic ways. This diachronic approach, as Ruddiman et al. argue (2015), would enable scholars to discuss the multiple ways in which anthropogenic activities are affecting the planet, looking at emergent processes rather than fixating on a particular date or activity to indicate the shift (see also Edgeworth et al. 2023).

Plastics have become so prolific in volume and widespread in their presence that they are now notable in the stratigraphic layers of the Earth. They are visible within soils and sedimentary deposits on the ocean floor (Zalasiewicz et al. 2016). In spite of the difficulties in identifying a clear marker to indicate the shift from the Holocene to the Anthropocene, as described above, some scientists have argued that plastics could be a potential marker of the Anthropocene or even of a 'Plasticene' (Corcoran et al. 2014, Haram et al. 2020, Zalasiewicz et al. 2016). Yet, unlike some of the other suggested stratigraphic markers, plastics don't seem to want to stay in their own epoch. Recent findings by Dimante-Deimantovica and colleagues (2024) demonstrate that, due to the ways that microplastics move, they can migrate and infuse sedimentary layers from previous eras. They found that in sedimentary samples from the three lakes that they studied in Latvia the presence of microplastics within the soil sediment was not time-synchronous with their usage and discard. In other words, the microplastics they found did not necessarily correlate with the date of their depositing, with some small, narrow particles migrating to previous layers of sediment that pre-date the widespread industrial expansion of plastic production in the 1950s (Dimante-Deimantovica et al. 2024). This capacity of plastics to shimmy down to earlier stratigraphic layers and thereby infuse (and confuse) the past, complicates the very notion of the Anthropocene. The widescale industrial generation of a material so prolific that it is found in every part of the planet not only leaves markers for its discovery to the future, but also unravels the very ways that scientists engage the past. Plastics, though created by presentist and progressive ambitions, do not conform to linear timelines. They slip, they shimmy and they suffuse.

As Jo explained to me during a longer interview in 2023: 'we're not ... in the future, going to uncover the kind of artefacts that archaeologists have been uncovering from the past, it is going to be masses and masses and masses of plastics.' What kinds of ouroboros stories will this ever-new material tell? Ones that, interrupting, slip both ways through stratigraphic layering, foretelling their own invention and long outlasting their final use? What novel, stubborn, yet unstable set of industrially manufactured entities do we leave to the past, the present and the future?

## CONCLUSION

On another visit to Greta beach in middle of 2024, I approached and chatted with some visitors eating lunch before they got ready to do a beach clean. It's the dry season on Christmas Island and the waves are visually saturated with endless fragments of plastics, ranging in size. The beach has recently had a cleanup, yet it is already covered, once again, in bottle caps, Styrofoam, fishing ropes and other plastic detritus. They joke that they thought it would be nice to go down to Greta and eat lunch while they 'witness the apocalypse'. Plastics, in their affordances and in their implication in ecological catastrophe, are one of the defining materials of the contemporary era. Along with leaving incalculable problems for the future, they have begun actively infusing the past. Generated from disinterred materials from deep time, they seem to be unwilling, once loose, to conform to the narrow time horizons of the people who have created them and who try their best to control them. They have been made by people, yet they refuse to do what they are told.

In this way, plastics are iconic of the Anthropocene as envisaged by the late Bruno Latour. It is the very recalcitrance of this industrially-produced material – busy even now infusing itself sardonically into the past – to be temporally arrested, which, rather than discounting it as a marker of the Anthropocene, makes it a perfect candidate for understanding this new epoch. As Latour wrote of the Anthropocene (2014), accepting the full gravity of the meaning of the term implies that the human–nature dichotomy is forever lost. Embedded within the Anthropocene idea is the awareness that there is no longer a possibility of an 'away' on Earth, no longer a place untouched by the activities of humanity. In its best light, the Anthropocene can contain a kernel of the realisation that people have at once had a profound impact on the planet, and cannot control the outcomes of their activities (Latour 2014). Could plastics be the defining non-marker of an Anthropocene that undoes even its own delineation? A material distinctive and pervasive, and completely out of control. A material created by a small number of people who profit inordinately from its ubiquity, and attendant damage (Abrahms-Kavunenko 2023). A material which, even as it instantiates a radical form of presentism and in its use obfuscates its own past, infuses and alters the very past it's made to obscure. And as it leaves its mark in unknown ways for the future of multicellular life (Davis, 2022) is it not the ultimate exemplar of a troubling present? Of an Anthropocene with no beginning, and no end.

## ACKNOWLEDGEMENTS

I would like to thank the wonderful friends that I have made on Christmas Island, without whom this paper



could not have been written. Thanks to the Freiburg Institute for Advanced Studies and to the *inherit. heritage in transformation* project at Humboldt University, during whose fellowships drafts of this article were written. I very much appreciate the feedback that I have received at the conferences and workshops where I have presented some of the ideas from this work, especially the *Objects. Between Absorption and Isolation* symposium at the Kunsthistorisches Institut in Florenz. Thanks, as always, to Shultz Abrahms-Kavunenko for his editorial suggestions and for his insights throughout, including during fieldwork on Christmas Island. I received funding for fieldwork from the Freiburg Institute for Advanced Studies and from the Velux Fonden grant number 34934 as part of the WASTE project at the Centre for Contemporary Buddhist Studies, the University of Copenhagen.

## REFERENCES

- Abrahms-Kavunenko, Saskia. 2023. 'Toward an anthropology of plastics'. *Journal of Material Culture* 28 (1): 3–23. <https://doi.org/10.1177/13591835211066808>
- Abrahms-Kavunenko, Saskia. 2022. 'Zombie waste, mummy materiality: The undead and the fate of Mongolian Buddhist waste'. In Trine Brox and Elizabeth Williams-Oerberg (eds), *Buddhism and Waste: The Excess, Discard, and Afterlife of Buddhist Consumption*. New York: Bloomsbury Publishing. p. 145–66. <https://doi.org/10.5040/9781350195561.0012>
- Abrahms-Kavunenko, Saskia and Trine Brox. 2022. 'Plastic Asia: Material ambiguities and cultural imaginaries'. *Copenhagen Journal of Asian Studies* 4 (1). <https://doi.org/10.22439/cjas.v40i1.6554>
- Amato-Lourenço, Luís, Regiani Carvalho-Oliveira, Gabriel Ribeiro Júnior, Luciana dos Santos Galvão, Rômulo Ando and Thais Mauad. 2021. 'Presence of airborne microplastics in human lung tissue'. *Journal of Hazardous Materials* 416: 126124. <https://doi.org/10.1016/j.jhazmat.2021.126124>
- American Anthropological Association. 2012. *Code of Ethics*. <https://americananthro.org/about/policies/statement-on-ethics/> (accessed 2 July 2025).
- Barthes, R. 1972 [1957]. *Mythologies*. Trans. Levers Annett. New York: Hill and Wang.
- Bauer, A., M. Jesús, M. Ramos, A. Lozano and A. Fernández-Alba. 2019. 'Identification of unexpected chemical contaminants in baby food coming from plastic packaging migration by high resolution mass spectrometry'. *Food Chemistry* 295: 274–88. <https://doi.org/10.1016/j.foodchem.2019.05.105>
- Bauman B. 2019. 'How plastics contribute to climate change'. *Yale Climate Connections*. <https://yaleclimateconnections.org/2019/08/how-plastics-contribute-to-climate-change/> (accessed 10 October 2020).
- Bergmann, M., F. Collard, J. Fabres, G. Gabrielsen, J. Provencher, M. Rochman, E. van Seville and M. Tekman. 2022. 'Plastic pollution in the Arctic'. *Nature Reviews* 3 (May): 323–37. <https://doi.org/10.1038/s43017-022-00279-8>
- Bhutia, Kalang Dorjee. 2022. 'Can pollution bring balance to the hidden land? Fibreglass interventions in the ecology of Sikkimese Cham'. *The Copenhagen Journal of Asian Studies* 40 (1). <https://doi.org/10.22439/cjas.v40i1.6558>
- Bredenbröker, Isabel. 2024a. *Rest in Plastic: Death, Time and Synthetic Materials in a Ghanaian Ewe Community*. New York, Oxford: Berghahn. <https://doi.org/10.1515/9781805395058>
- Bredenbröker, Isabel. 2024b. "Plastic stays beautiful": Attributing temporal and moral qualities in Ghanaian Ewe funerary contexts'. *Journal of Material Culture* 29 (2): 227–45. <https://doi.org/10.1177/13591835241248342>
- Brox, Trine. 2022. 'Plastic skinscapes in Tibetan Buddhism'. *The Copenhagen Journal of Asian Studies* 40 (1). <https://doi.org/10.22439/cjas.v40i1.6557>
- Chao, Sophie. 2019. 'The plastic cassowary: Problematic "pets" in West Papua'. *Ethnos* 85 (5): 828–48. <https://doi.org/10.1080/00141844.2018.1502798>
- Chia, R.W., J.Y. Lee and H. Kim. 2021. 'Microplastic pollution in soil and groundwater: A review'. *Environmental Chemistry Letters* 19: 4211–24. <https://doi.org/10.1007/s10311-021-01297-6>
- Corcoran, Patricia L., Charles J. Moore and Kelly Jazvac. 2014. 'An anthropogenic marker horizon in the future rock record'. *GSA Today* 24: 4–8. <https://doi.org/10.1130/GSAT-G198A.1>
- Crutzen, P.J. and E.F. Stoermer. 2000. 'The Anthropocene'. *Global Change Newsletter* 41: 17–18.
- Cyvin, Jakob Bonnevie, Hildw Ervik, Anne Aasen Kveberg and Christina Hellevik. 2021. 'Macroplastic in soil and peat. A case study from the remote islands of Mausund and Froan landscape conservation area, Norway; implications for coastal cleanups and biodiversity'. *Science of the Total Environment* 787 (147547): 1–9. <https://doi.org/10.1016/j.scitotenv.2021.147547>
- Davis, Heather. 2022. *Plastic Matter*. Durham: Duke University Press.
- Davis, Heather. 2015. 'Toxic progeny: The plastisphere and other queer futures'. *philoSOPHIA* 5 (2): 231–50. <https://doi.org/10.1353/phi.2015.a608469>
- De Wolff, Kim. 2017. 'Plastic naturecultures: Multispecies ethnography and the dangers of separating living from nonliving bodies'. *Body and Society* 23 (2): 23–47. <https://doi.org/10.1177/1357034X17715074>
- Dimante-Deimantovica, I., S. Saarni, M. Barone, N. Buhhalko, N. Stivrins, N. Suhareva, W. Tylmann, A. Vianello and J. Vollertsen. 2024. 'Downward migrating microplastics in lake sediments are a tricky indicator for the onset of the Anthropocene'. *Science Advances* 10 (8136): 1–10. <https://doi.org/10.1126/sciadv.adi8136>
- Edgeworth, Matthew, Phillip Gibbard, Michael Walker, Dorothy Merritts, Stanley Finney and Mark Maslin. 2023. 'The stratigraphic basis of the Anthropocene event'. *Quaternary Science Advances* 11: 100088. <https://doi.org/10.1016/j.qsa.2023.100088>
- Fache, Elodie, Marie Toussaint, Ahamada Saïd Djahere, Fereta Rodin Manjaka, Angela Fabiola Randrianomenjanahary and Espérant Flaubert Veriza. 2024. 'Suivre les bidons jaunes à Toliara, ville du Sud-Ouest de Madagascar: Contribution Exploratoire au Développement d'une Écologie Globale des Plastiques'. *Natures Sciences Sociétés* 32 (3). <https://doi.org/10.1051/nss/2024051>
- Gerhardt, Christina. 2021. 'Plastiglomerate: Plastics, geology, and the New Materialism of the Anthropocene'. In Trish Farrelly, Sy Taffel and Ian Shaw (eds), *Plastic Legacies: Pollution, Persistence and Politics*. Edmonton: Au Press. pp. 103–16.
- Gupta-Nigam, A. 2020. 'Plastic flowers: Overlooking resource scarcity in postwar America'. *Theory, Culture and Society* 37 (6): 111–33. <https://doi.org/10.1177/0263276420917468>



- Haram, Linsey E., James T. Carlton, Gregory M. Ruiz and Nikolai A. Maximenko. 2020. 'A Plasticene lexicon'. *Marine Pollution Bulletin* 150 (110714): 1–4. <https://doi.org/10.1016/j.marpolbul.2019.110714>
- Haraway, Donna. 2015. 'Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making kin'. *Environmental Humanities* 6: 159–65. <https://doi.org/10.1215/22011919-3615934>
- Hawkins, Gay. 2018. 'Plastic and presentism: The time of disposability'. *Journal of Contemporary Archaeology* 5 (1): 91–102. <https://doi.org/10.1558/jca.33291>
- Hawkins, Gay. 2013. 'The performativity of food packaging: Market devices, waste crisis and recycling'. *The Sociological Review* 69 (2): 66–83. <https://doi.org/10.1111/1467-954X.12038>
- Holmes-Tagchungdarpa, Amy. 2023. 'Preserving offerings, prolonging merit: Efficacy, skillful means, and re-purposing in plastic Buddhist material culture in contemporary Sikkim'. *Worldwide Waste: Journal of Interdisciplinary Studies* 6 (1): 1–11. <https://doi.org/10.5334/wwwj.96>
- Irvine, Richard. 2020. *An Anthropology of Deep Time: Geological Temporality and Social Life*. Cambridge: Cambridge University Press. <https://doi.org/10.1017/9781108867450>
- Klocker, N., P. Mbenna and C. Gibson. 2018. 'From troublesome materials to fluid technologies: Making and playing with plastic-bag footballs'. *Cultural Geographies* 25 (2): 301–18. <https://doi.org/10.1177/1474474017732979>
- Latkar, Aarti and Gauri Pathak. 2024. 'Plastic pollution, public framings, and plastic burning insights from three Indian towns'. *Economic and Political Weekly* 59 (4): 54–60.
- Latour, Bruno. 2014. 'Agency at the time of the Anthropocene'. *New Literary History* 45 (1): 1–18. <https://doi.org/10.1353/nlh.2014.0003>
- Leslie, H., M. van Velzen, S. Brandsma, A. Vethaak, J. Garcia-Vallejo and M. Lamoree. 2022. 'Discovery and quantification of plastic particle pollution in human blood'. *Environment International* 163 (107199). <https://doi.org/10.1016/j.envint.2022.107199>
- Lewis, Simon and Mark Maslin. 2015. 'Defining the Anthropocene'. *Nature* 519: 171–80. <https://doi.org/10.1038/nature14258>
- Liboiron, Max. 2016. 'Redefining pollution and action: The matter of plastics'. *Journal of Material Culture* 2 (1): 87–110. <https://doi.org/10.1177/1359183515622966>
- Liboiron, Max. 2018. 'How plastic is a function of colonialism'. *Teen Vogue*. <https://www.teenvogue.com/story/how-plastic-is-a-function-of-colonialism> (accessed 29 October 2020).
- McDougall, Debra. 2021. 'Trash and treasure: Pathologies of permanence on the margins of our plastic age.' In G. Hage (ed.) *Decay*. Durham, NC: Duke University Press. pp. 28–36. <https://doi.org/10.1215/9781478022039-003>
- McKay, D. and P. Perez. 2018. 'Plastic masculinity: How everyday objects in plastic suggest that men could be otherwise'. *Journal of Material Culture* 23 (2): 169–86. <https://doi.org/10.1177/1359183517742424>
- McKay, Deirdre, Elyse Stanes, Nicole Githua, Xiaoyu Lei and Simon Dixon. 2020. 'On global plasticity: Framing the global through affective materiality'. *New Global Studies* 14 (3): 307–26. <https://doi.org/10.1515/ngs-2020-0039>
- Meikle J. 1995. *American Plastic: A Cultural History*. New Brunswick and London: Rutgers University Press.
- Meiu G. 2020. 'Panic over plastics: A matter of belonging in Kenya'. *American Anthropologist* 122 (2): 222–35. <https://doi.org/10.1111/aman.13381>
- Monsaingeon, Baptiste. 2017. *Homo Detritus: Critique de la Société du Déchet*. Paris: Seuil.
- Morton, Timothy. 2013. *Hyperobjects: Philosophy and Ecology After the End of the World*. Minneapolis: University of Minneapolis Press.
- Nihart, A.J., M.A. Garcia, E. El Hayek, R. Lui, M. Olewine, J. Kingston, E.F. Castillo, R.R. Gullapalli, T. Howard, B. Bleske, J. Scott, J. Gonzalez-Estrella, J.M. Gross, M. Spilde, N.L. Adolphi, D.F. Gallego, H.S. Jarrell, G. Dvorscak, M.E. Zuluaga-Ruiz, A.B. West and M.J. Campen. 2025. 'Bioaccumulation of microplastics in decedent human brains'. *Nature Medicine* 31: 1114–19. <https://doi.org/10.1038/s41591-024-03453-1>
- O'Brien, S., C. Rauert, F. Ribeiro, E. Okoffo, S. Burrows, J. O'Brien, X.Wang, S. Wright and K. Thomas. 2023. 'There's something in the air: A review of sources, prevalence and behaviour of microplastics in the atmosphere'. *Science of the Total Environment* 874 (162193). <https://doi.org/10.1016/j.scitotenv.2023.162193>
- Pathak, Gauri. 2020. 'Permeable persons and plastic packaging in India: From biomoral substance exchange to chemotoxic transmission'. *Journal of the Royal Anthropological Institute* 26 (4): 751–65. <https://doi.org/10.1111/1467-9655.13365>
- Pathak, Gauri. 2023. "'Plastic pollution" and plastics as pollution in Mumbai, India'. *Ethnos* 81 (1): 167–86. <https://doi.org/10.1080/00141844.2020.1839116>
- Pathak, Gauri, Mark Nichter, Anita Hardon, Eileen Moyer, Aarti Latkar, Joseph Simbaya, Diana Pakasi, Efenita Taqeban and Jessica Love. 2023. 'Plastic pollution and the open burning of plastic wastes'. *Global Environmental Change* 80 (10264): 1–9. <https://doi.org/10.1016/j.gloenvcha.2023.102648>
- Peng, X., M. Chen, S. Chen, S. Dasgupta, H. Xu, K. Ta, M. Du, J. Li, Z. Guo and S. Bai. 2018. 'Microplastics contaminate the deepest part of the world's ocean'. *Geochemical Perspectives Letters* 9: 1–5. <https://doi.org/10.7185/geochemlet.1829>
- Rangel-Buitrago, Nelson, William Neal and Allan Williams. 2022. 'The Plasticene: Time and rocks'. *Marine Pollution Bulletin* 185 (114358): 1–9. <https://doi.org/10.1016/j.marpolbul.2022.114358>
- Reichhardt, Björn and Saskia Abrahms-Kavunenko. 2022. 'Plastic purity and sacred dairy: Microbes, vitality and standardisation in Mongolian dairying'. *The Copenhagen Journal of Asian Studies* 40 (1). <https://doi.org/10.22439/cjas.v40i1.6556>
- Rubin, E. 2008. *Synthetic Socialism: Plastics and Dictatorship in the German Democratic Republic*. Chapel Hill: The University of North Carolina Press.
- Ruddiman, William, Eric Ellis, Jed O'Kaplan and Dorian Fuller. 2015. 'Defining the epoch we live in: Is a formally designated "Anthropocene" a good idea?' *Science* 348 (6230): 38–39. <https://doi.org/10.1126/science.aaa7297>
- Schlehe, Judith and Yulianto Vissia Ita. 2020. 'An anthropology of waste: Morality and social mobilisation in Java'. *Indonesia and the Malay World* 48 (140): 40–59. <https://doi.org/10.1080/13639811.2019.1654225>
- Stager, Curt. 2011. *Deep Future: The Next 100,000 Years of Life on Earth*. New York: Thomas Dunne Books.
- Steffen, Will, Wendy Broadgate, Lisa Deutsch, Owen Gaffney and Cornelia Ludwig. 2015. 'The trajectory of the Anthropocene: The Great Acceleration'. *The Anthropocene Review* 2 (1): 81–98. <https://doi.org/10.1177/2053019614564785>

- Steger, Brigitte.** 2021. "Stingy, stingy, stingy government": Mixed responses to the introduction of the plastic carrier bag levy in Japan'. *Worldwide Waste: Journal of Interdisciplinary Studies* 4 (1): 1–11. <https://doi.org/10.5334/wwwj.76>
- UN Environment Report.** 2018a. Single use plastics: A roadmap for sustainability. United Nations Environment Programme. <https://www.reloopplatform.org/unep-report-on-single-use-plastics/> (accessed October 2020).
- UN Environment Report.** 2018b. Our planet is drowning in plastic pollution. <https://www.unenvironment.org/interactive/beat-plastic-pollution/> (Accessed October 2020).
- UNEP.** 2021. *Drowning in Plastics – Marine Litter and Plastic Waste Vital Graphics*. <https://www.unep.org/resources/report/drowning-plastics-marine-litter-and-plastic-waste-vital-graphics> (accessed 30 September 2023).
- Utami, D.A., L. Reuning, L. Schwark et al.** 2023. 'Plastiglomerates from uncontrolled burning of plastic waste on Indonesian beaches contain high contents of organic pollutants'. *Scientific Reports, Nature* 13 (10383). <https://doi.org/10.1038/s41598-023-37594-z>
- Vogt-Vincent, Noam, April Burt, David Kaplan, Satoshi Mitarai, Lindsay Turnbull and Helen Johnson.** 2023. 'Sources of marine debris for Seychelles and other remote islands in the Western Indian Ocean'. *Marine Pollution Bulletin* 187 (114497): 1–18. <https://doi.org/10.1016/j.marpolbul.2022.114497>
- Westmont, V.C.** 2020. 'Faux materials and aspirational identity: Celluloid combs and working class dreams in the Pennsylvania anthracite region'. *Journal of Material Culture* 25 (1): 93–107. <https://doi.org/10.1177/1359183519858377>
- Wirtz, Kristina.** 2009. 'Hazardous waste: The semiotics of ritual hygiene in Cuban popular religion'. *The Journal of the Royal Anthropological Institute* 15 (3): 476–501. <https://doi.org/10.1111/j.1467-9655.2009.01569.x>
- Witze, Alexandra.** 2024. 'It's final: The Anthropocene is not an epoch, despite protest over vote'. *Nature News*. <https://www.nature.com/articles/d41586-024-00868-1> (Accessed 25 March 2024). <https://doi.org/10.1038/d41586-024-00868-1>
- Wu, Ka-ming.** 2023. 'Sipping tea, plastics performing: Representational and materialist politics of boba tea consumption in contemporary China'. *International Journal of Asian Studies* 20: 353–65. <https://doi.org/10.1017/S1479591422000328>
- Wu, Ka-ming, Chris King-Chi Chan, Sin-Yuk Chan and Ka Wai Yung.** 2023. 'Plastic use in wet markets: A case of place-based sustainability education in Hong Kong'. *The Journal of Sustainability Education*, 27 March.
- Yang, Chun, Stuart Yaniger, Jordan Craig et al.** 2011. 'Most plastic products release estrogenic chemicals: A potential health problem that can be solved'. *Environmental Health Perspectives* 119 (7): 989–96. <https://doi.org/10.1289/ehp.1003220>
- Zalasiewicz, Jan, Colin N. Waters, Juliana A. Ivar do Sul, Patricia L. Corcoran, Anthony D. Barnosky, Alejandro Cearreta, Matt Edgeworth, Agnieszka Gałuszka, Catherine Jeandel, Reinhold Leinfelder, J.R. McNeill, Will Steffen, Colin Summerhayes, Michael Wagemann, Mark Williams, Alexander P. Wolfe and Yasmin Yonan** 2016. 'The geological cycle of plastics and their use as a stratigraphic indicator of the Anthropocene'. *Anthropocene* 13: 4–17. <https://doi.org/10.1016/j.ancene.2016.01.002>
- Zettler, Erik, Tracy Mincer and Linda Amaral-Zettler.** 2013. 'Life in the "plastisphere": Microbial communities on plastic marine debris'. *Environmental Science and Technology* 47 (13). <https://doi.org/10.1021/es401288x>
- Zhang, Q., E.G. Xu, J. Li, Q. Chen, L. Ma, E.Y. Zeng and H. Shi.** 2020. 'A review of microplastics in table salt, drinking water, and air: Direct human exposure'. *Environmental Science & Technology* 54 (7): 3740–51. <https://doi.org/10.1021/acs.est.9b04535>