Jonathann Yukio Arakaki, Fernando Rafael De Grande, Alexandre Luiz Arvigo, Juan Carlos Farias Pardo, Bruno Rafael Fogo, Fábio H.C. Sanches, Caio Akira Miyai, Murilo Zanetti Marochi, Tânia Marcia Costa. Battle of the borders: Is a range-extending fiddler crab affecting the spatial niche of a congener species? Journal of Experimental Marine Biology and Ecology. Volume 532, 2020, 151445, 0022-0981.

The article has been published in final form by Elsevier at
https://doi.org/10.1016/j.jembe.2020.151445

Jennifer F. Provencher, Garth A. Covernton, Rhiannon C. Moore, Dorothy A.Horn, Jeremy L. Conkle, Amy L. Lusher. Proceed with caution: The need to raise the publication bar for microplastics research. Science of The Total Environment.
Volume 748, 15 December 2020, 141426.

The article has been published in final form by Elsevier at
https://doi.org/10.1016/j.scitotenv.2020.141426

Proceed with caution: the need to raise the publication bar for microplastics research

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Abstract

Plastic is a ubiquitous contaminant of the Anthropocene. The highly diverse nature of microplastic pollution means it is not a single contaminant, but a suite of chemicals that include a range of polymers, particle sizes, colours, morphologies, and associated contaminants. Microplastics research has rapidly expanded in recent years and has led to an overwhelming consideration in the peer-reviewed literature. While there have been multiple calls for standardization and harmonization of the research methods used to study microplastics in the environment, the complexities of this emerging field have led to an exploration of many methods and tools. While different research questions require different methods, making standardization often impractical, it remains import to harmonize the outputs of these various methodologies. We argue here that in addition to harmonized methods and quality assurance practices, journals, editors and reviewers must also be more proactive in ensuring that scientific papers have clear, repeatable methods, and contribute to a constructive and factual discourse on plastic pollution. This includes carefully considering the quality of the manuscript submissions and how they fit into the larger field of research. While comparability and reproducibility is critical in all fields, we argue that this is of utmost importance in microplastics research as policy around plastic pollution is being developed in real time alongside this evolving scientific field, necessitating the need for rigorous examination of the science being published.

Keywords – plastic pollution, environmental contaminants, standardization, harmonization, peer-review

1. Introduction

Plastic pollution, because of its prevalence and persistence, is a defining pollutant of the Anthropocene. Plastic pollution, including microplastic, has been found from the Antarctic to the Arctic, and from urban landscapes to the deep sea (Cincinelli et al., 2017; Dris et al., 2015; Tekman et al., 2017; Woodall et al., 2014). Microplastics are most commonly defined as plastic particles >1 µm and < 5 or 1 mm along their largest dimension (Hartmann et al., 2019; UNEP, 2014). We will use the < 5 mm definition for our consideration of microplastics as this will include much of the literature. The number of peer-reviewed publications on microplastics has rapidly increased over the past decade (Cunningham and Sigwart, 2019), with studies finding microplastics across nearly all environmental systems (Guven et al., 2018), as well as in human food and beverages (Cox et al., 2019; Hernandez et al., 2019). While aquatic systems continue to be the most studied systems in terms of microplastics, studies in terrestrial systems are limited (de Souza Machado et al., 2018; Provencher et al., 2019; Rillig and Lehmann, 2020). The implications of microplastics in the environment, however are not clear, with some studies suggesting negative impacts to organisms, such as decreased growth rates, increased levels of contaminants, and deformities (Haegerbaeumer et al., 2019; Jeong and Choi, 2019), while others find neutral outcomes (Canniff and Hoang, 2018; Foley et al., 2018). This reported variability highlights the nature of microplastics as a diverse contaminant suite, with a range of polymers, particle sizes, colors, morphologies, and associated contaminants (Rochman et al., 2019). Coupled with the fact that microplastics often occur in patchy concentrations with complex mixtures of particle types, it is currently difficult to determine the ecological risk presented by microplastics in the environment (VKM et al., 2019). While further research is undoubtedly required, it is imperative that this research is rigorously reviewed and vetted before publication to ensure reproducibility and applicability in the field, as well as appropriate interpretation by the non-scientist public.

The exponential increase in microplastic research and publications has generated attention by the media, NGOs, policy and decision makers and the public, leading to a growing number of strategies and policies to address plastic pollution (Connors et al., 2017). This has resulted in plastic pollution being recognized as a globally important contaminant by the United Nations Environment Program (UNEP), as a threat to biodiversity by the Convention on Biological Diversity (CBD), and as an emerging pollutant by the Arctic Council (AMAP, 2017; UNEP, 2014). This global recognition of the scale and potential impacts of plastic pollution is resulting in increased calls for research by regional and national funding bodies. For example, Canada has recently stated its intentions to create a regulatory framework for plastics by declaring them to be a toxic substance (ECCC, 2020, 2019). Because of this attention, microplastics research must continue, but evolve to answer major questions about environmental and toxicological impacts.

Early microplastics research focused primarily on its environmental presence, especially in the marine environment and marine biota. This work was vital to establishing the extent of contamination and was critical to the foundation of our understanding of microplastics in the environment. Early microplastics studies could only hypothesize about the potential impacts of microplastics on environmental health, such as the potential accumulation of particles in food webs and by concentrating pollutants from the environment (Cole et al., 2011; Teuten et al., 2007). In some cases, these hypotheses are stated as facts by both popular media and scientific experts despite a lack of rigorous evidence, such as microplastic accumulation and magnification in food webs, or conflicting evidence and ongoing debate, as in the case of the complexities associated with the bioavailability and toxicity of polymers, monomers, additives, and sorbed chemicals associated with microplastics (Rochman et al., 2019). As the field of microplastics has moved beyond 'first time reported' papers, and further develops while continuing to shape policy, it must also be improved through more rigorous vetting by researchers, manuscript reviewers and journal editors.

There is a lack of quality assurance and quality control protocols for microplastics in this developing field (Cowger et al., 2020), but we argue that this also extends into the statements used by authors in their publications in relation to environmental and human health risks. This problem has developed due to the lack of a standard framework to ensure the findings and statements of studies are peer-reviewed in the context of what we know, and what we can know, rather than past unproven speculation. For example, some peer-reviewed studies lack field and laboratory blanks needed to identify the occurrence of sample contamination (VKM et al., 2019). Other studies overstate their conclusions about widespread presence, absence, or effects of microplastics when their experimental design and resulting data do not support such interpretations. This has subsequently resulted in misleading headlines in the press that are accurate based on the language used in the article, but factually inaccurate relative to the data presented. Examples such as this are detrimental to the progress and reputation of microplastics research, and can negatively impact the credibility of the microplastics research field.

Our knowledge of environmental impacts is further limited by variation in research methods and quality of reporting that have been adapted for a variety of research questions, yet often lack harmonization and comparable outputs (Brander et al., 2011; Hermsen et al., 2018; Renner et al., 2018). With rapid growth in this field generating a variety of methods, it is imperative that robust quality assurance/quality control and reporting criteria are included with each newly published study (Cowger et al., 2020; Dehaut et al., 2019). Microplastic researchers must continue to explore techniques and tools to quantify microplastics in the environment and answer a range of questions, but as this field evolves the rigor of research and the manuscript review process must improve with it. This requires that researchers, co-authors, manuscript reviewers, and editors are aware of the ongoing evolution of this research field and are also willing to hold each other accountable to the most recent advances that ensure only scientifically sound research is published. In addition, when editors are not knowledgeable, editors must ensure that a manuscript is allocated to a knowledgeable person who is familiar with the current field, can make hold authors to the standards of the field. Some examples would be requirements for the use of standard nomenclature, method validation, contamination control, inclusion of standard protocols (if available), thorough reporting of all methods and techniques used, and clear and explicit discussion of the studies limitations (Cowger et al., 2020). Importantly, given the public interest, press, and rapid growth of policies based on published science, authors, peer-reviewers and editors must ensure that the language, especially in titles and abstracts, accurately reflects the work done, data generated and the broader literature in this field. Collectively, as a field of researchers, reviewers, editors, and publishers, we must lift the entire field to ensure that sound science is available to inform decision makers on plastic pollution policy. This paper provides recommendations to guide and improve the review and publication process for microplastic pollution research.

2. Words matter

While standardized methodology may not be necessary for the harmonization of microplastics research, standardization of reporting and terminology is essential. For every emerging field the development of suitable, common nomenclatures is critical in order to promote constructive and productive scientific discourse. Clear, accurate, consistent, and specific language is essential in science. Firstly, for the work to be interpreted correctly by those in the field who are looking to test the ideas presented and build on the work published

(Hartmann et al., 2019). Secondly, for non-expert readers who are trying to expand the work on microplastics to other biota or compartments. And lastly, for scientific papers to be interpreted correctly by non-researchers such as policy makers and the media who are often tasked with summarising complex science findings in only a few lines.

There have been many discussions by experts over the last few years about microplastic terminology relating to size classes (Hartmann et al., 2019) and microplastics (GESAMP, 2019). Given the legislated definition of microplastics in some regions, and the ongoing discussion about the size classes, it is imperative when researching microplastics that manuscripts define microplastics, explicitly stating numeric size classes. This enables the media, and more importantly researchers, to integrate and synthesize data from a variety of studies across disciplines and publishing eras - regardless of the terms used for plastic pollution.

As the field currently lacks standardized definitions, studies should clearly define all terms that they use that could be misinterpreted by readers less familiar with the field. Recently, there have been calls for applying a more ecotoxicological framework of terminology when referring to plastic pollution in biota (Provencher et al., 2019). This includes the difference between the intake (ingestion) of microplastics, and the accumulation (when ingestion exceeds the rate of excretion) of microplastics. Furthermore, while plastic pollution has been shown to accumulate in the gastro-intestinal tract of animals, there is little evidence to date demonstrating that the most commonly measured sizes of microplastics (>100 µm) accumulate in the tissues of animals as traditionally defined by ecotoxicology. Therefore, additional terms or qualifiers may need to be established traditional toxicological frameworks to account for accumulation in different compartments of the body (Lusher et al., 2017; Provencher et al., 2019). Synchronization and consistent terminology use are essential to compiling the most robust data available on microplastics; therefore, authors, editors and reviewers must critically assess manuscript submissions to ensure accurate reporting so that results can be meaningfully interpreted in the correct context.

Most importantly, studies must explicitly report all the details of the methodologies they have used and clearly present any limitations (Dehaut et al., 2019; Hermsen et al., 2018). These limitations should also be evident in the titles and abstracts of published studies, such as the size range and types of particles detected by the study. For example, reporting that no plastics are found in an organism or habitat is very different from reporting no plastics over a certain size (i.e. > 50 µm or > 425 µm). While these differences can be difficult to state clearly in a title, the abstract of a paper should be as specific as possible so that even those skimming the abstract do not come away with the wrong conclusions (i.e. Bourdages et al., 2019). Another avenue that should be taken with caution for microplastics research is the use of beach survey data, and other data sets collected by volunteers. While we are supportive of citizen science, and the strength of citizen science has a very strong place in plastic pollution science, the role of citizen science in microplastic research needs to be critically considered. The limitations for citizen science need to be recognized as cross-contamination of samples for microplastics < 1mm is common and occurs easily (Connors et al., 2017; Hermsen et al., 2018).

These issues of language and reporting presented above may seem pedantic, but they are important to the integrity of the field, and the fast-evolving policies that are drawing on the published research. Global policy makers are looking to researchers to answer health related questions regarding microplastics, and we must have reliable data to answer with. Given that sampling in remote areas, such as the polar regions, is extremely difficult and repeat sampling may not occur for almost a decade in these regions (i.e. Baak et al., 2020; Poon et al., 2017; Provencher et al., 2009), it is extra critical that rigorous protocols, reporting and terminology are used.

3. Quality matters

In a growing field such as that of microplastics, there is a need to balance novelty and innovation in methodology against accessibility to a wide diversity of traditional and citizen scientists, and at the same time meet a necessary standard of reporting, reproducibility and quality of methodology. According to a recent assessment by the Norwegian Scientific Committee for Food and Environment (VKM et al., 2019), which reviewed the state of knowledge on microplastics (less than 1mm), in relation to environmental and human health (n = 171 publications from 33 journals from 2016 to 2018), a large proportion (60%) of the scientific microplastic papers in the peer-reviewed literature were not of sufficient quality to include in the data analysis review. A closer look at the data, specifically related to environmental levels of microplastics revealed that the two most highly cited journals, *Marine Pollution Bulletin* and *Environmental Pollution*, are also responsible for a large proportion of the poor quality publications (both journals had over 30% poor quality publications). Of the 33 journals examined in this review, 12 failed to publish any articles that received acceptable scores (VKM et al., 2019). None of the top three journals with the most publications (*Marine Pollution Bulletin*, *Environmental Pollution, and Science of the Total Environment*) had any publications that ranked excellent quality condition (VKM et al., 2019).

This indicates that there is widespread publication of poor-quality research in the field of microplastics. While some of these exclusions may be due to changes in methodologies as the field has progressed, the number of recent publications excluded, indicate a contemporary lack of rigorous scientific method and protocols being applied (Fig 1). This lack of quality in peer-reviewed microplastic publications is leading to the exclusion of many of these papers from synthesis assessments (VKM et al., 2019), as well as making it difficult to make firm conclusions based on these assessments. While we recognize that the field is emerging, and harmonization is not always going to be possible, the lack of an increase in excellent papers in the last few years is concerning (Fig 1). Given the challenges recognized in science with repeatability and standard reporting it is the synthesis of data from many publications that are the most useful in making evidence-based decisions (Roche et al., 2019). To ensure that peer-reviewed publications meet their full potential in contributing to informing our understanding of microplastics it is critical that microplastic papers are reviewed with a critical eye to methods, findings and conclusions. We discuss each and how they can be improved in publications below.

4. Inter-comparability matters

One of the fundamental needs in the study of any environmental contaminant is the inter-comparability of findings across studies (Cowger et al., 2020). The above examples highlight the confusion related to this that currently exist in the field of microplastics. Moving forward, we suggest that these issues can be solved through a better understanding and application of some key ideas and how they work together, including standardization, harmonization, validation, and optimization.

In general, methods in peer-reviewed publications must first be optimized via development and fine-tuning to make them as effective as possible for the type of sample at hand. These methods assist in producing high quality results but require validation in order to ensure them. For example, methods with KOH have been fine tuned to work with blue mussels (Thiele et al., 2019). A method can be considered validated when there have been sufficient QA/QC procedures implemented to ensure the results generated meet predefined quality criteria. These methods produce high quality data but may be different from other approaches that have been used in the field. For example, with microplastics, methods are tested for extraction efficiencies, and recovery of spiked polymers, the impact on polymers, as well as potential for background contamination (Hurley et al., 2018). Specifically, validation of applied methods must be included in all research outputs. Method validation, such as extraction efficiencies, must be performed for all studies and include a variety of microplastic morphologies and polymers reflecting those previously observed in the target matrix. Variable recovery rates have been reported in the literature (e.g. Hurley et al., 2018; Jung et al., 2018) which may need to be adjusted for in order to prevent false estimation of microplastic quantities

Once methods have been optimized and validated for specific samples types, the gold standard for the study of contaminants would generally require standardization. Standardization refers to the application of certain methods according to robust criteria, with limited flexibility, to allow for comparability between laboratories. This has the significant limitation of restricting the scientific freedom of method development, but is commonly applied for standard analytical procedures, such as the International Organization for Standardization (ISO) and General Laboratory Practices (GLP) ecotoxicological approaches. While the benefits of standardization are clear, we suggest that in its current state, microplastics research does not require, and would in fact be hindered by, standardization, but would rather benefit the most from harmonization.

Harmonization occurs when the methods used by different studies have been rigorously tested to the point that results can be viewed as comparable despite differences in methodologies. In this sense, harmonization is possible through standardization, but standardization is not a requirement. For the case of microplastics, methods -optimized and validated- can be compared to ensure they work the same or in a similar manner in different institutions so that the outcome can be used together more easily. This means that data can be generated across institutions using different, but similar, methods. The limitations of each method are known, comparison coefficients can be defined, and the different activities/data generated can be combined. Importantly, instead of requiring standard methodology, harmonization includes a diverse suite of investigatory techniques, and for reports to be comparable a minimum list of reportable metrics (i.e. size, polymer type, etc.) as well as complete/exact methods reporting must be presented in comparison to other studies.

Examples already exist where harmonization rather than standardization has led to useful information about microplastic contamination of the environment. For example, in the North Sea, the northern fulmar (*Fulmarus glacialis*), a common seabird, is used as a biological indicator of plastic pollution levels in the environment (Provencher et al., 2017). Throughout the North Sea, the Convention for the Protection of the Marine Environment of the North-East Atlantic (the OSPAR Convention) has a standard protocol for the collection and examination of fulmars to track trends in environmental plastic pollution (> 1 mm) in the region (van Franeker et al., 2011). The North Sea protocol is based on beached birds being examined for ingested plastics pollution (van Franeker et al., 2011). Since the early 2000s, the protocol has been applied to regions outside of the OSPAR, but often in regions where beached bird surveys are not possible (Provencher et al., 2017). In regions such as Arctic Canada, collections depend on local Inuit hunters to collect carcasses from local colonies or on fishers submitting fulmar incidentally caught in their nets. While the collection methods are different, researchers in the region have worked with international colleagues to ensure the methods are harmonized and thus can contribute to reporting standardized data that can be compared across the northern hemisphere (Provencher et al., 2017). Similar approaches are now emerging for invertebrates, such as the investigation of 100 sites in the Nordic countries looking at microplastic presence in bivalves (Bråte et al., 2020).

5. Conclusions matter

Alongside the vocabulary of microplastics, there is the terminology of reporting new information. Wording of titles and conclusions also warrant attention in the developing field of microplastics where scientific papers are quickly turned into popular science articles. As in all new fields, there are many reports of ‘firsts’ and areas ‘free from …’. This type of statement is critically important as policies regarding human health and the impacts of microplastics are under review. In a field that is emerging in a time where hundreds of journal articles are released each month, the language of findings should be critically considered. For example, a recent publication declared the offshore surface waters around Antarctica “free of floating microplastics” (Kuklinski et al., 2019). Given that the surface waters of Antarctic consist of thousands of kilometers of ocean encircling the continent and the study only examined 10 sites, declaring the waters “free” of microplastics is misleading at best, and ignores findings of microplastics in the Antarctic by other studies documenting microplastics in the region (Cincinelli et al., 2017; Isobe et al., 2017; Lacerda et al., 2019; Munari et al., 2017; Reed et al., 2018; Waller et al., 2017). A more critical assessment and appropriate terminology would have been to state that given the sampling regime, no floating microplastics were detected using this specific set of techniques and in these locations. While a single study may not detect microplastics over a certain size as dictated by the methods, papers that declare species or areas ‘plastic-free’ can be misleading to policy and decision-makers. It is important to be extremely specific regarding the size range of possible microplastics are detected or not, as the paper above could have easily missed the smaller end of the microplastics size spectrum due to their filtration size.

Concluding statements in microplastics research should also be examined critically as many decision-makers and policymakers are asking for science recommendations in real time - whilst many studies are underway. For example, studies that suggest the use of certain animals as potential bioindicators for microplastic contamination of the environment, despite not measuring any microplastics in the environment as a comparison (Garcia-Garin et al., 2019), studies that report microplastics in the environment or biota but did not use material verification methods or report identification error rates (i.e. Saley et al., 2019; Villagran et al., 2020), and studies that claim to have found bioaccumulation and biomagnification in organisms despite a lack of proof according to ecotoxicological standards (Saley et al., 2019).

6. Reviews matter

A critical component of the peer-review system are the editors and the reviewers that dedicate time reviewing manuscripts to ensure accepted manuscripts contain rigorous research. The review process includes consideration of the most recent literature that relates to a specific topic. Editors should ensure that reviewers are selected who will understand the nuance and pace of change in the field of microplastics, and that journals publish only papers that meet the current standards of the field. This includes seeking reviewers that are active in the field, have experience in reviewing as well as publishing peer-reviewed research, or can be supported by someone who is. Reviewers should conduct thorough reviews and provide feedback to authors on how to improve studies, including pointing to papers that promote harmonized protocols and reporting guidelines. Given widespread reporting of unprofessional comments during reviews (Gerwing et al., 2020), we specifically encourage reviewers to provide critical and constructive reviews, so that authors are encouraged to address comments to improve manuscripts, rather than feeling discouraged. Additionally, to help editors make informed decisions about the rigour of submitted manuscripts, reviewers should also include that information directly in the comments to the editors with references so that the editors can understand the context of comments based on technical developments in the field. This will assist editors with publishing decisions while helping authors meet currently accepted rigor that will improve their papers and citation potential. With the increase in papers in the field of microplastics research there are many manuscripts being submitted for review, but the quality of science should not be compromised by shorting the length of the review period. In this emerging field where outputs are of immediate policy interest, the publication process remains critical. Therefore, we stress that reviewers must perform rigorous reviews, and expect the same in return from their peers. Taken a step further, editors must also consider reviewers comments critically, in most cases senior reviewers will have more current knowledge of the topic than the editor; but this can be clouded by junior less experienced reviewers.

7. Recommendations for raising the microplastic publication bar

While we recognize the research that has led to the prominence of microplastics research today, we propose that in order to produce the most robust science for evidence-based decision-making the level of standards for microplastics must be increased in the peer-reviewed literature. The following recommendations are provided in the context that they will improve the field of research and push us all to deliver high quality science on microplastics which will benefit the field, and the policies derived from the research.

I. **Clear protocols, Quality Assurance/Quality Control and methodological limitations recognized** – As discussed above the use of out-dated methods, lack of quality assured and quality-controlled approaches (or at least documentation to prove otherwise) are an ongoing challenge in the field. While the need to tackle each of these methodological constraints are addressed by other studies (i.e. GESAMP, 2019; Lusher et al., 2017; Provencher et al., 2017), we argue that it is the responsibility of authors, editors and publishers to improve transparency and the overall quality of future published studies. Data should be held in an open-access repository (Cowger et al., 2020). The use of online supplemental material should be considered for details that are not of immediate relevance to the study but are of utmost importance for comparing microplastic results to other studies. Where investigations have been performed prior to the requirement of full QA/QC measures, researchers must be open and address all limitations. Those investigations shouldn't be discouraged but should be clearly communicated.

II. **Critical reviews applied via a reviewer checklist** – As methods and approaches evolve, researchers must also evolve accordingly, rather than following the blueprint in an older paper that used methods now considered substandard. Researchers must work to have an understanding of the key questions within the field, whether they be ecological, toxicological, or hydrodynamic in nature, and ensure that their research plays a role in finding answers to these questions. Reviewers must hold authors accountable to this, and clearly and concretely articulate these concerns to editors. Editors themselves should be familiar with the state of the literature to not waste the time of reviewers when papers clearly do not meet current standards. We propose the use of a microplastics research checklist for authors, editors, and reviewers to help ensure that the best science possible is being considered and passed through the peer-review process (Table 1).

III. **Contextualised hypothesis-driven research questions** – given that microplastics research has been published in some taxa since the 1960s (in fish and seabirds), and more broadly since the 2000s (Andrady, 2017; Cole et al., 2011; Provencher et al., 2017), there is a need for the field as a whole to move towards more hypothesis driven research that is based on prior findings and within the context of the larger study system. While exploratory and opportunistic sampling have built a foundation of microplastics research, there is now a need for hypothesis driven research to generate a deeper understanding of microplastics as a contaminant, and the implications for the environment. Thus, every microplastics paper should now be examined in the context of prior work on microplastics in the region and environmental compartment, and any paper claiming to be the ‘first report’ should be carefully considered before publication. Additionally, baseline sections of journals should be expanded in to accommodate studies that report microplastics in the environment via monitoring programs.

8. Conclusion

We need to continue to encourage and establish rigorous, tested, validated and robust data within the field of microplastics. While we need to foster and support exploratory methods and discovery of techniques and sampling types, because the science on microplastics is being incorporated in real-time into policy by decision-makers, there needs to be extra attention in this field to rigorous review of methods and conclusions. No longer can we publish microplastic papers in silos. We must move microplastics research to the next level to provide the best available evidence for decision and policy makers.

Regardless of the effects, many agree that there are large knowledge gaps in our understanding of microplastics, and that more research is needed on both the fate and effects of microplastics. Therefore, the work must be transparent in the reporting, and include discussions of caveats in the description of the methodologies, so the results are useful to the field. Only then can the scientific community know how to appropriately assess the results in each study, and incorporate them into literature review and meta-analyses. When vague terms are used, methodologies are not reported in detail in the context of other papers in the field, and bold statements are made using terms like ‘free from plastics’, papers are contributing to the confusion of both the researchers in the field, as well as to the non-experts who will interpret results based on the title and abstract of the publication.

In conclusion, we suggest that authors, editors and publishers need to turn a more critical eye to microplastic publications to ensure peer-reviewed publications are producing the best science possible in this time of rapid policy adoption on this emerging environmental issue. Microplastic research now receives significant global attention from the media and policymakers, yet lower quality or out of context research has the potential to discredit the field and limit timely and science-based discussion and mitigation of microplastic contamination of the environment. Microplastics science has a unique opportunity to directly inform policies as they are being developed for the first time in many places. Thus, it is critically important that we balance testing and sharing new ideas with the need for rigorous standardized methods.

Acknowledgements

We are very grateful to all researchers who are publishing on microplastics in the environment and continue to develop methods and understanding of microplastics. We also thank the anonymous reviewers who helped improve the quality of the manuscript.

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TABLES AND FIGURES

Table 1: Critical aspects to address when formulating, reviewing and publishing microplastic research that should be considered by authors, reviewers and editors.

Aspect	**Explanation**
Main claims	- How significant are the claims of the paper? - Does the paper add further information to the understanding of the topic, or are they just another report of occurrence? - Is the chosen journal a suitable option for said claims? - Is this more relevant in a baseline section? - Are first report of microplastics in a species/region considered in context?
Methodological approach	- Are all instruments and materials clearly described with sources of error? - Were methods tested/validated before analysis? - Are the limitations of the approach addressed? - First use of a new technique? - Were replicates used and treated appropriately?
Quality assurance	- Were procedural controls, carried out and treated appropriately? - Were positive controls used to test methods? - How were the field and laboratory blanks dealt with in processing data? - Data adjustments or limits of detection considered?
Terminology	- How are plastic polymers determined? - What size classes are examined and what terminology is used for sizes? - Are microplastics confirmed as polymer or just anthropogenic?
Detection limits	- Are the detection limits clearly defined? - Are the methodological limitations clearly stated in the abstract?
Reporting	- Is data made available? - Is an appropriate analysis carried out?
Understanding of recent literature	- Has enough modern literature been included, or does the manuscript reply heavily on early publications from the research field that are no long state-of-the-art (i.e. protocols which are no longer fit for purpose)? - Are the citations of methods up to date, or explained in the context of why methods are used
Reviewer expertise	- Is the manuscript within your area of expertise? - Do you have enough experience reviewing? - If not, can you work with a mentor to review the manuscript with you and help you develop this skill?

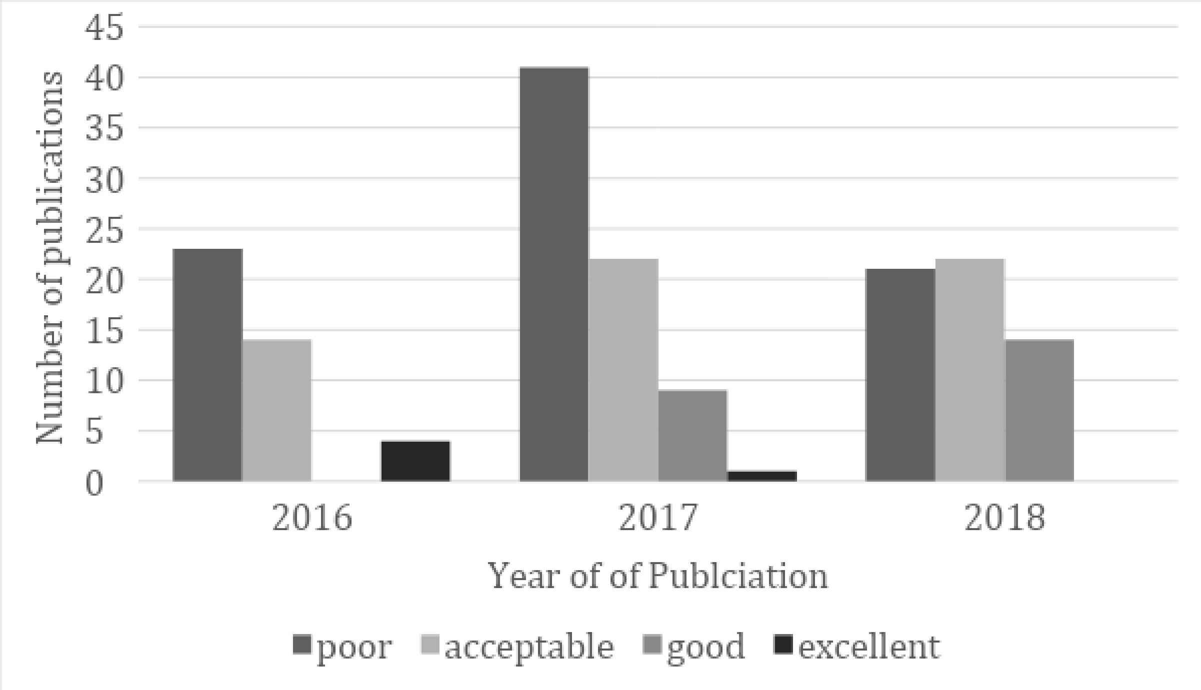

Figure 1 – Rating of the quality of microplastics (poor, acceptable, good, excellent) publications over a three-year period in peer-reviewed journals (source of data VKM 2019).