

Microplastics in the environment: much ado about nothing? A debate

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Abstract

This manuscript documents a debate between the two authors on the issue of microplastics in the environment. It was sparked by a recent viewpoint article published by G. A. Burton in *Environmental Science and Technology* (Burton, 2017). Currently, the text contains only the introduction, which sets the scene for the article. Martin is currently writing the first commentary, which we plan to have online on the 26th of February 2018. Thomas will then follow up with his comment & rebuttal two weeks later.

Introduction

The idea for this slightly unusual article was born from a debate on Twitter. Both of us read the recent viewpoint article by G. Allen Burton, the editor-in-chief of *Environmental Toxicology and Chemistry* (Burton, 2017). In his opinion piece, Burton argues that exposures to microplastics are too low, so they do not represent an environmental risk. As a result, Burton concludes that their investigation could be safely abandoned. We both found Alan's text thought provoking but came to different conclusions.

Basically, Martin perceived Burton's viewpoint as "too simplistic", while Thomas agreed with Burton that the risk of microplastics is overstated. Martin pointed out that our lack of knowledge on the environmental impacts of microplastics warrants further investigation. Thomas argued that – keeping limited resources in mind – other environmental risks are more pressing than microplastics and deserve our attention. We both agreed that our disciplines are not really good at prioritizing risks and that scientists are too often hunting for the "next big thing" are a result of perverse incentives in academia. The complete Twitter conversation is provided in the supporting information (SI).

However, Twitter quickly proved to be too clumsy for a decent debate. So, we decided to continue the conversation in a format that is more suitable for an exchange of real arguments and viewpoints. This paper documents our conversation, statement by statement.

Our setup for the debate was as follows:

- 1) An initial statement from Martin.
- 2) Comment/rebuttal from Thomas.
- 3) Re-rebuttal by Martin.
- 4) Re-rebuttal by Thomas.
- 5) Final statement by Martin and Thomas, written independently and in parallel by each author.

Each statement is allowed a maximum length of 1000 words and 10 references. A figure counts as 200 words. We will amend/have amended this debate article successively with each new piece of text, making use of the fact that a preprint can be updated. The final comments will be written in parallel by both authors, on the basis of the first four statements.

This paper is, therefore, certainly not a classical peer-reviewed scientific article or review paper. Instead, it is a debate that reflects our individual perspectives, value judgments and scientific backgrounds. The text is initially published as a PeerJ preprint, which allows readers to post comments. We welcome any and all feedback and hope our conversation adds to a broader discourse on the environmental relevance of microplastics.

Soul-searching on microplastics: Lost in translation, prioritization and communication?

Martin Wagner

By taking an extreme stance (microplastics = no risk), Burton's polemic (Burton, 2017) forced me to reflect on my position as well as the underlying arguments and motivations. Sometimes, it takes a devil's advocate to move the debate forward and I am grateful to Burton for playing that role. However, the scientific partisanship regarding microplastics is irritating: In one corner, we have Burton's "null risk" camp directly opposing the "all risk" camp (Rochman et al., 2015) in the other. Holding extreme positions on either end of the spectrum is valid when backed by strong arguments. I find these missing on both sides (see SI). For the sake of this discussion, I will, however, focus on less obvious aspects I encountered during my soul-searching.

Lost in translation?

At times, one can get frustrated with sensationalist media reports on (micro)plastics, I give Burton that. The question now is: Does the sensationalism originate in exaggerated scientific publications, as he claims? I believe – for most cases – this is not so. The majority of publications introduce plastic pollution as global problem referring to the massive amounts humankind produces and emits. This is something we all can agree upon. They continue by highlighting its potential biological or ecological impacts leading to the specific research question. Although it may become boring reading this over and over again, nothing is wrong with it as long as we take it for what it is: A hypothesis.

Misinterpreting hypotheses as facts is a translational problem we often encounter in risk communication. Journalists sometimes fall for that fallacy ("microplastics may be toxic" is received as "microplastics are toxic"). Burton does the same when he accuses "fellow scientists" of exaggeration. To test whether this is such misinterpretation, we analyzed the content of microplastics publications in "high-impact" journals. We found most narratives on their impacts to be associated with subjunctive phrasing, i.e., these indeed are hypotheses (Kramm & Völker, unpublished data). Nonetheless, our community can certainly improve in formulating explicit and specific hypotheses to avoid ambiguity. This is something we as authors, reviewers and editors clearly need to work on.

We encounter another translational issue: As toxicologists, we have internalized a very specific risk conception, namely that $\text{risk} = \text{exposure} \times \text{hazard}$. Other disciplines involved in

microplastics research may apply different concepts. For instance, marine biologists often consider microplastics a risk because they are ubiquitous, persistent and ingested by biota. From this perspective, it is imperative to raise the red flag. Is their risk paradigm less valid than ours? I am not so sure anymore, especially since we have little means to assess the long-term ecological consequences of (micro)plastics. We might experience “domain inequality” in the sense that one pieces of disciplinary information cannot be understood without completely different expertise (How to avoid glib interdisciplinarity, 2017). To solve the wicked problem of plastic pollution, we need to work interdisciplinary. To work interdisciplinary, we need to overcome this inequality and develop a mutual risk understanding.

Attention deficit syndrome?

Colleagues often banter about the massive attention microplastics receive, both, inside and outside academia. Rather than culturing professional jealousy, they may worry that the “microplastics hype” withdraws attention and consequently resources from more relevant issues. Although I am not aware that microplastics drain for instance global warming science, this concern reveals a fundamental issue: A system in which researchers vigorously compete for resources produces a range perverse incentives (Edwards & Roy, 2017). One of the unintended results is that such system rewards those that exaggerate environmental risks. This can even turn into scientific fraud as the recent #perchgate episode painfully demonstrated (Enserink, 2017).

In that sense, we have built a system in which environmental issues compete against each other for attention. This conflict is amplified when it enters the 24/7 news cycle, which favors doomsday communication. Today, microplastics may have won the competition. Tomorrow, there will be another champion (glyphosate, NO_x etc.). Is this an academic problem? It becomes one once decision makers allocate research dollars according to news coverage. However, we cannot blame others. The root of the problem is rather that the community has no adequate tools to prioritize environmental issues and reach consensus on their relevance. This may be due to the skepticism inherent in the scientific endeavor, disciplinary echo chambers or academic inertia.

In any case, our inability to prioritize diminishes the impact of our science on societies and political decisions. If science cannot decide, societies will decide without science; as the microplastics case illustrates (Kramm et al., 2018). If we want our voices to be heard, we should learn from global warming science and instate an Intergovernmental Panel on Chemical Pollution (Scheringer, 2007) or on Plastic Pollution (IPPP) for that matter. Such bodies could identify priority pollutants, assess the state of the science and propose research agendas from a multidisciplinary perspective. This would foster building scientific consensus and communicating environmental issues.

Communicating the right thing in the wrong way?

The aspect I most struggle with is Burton's claim that science has "adversely influenced" political decisions on microplastics. To me, it is obvious that the way we currently produce and use plastics is not only unsustainable but plainly silly. The public debate on microplastics helped exposing the many shortcomings of our linear economy, raised public awareness and generated positive momentum for change. The European Union's Strategy for Plastics in a Circular Economy is one example of this (European Commission, 2018).

Even if the environmental risks of microplastics were low, would we do wrong in promoting a more sustainable use of plastic materials? I do not think so. However, I believe the current narrative we use to legitimize such change is inadequate (see Tab. S2). It mainly builds on the hypothesized risks of microplastics to wildlife and humans health and often ignores context and uncertainty (Rist et al., 2018). More importantly, a narrative based solely on toxicity neglects other important aspects regarding the societal and economic implications. I believe, we need a new narrative on (micro)plastic pollution that covers all these factors.

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References

- Burton Jr, G.A. (2017) Stressor Exposures Determine Risk: So, Why Do Fellow Scientists Continue To Focus on Superficial Microplastics Risk? *Environ. Sci. Technol.* 51, 13515–13516, <http://dx.doi.org/10.1021/acs.est.7b05463>
- Edwards, M. A. and Roy, S. (2017) Academic Research in the 21st Century: Maintaining Scientific Integrity in a Climate of Perverse Incentives and Hypercompetition. *Environ. Eng. Sci.* 34(1): 51-61, <http://dx.doi.org/10.1089/ees.2016.0223>
- Enserink, M. (2017) Swedish plastics study fabricated, panel finds. *Science* 358(6369): 1367, <http://dx.doi.org/10.1126/science.358.6369.1367>
- European Commission (2018) A European strategy for plastics in a circular economy. <http://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf> (accessed Feb. 26, 2018)
- How to avoid glib interdisciplinarity (2017), *Nature* 552, 148, <http://dx.doi.org/10.1038/d41586-017-08465-1> (accessed Feb. 26, 2018)
- Kramm, J., Völker, C. and Wagner, M. (2018) Superficial or substantial: Why care about microplastics in the Anthropocene? *Environ. Sci. Technol.* (accepted)
- Rist, S., Carney Almroth B., Hartmann, N. B. and Karlsson, T. M. (2018) A critical perspective on early communications concerning human health aspects of microplastics. *Sci Total Environ* 626: 720-726, <http://dx.doi.org/10.1016/j.scitotenv.2018.01.092>
- Rochman, C. M., Kross, S. M., Armstrong, J. B., Bogan, M. T., Darling, E. S., Green, S. J., Smyth, A. R. and Veríssimo, D. (2015) Scientific evidence supports a ban on microbeads. *Environ. Sci. Technol.* 49, 10759–10761, <http://dx.doi.org/10.1021/acs.est.5b05043>
- Scheringer, M. (2007) Towards an intergovernmental panel on chemical pollution (IPCP). *Chemosphere* 67(9): 1682-1683, <http://dx.doi.org/10.1016/j.chemosphere.2006.11.023>