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Consortium Authorship: Ethical Tensions in Emerging Authorship Practices in Interdisciplinary Collaborative Research

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Abstract
Traditional conceptions of academic authorship, e.g., the seemingly self-evident assumption that an author is someone who actually *writes* a text, is challenged by the complexity, scale, and collaborative nature of scientific research. Authors are expected to make a substantial contribution and to assume accountability for all aspects of the work, but in practice, many individuals listed as authors fail to meet all these criteria, notably in biomedical fields. In view of this tension between norm and practice, new conceptions of authorship have emerged, reflecting the growing importance of team science. This paper assesses whether *consortium authorship* as an emerging practice (also known as 'group authorship' or 'team authorship') offers a viable approach. Besides practical benefits, there is a normative dimension behind this concept, as it aims to acknowledge the importance of collaboration (seeing it as more than the sum of contributions attributable to individuals), but it also raises ethical questions concerning the responsibilities of consortium authors for the text as a whole. We opt for a *case study approach*, zooming in on experiences within a research consortium. Besides a literature review, we analyse the results of a deliberative workshop on consortium authorship and analyse how consortium authorship is currently handled in academic journals, notably in the biomedical field. We argue that consortium authorship works best when used in combination with individual authorship, but also notice that it challenges us to rethink the concept of academic authorship as such, for which we use Donna Haraway's concept of sympoiesis as a starting point.

Keywords Academic authorship · Consortium authorship · Publication ethics · Acknowledgement and reward · Accountability · Microbiology journals · Sympoiesis

Extended author information available on the last page of the article

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Introduction

Problem Statement

The traditional concept of academic authorship, and the seemingly self-evident assumption that an author is someone who actually *writes* a text, is challenged by the expanding complexity and scale of scientific research (Fontanarosa, 2017, p. 2433) and the growing importance of large-scale collaboration, especially in fields requiring large infrastructures such as high energy physics and high throughput biomedical research (Cronin, 2001, p. 556). The emergence and growth of multiple authorship is often associated with big science and large-scale interdisciplinary consortia that use advanced equipment and receive substantial research funding. In 2015, a CERN paper broke the record by listing more than 5,000 authors for a single paper (Castelvecchi, 2015). These developments raise a basic question: What is an author? And, in a more practical vein: *who* should be listed as an author in scholarly publications? According to the recommendations issued by the *International Committee of Medical Journal Editors* (ICMJE), authors should have made a "substantial contribution" to the research, as well as to the process of drafting, reviewing and approving the final version of the text, and should be able to assume accountability for the accuracy and integrity of all aspects of the work (2024, p. 2).[1] Here, however, we are faced with a tension between efforts to uphold and define the concept of authorship, and what actually happens in practice. Many individuals listed as authors in biomedical publications fail to meet all these criteria, for instance, because their contribution to the actual writing process was limited (Cronin, 2001). Meursinge Reynders and colleagues (2024) likewise found that decisions on authorship often fail to live up to these criteria, for instance because senior researchers and lab managers are automatically included in papers without having made a substantial contribution. Notably in biomedical fields, the "death of the author", heralded in French philosophy some decades ago (Foucault 1977, Barthes 1977), has resulted in research practices where authorship no longer implies that all authors are necessarily *writers* in the literal sense.

Emerging Practical Solutions

Against the backdrop of this tension between concept and practice, a "dizzying array of authorship possibilities" has emerged over the past few decades, reflecting the growing importance of team science and concerns regarding appropriate distribution of credit to those who contributed to the research (Fontanarosa, 2017, p. 2437). Some proposed to replace "authors" by listings of "contributors" (Rennie, Yank and Emmanuel, 1997; Biagioli, 2003), but this raises tensions with established mechanisms of academic acknowledgement and reward, which tend to focus on individual performance rather than collaboration, while it also obfuscates how authorship is linked with intellectual property rights (Lissoni & Montobbio, 2015; Lissoni et al., 2013). In this paper we zoom in on another emerging practice, namely *consortium authorship* (also known as 'group authorship' or 'team authorship'), to assess whether consortium authorship (CA) offers a viable alternative, both to the standard model of authorship and to the alternative 'contributor' approach.

[1] International Committee of Medical Journal Editors. Recommendations for the conduct, reporting, editing, and publication of scholarly work in medical journals. https://www.icmje.org/recommendations/, p. 2.

Consortium Authorship: a Viable Solution?

CA attributes authorship credit to a collective of participants (e.g., in an externally funded, multi–centre research endeavour), who are presented as having contributed to the publication and whose names are listed somewhere in the paper, but not as individual authors. CA has a number of benefits. Besides *practical* benefits (as a possible solution to the ambiguities of academic authorship outlined above), there is a *normative* dimension to this concept as well, as it aims to support (and acknowledge the importance of) collaboration and mutual dependence rather than individualism in scientific research practices. Yet, CA also raises ethical questions (Hosseini et al., 2024), for instance when it comes to academic reward mechanisms (often focussed on individual performance indicators) or when consortia involve interdisciplinary collaboration across epistemic communities and research cultures with diverging authorship conventions (e.g., collaborations involving experts from biomedical and life sciences, but also from philosophy and ethics). This paper intends to assess the pros and cons of CA, both on a practical and on a normative level.

Methodology

We opt for a *case study approach*, zooming in on experiences within a particular research consortium devoted to studying the human microbiome. Benefits and caveats of consortium authorship will be analysed in four steps. We start with an overview of conceptual ambiguities entailed in contemporary academic authorship as presented in scholarly discourse (a). This allowed us to present a summary of emerging practical and normative questions concerning CA (b). Subsequently, we organised a deliberative workshop on CA, in which a number of consortium members participated as well as some experts on emerging issues on academic authorship. The results of this deliberative workshop will be presented an analysed (c). Next, to put these results in a broader context, we explored how CA is currently handled in academic journals in the field of microbiology, comparing it with philosophy, and the results of this exercise are presented and analysed as well (d). We conclude that, while technical and research ethical issues can best be addressed by combining consortium authorship with individual authorship, a more fundamental (even *ontological*) reassessment (Cronin, 2001, p. 567) of authorship is required, especially in emerging practices involving intense collaboration within interdisciplinary and international consortia, such as the human microbiome (which itself is often referred to as a collaborative ‘consortium’).

A Concise Overview of Conceptual Ambiguities Entailed in Academic Authorship

From the beginning of modern authorship in the seventeenth century up to the 1920s, sole authorship (the one-paper-one-author model) was the norm. Academic publishing functioned to communicate findings and results, but also to prevent ambiguities concerning priority and to determine who should be held responsible in the case of a controversy. During recent decades, however, in many areas of research, including biomedical fields, the average number of authors in research papers has significantly increased (Jakab et al., 2024) and continues to do so, while single authorship has decreased and is becoming limited to specific

genres (e.g., editorials or memoirs) or disciplines (e.g., literature studies, mathematics). As Greene (2007) phrased it, any issue of *Nature* today has nearly the same number of articles as an issue from 1950, but about four times as many authors. The lone author has all but disappeared. Especially the use of computers and shared digital files made solitary authorship anachronistic. Authorship has become a collective activity and not all authors are writers (Cronin, 2001). Besides writing a text, authorship may also consist of adding comments, questions, and suggestions in the margins for instance. Indeed, "writing is no longer a necessary condition of co-authorship" (Cronin, 2001, p. 565).

This development also has a qualitative dimension in the sense that scientific discourse has become "impersonal" and is mostly written in the passive voice (Webster, 2003, p. 218). Accordingly, individual idiosyncrasies of writing style tend to be diminished or erased. In most fields, fewer and fewer people know enough to work and write alone (mathematics and humanities are among the exceptions, but in these disciplines too, publication practices are changing). In philosophy, for instance, although historical studies and author studies continue to be written mostly by single authors, many philosophers also participate in interdisciplinary projects, where multiple authorship is common.

Against this backdrop, the relatively new phenomenon of *consortium authorship* (CA), also known as 'group authorship' or 'team authorship' has emerged (Hosseini et al., 2024). CA attributes authorship credit to a collective of participants (e.g., in an externally funded, multi–centre research endeavour), who are presented as having contributed to the publication and whose names are (ideally) listed somewhere in the paper, but not as individual authors. *Nature* is an example of a journal offering CA as an option to authors.[2] As explained in the *Nature* authorship guidelines, individual authors can be listed "in both the main author list and as a member of a consortium". All authors within a consortium are "listed at the end of the paper", while specific details can be added in the supplementary information. Notably in cases where large numbers of participants are involved in a project, CA has evident benefits. It could minimise tensions about who should be listed in the authorship by-line and about authorship order, while explicitly acknowledging the value of collaboration. However, CA also entails a number of ambiguities which deserve further reflection, e.g. the question whether all contributors listed as consortium members made a substantial contribution and can take full responsibility for the content of the publication.

Basically, two types of arguments can be made. On the one hand, since multiple authorship is common in many fields, CA offers a practical solution to address tenacious authorship issues (*who* may be listed as co-author, and in what order, etc.), allowing us to by-pass complicated alternatives (such as using percentages and assigning a score to contributions proportionate to the required time and effort to complete tasks (Verhagen et al., 2003). CA may even be seen as an inevitable development and as a logical next step. There is also a positive normative dimension involved here. CA acknowledges that, in scientific collaborations, the end result is more than the sum of partial contributions attributable to individual effort. CA indicates that the research results presented in a paper could not have been achieved without intense teamwork. CA takes us away from an individualistic view on authorship by putting more emphasis on the importance of working closely together and of mutual dependence, on the research ecosystem if you like. On the other hand, CA blurs authorship assessment and confronts us with novel ethical quandaries such as: (a) to what

[2] Available from: https://www.nature.com/nature-portfolio/editorial-policies/authorship#consortia-authorship, last accessed 29 November, 2024.

extent are individual consortium members still responsible and accountable for a publication, for instance, in cases of misconduct or fraud? And (b) should CA be counted the same way as individual authorship (e.g., by Web of Science and Google Scholar) or differently? In short, while CA offers benefits and opportunities compared to conventional authorship, it also raises a number of ethical and practical questions that have not yet been convincingly addressed (Hosseini et al., 2024).

In this paper we opt for a case study approach, to ensure that our normative reflections are informed by practice. We use the research consortium entitled *Human Microbiome Action* (HMA, EC-Grant No. 964590; IHMCSA) as our starting point. This project is devoted to studying the role of the human microbiome in human health. By aligning microbiome research in Europe, the project aims to contribute to a health care system that takes the human microbiome into consideration.[3] It is an interdisciplinary project, which means that, while some participants (especially those coming from biomedical or life sciences fields) may already have significant experience with CA, for others (especially for participants coming from a philosophy background) it may be both new and questionable.

There is an additional reason, however, for using this particular project as a case study. The human microbiome itself, i.e. all the microbes (bacteria, fungi, viruses) living inside us, as a symbiotic community, are often referred to as a *consortium* (Woyke et al., 2006; Koenig et al. 2011; Lee et al., 2013; Moshkelgosha 2021).[4] In a paper entitled *Defining the Human Microbiome* (Ursell et al., 2012), for instance, the authors emphasise how vertebrates and their *microbiome consortia* evolved over hundreds of millions of years. Thus, the HMA research community could be seen as a symbiotic ensemble of researchers; *a consortium studying a consortium*. In other words, symbiosis and collaboration is not only found in nature, but also in contemporary science, and CA reflects this.

Ethical questions raised when adopting CA.

From a normative perspective, CA acknowledges the value of academic collaboration, thereby fostering and rewarding teamwork. Yet, the destabilisation of the authorship concept creates practical challenges and raises ethical questions, for instance because of the varying visibility of CA in search engines. Currently, there is a lack of persistent identifiers for consortia (comparable to ORCID for individual researchers), while it is unclear how CA contributes to citation indices. If CA contributes to the citation index of all consortia members (regardless of their contribution) in the same way as individual co-authorship, this may be seen as unfair by authors who made a substantial contribution to drafting and finalising the text. In the case of PhD researchers, the question emerges whether a consortium-authored paper may count as a valid part (say, a chapter) of a PhD thesis. And can academics still be members of thesis committees if they are listed as a member of a consortium involved in authoring one of the thesis chapters? What would happen in the case of research misconduct: are all consortium authors responsible for the overall integrity of the study? Finally, there is a risk that CA, rather than being an option, will be enforced as an obligatory requirement, for instance when joining a research consortium. We decided to address these questions by organising a deliberative workshop on CA.

[3] https://humanmicrobiomeaction.eu/about/.

[4] Cf. The opening sentence of the Wikipedia page entitled *Microbial Consortium*: "A microbial consortium or microbial community is two or more bacterial or microbial groups living symbiotically".

Deliberative Workshop on Consortium Authorship

Methodology

In November 2023, we organised a deliberative workshop on CA, involving thirteen participants. The purpose of the workshop was to facilitate a deliberation among researchers involved in the HMA project who were interested in exploring, collecting, exchanging and fine-tuning researchers' views and experiences concerning the pros and cons of CA, to support our ethical analysis, in combination with our survey of the scholarly literature on CA and our empirical analysis of the actual use of CA in journals. The workshop was open to all 48 members of the HMA consortium. Our email invitation resulted in nine HMA participants (one of whom acted as chair), including the consortium coordinator. In addition, we invited a research ethics expert, a sociology of science expert specialised in academic publishing, and a university librarian. The other participants were two research assistants. On the basis of a preparatory reading of papers available in the academic literature on CA, a draft listing of questions and issues was discussed among the authors of this paper, resulting in a list of eight statements prepared for the discussion (see Table 1). Using online interactive presentation software (Mentimeter), we offered an overview of initial positions for each of these statements and invited participants to indicate whether they agreed or disagreed (on a five-point scale ranging from *strongly disagree* to *strongly agree*) with each statement presented. We recorded the workshop with consent of all participants. After the workshop, we transcribed the recording to analyse the responses to each statement.

After exploring the transcripts, we collected what we considered to be the most salient responses to these statements in terms of arguments and questions, or pros and cons regarding CA made during the deliberative workshop. For every statement cited below, the (numbered, anonymised) participant by whom that statement was made is indicated. None of the statements cited were made by the chair.

Table 1 List of statements discussed during the workshop with initial average scores on a scale from 1 to 5, where 1 indicates strong disagreement and 5 indicates strong agreement

1. CA reduces tensions and conflicting expectations about authorship notably in large-scale interdisciplinary projects (3.7, $N=13$).
2. CA acknowledges the value of academic collaboration and fosters teamwork (4.1, $N=12$)
3. Due to lack of persistent identifiers such as ORCID, CA makes it difficult to assess credibility and conflicts of interest of contributors (3.8, $N=11$)
4. If CA contributes to the citation index of a scholar in the same way as individual co-authorship, this may be seen as unfair by individual authors who made a substantial contribution (2.1, $N=9$).
5. In the case of PhD researchers, a consortium-authored paper may count as a valid part (say, a chapter) of a PhD thesis? (3.5, $N=13$)
6. Scientists can be members of thesis committees if they are listed as a member of a consortium involved in CA of one of the chapters? (3.0, $N=12$)
7. In the case of research misconduct, all consortium authors are responsible (3.2, $N=12$)
8. CA, rather than being an option, will be enforced as an obligatory requirement, for instance when joining a research consortium (2.5, $N=11$).

Statement 1 (CA Reduces Tensions and Conflicting Expectations About Authorship Aotably in Large-Scale Interdisciplinary Projects)

One participant (P1) pointed out that, in the absence of CA, much emphasis is given to "having your own name spelled out [preferably] as first or senior author", while the work is of a collaborative nature. Another participant (P2) argued, however, that, although CA may have practical benefits, it actually "hides a lot of information", and may therefore even "increase tensions" concerning authorship instead of alleviating them. CA may "alleviate tensions or discussions about authorship order", especially about "who should become first or last", another participant (P3) argued, but precisely for that reason there is ambiguity concerning the level of involvement of the consortium authors. P3 emphasised that, in the case of individual authorship, all authors "are expected to have seen the final version of the manuscript and … need to be accountable for all aspects of it", but in the case of CA it is unclear whether these conditions can be met for all consortium members. Finally, one participant (P4) argued that the assessment of CA depends on "whether we use the group as the only author or if we combine CA with individual authors." Another participant (P5) added: "usually, at least one or two people contribute more to the writing of the paper, but then it is also important to add CA to acknowledge that the project and its result would have not been possible without the whole group or consortium. So, for me it is very important to combine both. In my opinion, I will never write a paper with only a consortium authors." This option, using CA and individual authorship in tandem, will be discussed more extensively below.

Statement 2. CA Acknowledges the Value of Academic Collaboration and Fosters Teamwork

In response to this statement, P1 argued that CA acknowledges that "there was a strong collaborative contribution" so that the result could not have been achieved without the work of the consortium as a whole, while the option of "combining [individual] authors with CA was stressed again. The question is, one participant argued: "can I achieve the goal of what I am trying to do without the consortium? If the answer is no, it is fair and square that consortium members, even if they contributed just 1%, are attributed CA for their contribution".

Statement 3: Due to Lack of Persistent Identifiers Such as ORCID, Group Authorship Makes it Difficult to Assess Credibility and Conflicts of Interest of Contributors

P1 commented that currently, there are significant differences in how journals or databases used for citation analysis such as PUBMED or SCOPUS deal with persistent identifiers such as ORCID in the case of CA. While another participant (P3) saw the use of persistent identifiers as beneficial "to avoid name ambiguity", a harmonised policy for CA has not been established yet. Some journals explicitly ask corresponding authors whether the manuscript involves CA and request a listing of names of consortium members, but space for this is often limited: "The infrastructure to support CA is simply not there. This is one of the reasons why we think adding a persistent identifier like ORCID for groups is actually beneficial and necessary." According to P3, we can combine individual authorship with CA by connecting individual ORCIDs to the persistent identifier that is designated for consortiums. Thus, ORCIDs can also be added to the listing of authors involved in CA. Another

participant (P6), however, pointed out a caveat here, namely that, according to ORCID's terms of use, users may not "obtain an ORCID ID and create an ORCID record for anyone other than yourself".[5] This seems to restrict ORCID records to individuals. Yet, in practice, consortium ORCIDs do exist.[6]

Statement 4. If Group Authorship Contributes to the Citation Index of a Scholar in the Same Way as Individual Co-Authorship, this May be Seen as Unfair by Individual Authors who Made a Substantial Contribution

There was uncertainty among participants as to whether a member of a consortium counts as an author in the case of CA. P1 contended that "in my experience – and I have been a member of several consortia – is that in the end, the people who are [listed as consortium members] are acknowledged as an author by PubMed" in the same way as individual authors, even though their contribution was less substantial (otherwise they would have been listed as individual authors). Another participant (P7), however, doubted whether this is the case. When a paper is cited by another paper, "this does not add up to my number of citations on Google Scholar or SCOPUS. To my knowledge, it does not." This depends on the databases and search engines that are used. The search systems of Google Scholar, for instance, primarily cite individual authors. "According to their website," one participant (P8) added, "the names of those listed right below the title on a separate line are designated as authors."[7] It also depends on whether identifiers such as ORCID are mentioned, but (as indicated) ORCIDs are not always used. Regarding fairness, P1 argued that, if the result could not have been achieved without the work of the whole consortium, it is fair that the contribution of all consortium members is acknowledged, although one particular member may have made a bigger contribution to one particular paper than to another paper.

Overall, joining a consortium tends to boost an author's citation index in Web of Science of Google Scholar and therefore works as an incentive to become involved in team science. As team science in many areas of research is already the default, the main implication would be that authors active in research fields that involve team science will have higher citation scores than authors active in fields where individual authorship is the dominant trend.

Statement 5: In the Case of PhD Researchers, a Group-Authored Paper May Count as a Valid Part (Say, a Chapter) of a PhD Thesis

Can a paper authored by a consortium become part of a thesis? At the start of the discussion, it was mentioned that, as a rule, PhD candidates are first authors of academic papers that are included in their doctoral thesis. In the case multiple PhDs collaborate on a paper, co-first authorship may be an option (cf. Hosseini, 2020). One participant (P1) argued that, in research endeavours such as microbiome research, nothing can be achieved without "a

[5] https://info.orcid.org/terms-of-use/#:~:text=You%20may%20not%20use%20any,prior%20written%20consent%20of%20ORCID.

[6] e.g. ORCID record 0000-0003-3713-8364, used for the *Netherlands Brain Bank*. The use of identifiers such as ORCID is recommended to enhance transparency, but may have implications for whether authors listed as consortium authors are treated in the same way or differently than individual authors, for instance in PubMed or SCOPUS.

[7] https://scholar.google.com/intl/en/scholar/inclusion.html.

multitude of colleagues with expertise," and your hypotheses cannot be tested "without the contribution of many competencies". If you are listed among consortium members, "it means that your contribution was not major", but nonetheless of value, so that it would be fair to acknowledge this in thesis chapters as well. Another participant (P9) informed us that she recently finished a philosophy of science thesis, working in labs to study how scientific research cultures evolve. The research would not have been possible without this collaboration. Thus, philosophers now tend to adopt practices from the fields they study ("going native"), including CA. Philosophers of science join the fields they study also practically, which means that CA becomes part of their practice. Still, as another participant (P7) argued, a chapter of a PhD thesis would require a major contribution from the PhD student. To be able to submit and defend a thesis requires that the bulk of the work can be attributed to the PhD candidate. Here again, it was proposed that a thesis chapter should combine individual authorship (emphasising the significant contribution made by the PhD research) with CA (acknowledging the importance of consortium collaboration at the same time), for then "it is unlikely that you made a major contribution but did not end up separately listed as individual author", P7 added. The rules may be "completely different depending on the university or country where you are doing your PhD", but for me, "a PhD means original research, your own research". Sections from consortium authored papers "can be part of your introduction of your thesis, this would be completely fine. But it should not be part of… the original results that you obtained during your thesis." Another participant agreed with this: "You can only include a paper [in your thesis] only when you are first author." CA is comparable to being a third or fourth author: you contributed to the work, but it is not your own work. P1 added a concrete example. Because their work involves intense collaboration with an expert in data science, "we have many publications where we are joint primary or first authors, one author being a biologist, the other being a mathematician. This is becoming more and more common." And in the case of a PhD thesis, where two people are co-first-authors, they both can use this as a chapter of their thesis: "They both defend specific contributions to the work that would never be there if it was not for the joint contribution of the mathematician and the biologist. You can have originality in the way you analyse the data, and you can have originality in the biological questions that you raise and the way you design the study.

Statement 6. Scientists can be Members of Thesis Committees if they are Listed as a Member of a Consortium Involved in Consortium Authorship of One of the Chapters

At the start of the discussion, it was stated that, as a rule, an expert who assesses a PhD thesis is not a co-author of one of the chapters, to ensure independence of judgement and avoid conflicts of interest. CA might blur this requirement. One participant indicated that there should be no links between candidate and committee members and that a slippery slope should be avoided. Others argued that, in highly specialised fields, such as microbiome research, it might be difficult to recruit experts who can assess the quality of the thesis and have no involvement in projects to which the PhD research contributed. Several participants indicated they could live with minimal involvement, e.g. seeing it as acceptable if the reviewer is part of the same consortium in one of the chapters, because in that case potential conflict of interest or link between PhD candidate, supervisor and evaluator is limited. Should it apply to more than one chapter, this would become problematic, P1 argued:

> We know that sometimes it is very difficult to find evaluators for a PhD thesis. Then it is better to have someone who is a specialist and with a very limited link, as mentioned here, only with one chapter, than someone with less expertise on the subject. With one chapter it would be acceptable for me, with multiple chapters I would change my answer, clearly.

Statement 7. In the Case of Research Misconduct, All Consortium Authors are Co-Responsible

Most participants felt that consortium authors share the same responsibilities as individual co-authors. "In the case of misconduct," one participant argued, "there should be no difference with individual authorship, P1 stated. If misconduct happens then all authors should be accountable. Individual authors are expected to have assessed and assume responsibility for the full manuscript. In the case of CA, this puts significant demands on the quality of the collaboration within the consortium. Consortium members must build a culture of trust based on awareness and transparency concerning what other participants are doing, in combination with internal mechanisms for quality care (e.g., reviews of deliverables). Yet, in practice consortia may involve a variety of experts from multiple disciplines, and they cannot really check what others did. Should misconduct occur, and the paper has to be retracted, one participant argued, all consortium authors face the same penalty: the retraction of a paper that is associated with their name, listed somewhere in the paper. Thus, misconduct will have repercussions for the whole consortium, for instance when a funding agency decides to discontinue the funding, as all consortium members are co-responsible, P7 contended. Consortia often involve collaborations across disciplines, which may make it difficult for participants to assess the quality of the work conducted by experts from other fields. Therefore, it is important to establish a culture of trust. Should misconduct occur, it would be detrimental to the work and reputation of the consortium as a whole, although certain penalties such as termination of a contract because of misconduct would apply only to those individual members who de facto committed the misconduct. Thus, the most important responsibility of the consortium is to collectively prevent misconduct from happening, by building a research culture of responsibility, transparency, and trust.

One participant (P5) mentioned a concrete example of misconduct concerning a consortium that had published an academic article (the result of two years of work), where one of the participating authors had copy-pasted a section from another article. Shortly after the consortium paper was published, the journal editor received complaints and eventually the paper was retracted. Thus, although only one of the participating authors had committed the misconduct, the whole consortium faced the consequences. Therefore, the focus should be on prevention and on collaborating closely as a team, because in the case of misconduct the repercussions for consortium authors are basically identical, e.g. paper retraction and reputational damage.

Statement 8. CA, Rather than Being an Option, will be Enforced as an Obligatory Requirement, for Instance when Joining a Research Consortium

The decision to join a consortium is taken on the basis of a consortium agreement, and this may include particular publication policies, with a preference for CA. In principle, work-

shop participants agree it is possible to refuse to join a consortium if a proposed member is uncomfortable with CA. Some participants argued that it is good that participants are invited or even nudged to adopt CA. After all, promoting collaboration and teamwork will further the research and CA can be one of the instruments to foster such objectives.

Inventory of Consortium Authorship Practices

To situate CA practices in a broader context, we studied CA in the publication practices of microbiology and philosophy journals. We analysed CA policies of academic journals in the life sciences field and academic journals in philosophy and stored all collected data in an Excel worksheet. To narrow down our search, we used SCImagojr.com to find papers in the highest-ranking journals in 2022. We selected the top twenty ranked journals in the subject areas 'Immunology and Microbiology' and 'Arts and Humanities', respectively with 'Microbiology' and 'Philosophy' as categories. For each journal, we first checked the accessibility of information about CA. Assuming that researchers would first search this information through a search engine, we googled "{insert journal title}" [AND] "consortium authorship" [OR] "group authorship" [OR] "consortium author" [OR] "group author". If the search result included the web page of the journal or publisher about CA, we assigned accessibility category (A) If this was not successful, we manually browsed the authorship information or author instruction pages of the journal website itself to find information about CA. If successful, we assigned accessibility category (B) If this was unsuccessful, we assigned category C, which means that information about CA can only be found by checking whether it occurs in papers published in these journals.

We then proceeded by mapping the CA practice of each journal, starting from 1994 (where we found the first CA paper) up to 2023. Since CA is an emergent practice, it is generally ill-indexed. To stay close to the source of any indexed papers, we first attempted to use the advanced search of the journal website to look for papers with an author list containing authors named 'consortium' or 'group'. Where this was impossible (e.g. when there was no advanced search option available), we used Google Scholar with the search term author: consortium OR author: group source:"{insert journal title}". For each paper resulting from this search, we collected data including the title, the DOI, aspects of the author list, the location of the names of consortium members and publication date.[8]

Next, we used Web of Science to collect the total number of regular and CA articles published in each journal between 1 January 1994 and 31 December 2023, using the search term SO=("{insert journal title}") with and without AND TI=("COVID-19" OR "SARS-CoV-2"). We also used Web of Science to determine the total number of regular and CA publications of all twenty journals together in each discipline for each year in the range of 1994 to 2023, using the search term SO=("{insert journal title 1}" AND "{insert journal title 2}"… AND {insert journal title 20}) with and without AND TI=("COVID-19" OR "SARS-CoV-2").

Subsequently, we used Python 3.12 in Spyder 5.5.0 to analyse the dataset and create figures (see SI). We used ChatGPT 3.5 to aid in the programming. We also excluded all papers in our dataset published after 2023.

[8] We realise that our method runs the risk of missing out on some forms of collective authorship that do not use the terms 'group' or 'consortium', for instance articles published by "the editors" of a journal.

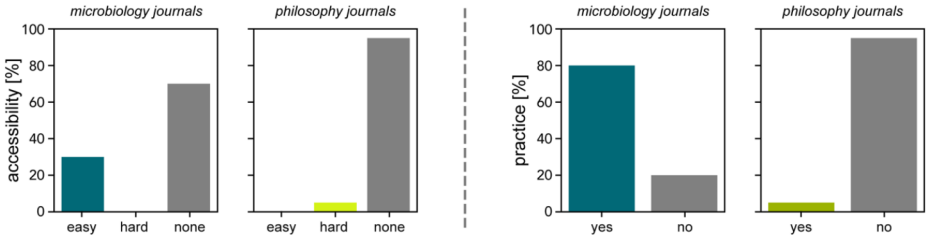

Fig. 1 The accessibility and practice of CA in microbiology and philosophy journals. The accessibility of information about CA provided by (left panel) and occurrence of CA publications in (right panel) the top 20 journals in microbiology and philosophy

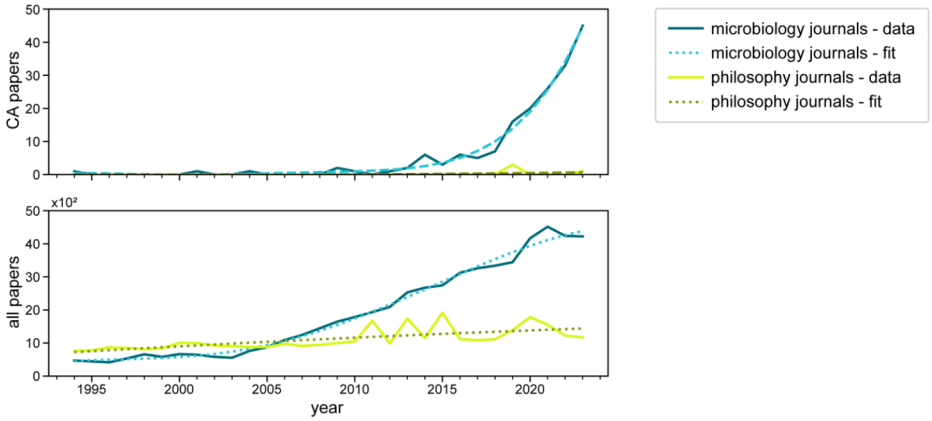

Fig. 2 The publication trend CA compared to all papers during the last decades. The publication trend of CA papers in the top 20 microbiology and philosophy journals with CA practice (top panel) compared to all papers in microbiology and philosophy (bottom panel) between 1994 and 2023

Interested in the extent to which CA is supported in these disciplines, we first assessed the facilitation of information about CA provided by the top 20 ranking journals in each discipline (Fig. 1). In microbiology, 6 (30%) journals provided easily accessible information, while the other 14 (70%) journals failed to provide accessible information and required checking whether the paper had published papers with CA. In philosophy, 1 (5%) journal required manually searching its website to find information about CA and the remaining 19 (95%) had no accessible information on their website. These various levels of information accessibility indicates that CA is more embedded in the discourse of microbiology than of philosophy. This observation corresponds to the CA practice of each discipline: we found CA in 16 (80%) of the microbiology journals, but only in 1 (5%) philosophy journal. Comparing the observed facilitation and actual occurrence of CA shows that less journals provide information about CA than journals that published CA papers, suggesting that theory lags behind practice.

We found that, over the last few decades, CA has exponentially increased in microbiology (Fig. 2). Based on the fitted curves, CA occurred 24 times more often in microbiology in 2023 compared to 2013, while the number of articles has increased only with a factor 1.8, that is,13 times less quickly over the same period. In philosophy, where CA is basically

absent, it is hard to speak of a CA trend. Thus, these publication trends confirm that CA is a quickly emerging practice in microbiology.

To explore how the emergence of CA evolves in practice, we investigated the author lists in more detail (Fig. 3). In 67% of all author lists CA was not represented by an individual (e.g. 'on behalf of'), which implies that consortia are seen as self-supporting entities. In 64% of all author lists, CA was listed as the last author. This indicates that consortia are regarded as important in the publication process, since the last position in the author list is usually occupied by the principal investigator of a project. Most strikingly, CA was combined with individual authorship in 97% of all cases. This concurs with the results of the workshop, where listing both individuals and a consortium as author was proposed as a best practice. In short, CA practice concerning the author list is crystallising in the form of CA combined with individual authors, where the consortium is not represented by a particular author (e.g., the Principal investigator) and listed as last author.

As opposed to the author lists, where in most cases the consortium is listed as the last author, the location where the list of consortium members is included in articles varies greatly (Fig. 4). Some journals have established a clear internal practice in this respect, scoring near the extremes in terms of visibility and allocation. Other journals gravitate more towards the middle of the figure, which means that location may vary. The same holds for the average trend of all CA papers. Only four journals fall in the upper right quadrant, which corresponds with a practice that facilitates easy identification of consortium members by locating the lists logically and with high visibility. These results suggest that a best practice concerning the location of the list with individuals that fall under CA has yet to be established.

In short, CA practice has recently emerged in microbiology, occuring in sixteen out of twenty top microbiology journals, whereas hardly any instances of CA are found in philosophy journals. This concurs with our workshop: most participants from microbiology and life sciences research have experience with CA, whereas for philosophers it is a new phenomenon. When CA is used, it is almost always combined with individual authorship. The name of the consortium often appears last in the author list and sometimes an individual author is

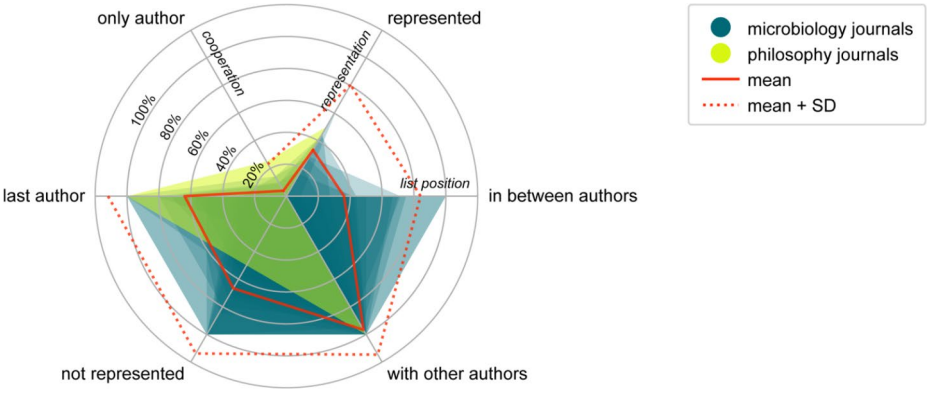

Fig. 3 Author list formats of CA papers. A radar chart depicting the trends of each journal ($N=17$) and the mean trend of all CA papers ($N=180$, in red) stacked on top of each other. Each trend is a topology on three axes: list position, representation status and cooperation status

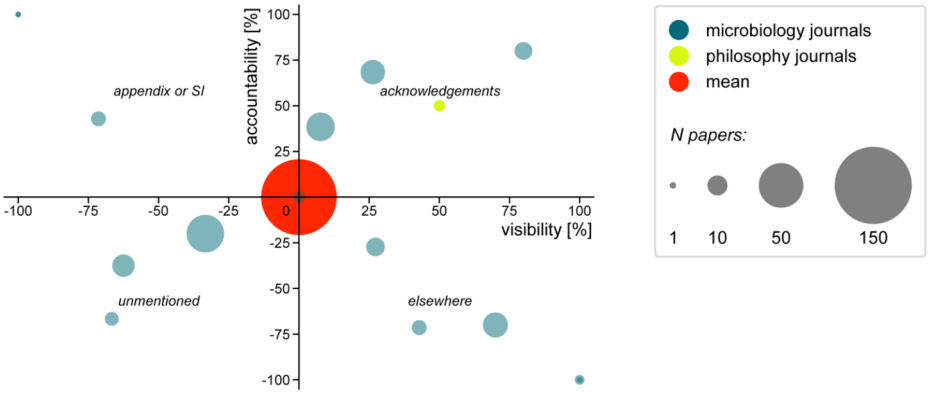

Fig. 4 Location of list with consortium members of CA papers. The location of the member list (appendix/SI, acknowledgements, elsewhere in the article or not mentioned) was determined for all publications (N=180, in red) in total and for each individual journal (N=17). The relative occurrence [%] of each category was mapped on two axes. Visibility was determined as (acknowledgements + elsewhere) - (appendix/SI + unmentioned) and allocation with the formula (appendix/SI + acknowledgements) - (unmentioned + elsewhere). The size of each circle corresponds to the number of papers included

mentioned as representing the consortium. Contrary to CA author list practices, practices as to where consortium membership lists can be found vary greatly.

Discussion

Growing Tensions Between the Collaborative Nature of Research Practices and Competitive Performance Assessment

As indicated in scholarly discourse (outlined above) research collaborations have grown in size and scope, resulting in tensions with traditional institutional structures of science, focused on research performance of individual authors where individual scholars are primarily seen as competitors rather than as collaborators. Meanwhile, large-scale research funding programs launched by the European Commission explicitly aim to foster the development of trans-national, interdisciplinary research consortia. Traditional models of authorship attribution seem increasingly at odds with how research is practiced in large-scale collaborations. In other words, while collaboration is encouraged, reward systems tend to be based on individual performance. How does this tension work out for academic authorship?

Diverging Assessment of Emerging Trends in Academic Authorship

While we noticed consensus in the scholarly literature that authorship practices are changing, the normative assessments of these changes tend to diverge. Discussions about multiple authorship and the growth of the number of authors often voice concerns regarding the *inflation* of the authorship concept and *ambiguities* concerning responsibilities of authors or contributors, possibly resulting in "unethical authorship practices" (Marušić et al., 2011) or "strategic behaviour" (Hosseini and Gordijn 2020). Yet there is a positive side to consor-

tium authorship as well, we have argued, namely: emphasising the value of collaborative efforts as part of emerging research cultures. The importance of collaboration is much less visible in listings of individual authors, suggesting that the published result can be seen as the sum of individual contributions, thereby obfuscating the added value of synergy and teamwork entailed in consortium science. We argued that CA will notably be considered when a publication builds on intensive teamwork and could not have been written without the work of multiple participants in the research who are not listed as individual authors: when the whole (the research result) is more than the sum of parts attributable to individuals. In other words, CA can be important for those participants who contributed significantly to the research *process* and are not listed as an individual co-author of the manuscript (the *product* of the research process), but care about team effort and the social aspects of science. Thus, CA will be relevant for those researchers who experience science not as an individual task-oriented endeavour but as a social activity.

Deliberative Workshop Results

We noticed the same ambiguity in our analysis of the results of the deliberative workshop. On the one hand, several participants emphasised that they see CA primarily as an acknowlement of the importance of collaboration as a key dimension of research. Whereas other fields (e.g., high energy physics) opt for extensive lists of authors, often in alphabetical order, CA offers a viable alternative. CA is not only adopted for pragmatic reasons. There is a normative objective involved, namely ensuring more equitable distributions of authorship credits by putting more emphasis to the importance of collaboration while being less concerned with individual performance. At the same time, while CA is spreading in biomedical fields, it was also emphasised during the workshop that several implications still need to be thought through (cf. Hosseini et al., 2024). As indicated earlier, CA seems difficult to reconcile with the demand that all authors should take full responsibility for the publication as a whole, and we also notice a tension with academic systems of acknowledgement and reward, often focussing on individual authorship performance.

CA acknowledges that the work reported in a scholarly publication could not have been conducted without the support of the consortium as a whole. Yet, as Hosseini and Gordijn (2020) argue, authorship is a "two-sided coin", with credit on the one side and responsibility on the other. While rewarding teamwork via CA seems laudable, many of the questions discussed during the workshop had to do with the responsibilities of consortium authors compared to individual authors. Here, however, a best practice has emerged, as was attested both during the workshop and in our analysis of journal practices, namely: *combining individual authorship with CA*. This allows CA to address many of the issues listed above. While acknowledging that the work could not have been done without the consortium, some authors (listed as individual authors) made a more significant contribution and carry a larger share of the responsibility than those contributors that are solely listed as consortium members. Only if an author is listed as an individual author, preferably as the first author or co-first author, can a paper be included as a chapter in a thesis.

As to unintentional error or even misconduct, not all contributors may have the skills and knowledge necessary to assess whether the contributions made by others contain errors or questionable research practices. Yet, this challenge is also an issue when co-authors are listed as individual authors. Therefore, we concluded that cases of error or misconduct affect

the work in the same way as in the case of individual authorship, except for the fact that, in the case of a retraction, no individual member of the group will be singled out, thereby reducing the possibility of individual reputational damage. Rather, the reputation of the consortium as a whole will be blemished.

Last but not least, this result confirms what we see happening in practice. In the biomedical journals we assessed, we likewise noticed the prevalence of combining of individual authorship with CA. This combined approach seems a viable practice, offering practical solutions to most if not all of the questions that we raised.

CA as Part of a Broader Process of Change

CA, we have argued, is part of a broader transition, shifting the focus from the individual researcher to the collaborative team, from individual performance to the functioning of knowledge ecosystems, and from competition to mutual dependence. Whereas traditional performance indicators such as the *h* index (Hirsch, 2005) are still widely used to assess scholarly impact based on citations, there are many caveats, one of them being that h-scores fail to reflect the crucial importance of teamwork. CA acknowledges that the results could not have been achieved without the consortium as a collaborative entity, where the end result is more than the sum of individual contributions. CA challenges how academic reward is currently distributed. This is not only relevant for biomedical fields, but also for the humanities, especially for philosophers who engage in interdisciplinary teamwork, for instance in the context of European projects, addressing the ethical, philosophical and societal aspects of life sciences research. Therefore, not only scientists in biomedical fields, also humanities and social science experts will be challenged to take issue with the ethical and practical quandaries concerning CA as discussed in our paper, e.g. in data-driven humanities or computational social science, but also when participating in interdisciplinary projects involving researchers from fields where CA is more common. Rather than detachment (philosophers seeing themselves as outsider studying the research groups involved), this should entail *working together* to come to terms with the phenomena of life (philosophy *in* science, contributing to sympoiesis, Zwart, 2023). The group, rather than the individual, is the starting point. This implies that CA, besides being an empirical phenomenon, has repercussions for understanding science on a philosophical level as well, as will be discussed in more detail in the next subsection.

Philosophical Considerations

There is more to CA, we argued, than practical problems and solutions. CA is part of a broader spectrum of evolution of the concept of authorship, which challenges us to rethink this concept and adopt new policies. CA emerges when interdisciplinary consortia are established to study complex phenomena, such as the human microbiome and its relationship with health, well-being and cognition. We captured this above by arguing that our case study (the HMA consortium) is *a consortium studying a consortium*. We could also phrase it with the help of a concept introduced in philosophy of science by Haraway (2016), who understands living systems as "sympoiesis", so that phenomena of life are made collectively, together, by consortia of entities. In the case of microbiome research, the *study of life* reflects this, as the interactive and synergetic study of life requires sympoiesis too. Or, as

Barad (2007) has argued, the traditional ontology positing a rational subject (detached from nature) versus an objectified target of research must give way to awareness of relationality and embeddedness, not only of the microbiome that is being studied, but also of the individuals that are doing the research. Just like individual microbes must be studied in the context of the microbiome as a whole (as a consortium of living entities), the work of individual researchers cannot be isolated from the interactive activities of the team.

These insights resonate with a more extensive history of reflection on the nature of scientific research, problematising egocentric approaches to scientific practices. Friedrich Nietzsche once argued that the most important scientific virtue of all is the willingness to accept a form of authorship which borders on anonymity: *Was liegt an mir!* It is not me that counts. For Nietzsche, this phrase summarises the core of the scientific ethos, the quintessence of being "in science" (1980, § 547). This view was taken up many years later by Michel Foucault, who likewise argued that a key ethical principle of contemporary scientific discourse resides in a basic indifference towards the fact that authorship primarily serves functional roles, for instance in the context of information retrieval and quality assessment of research teams. In many scientific fields, academic authorship comes very close to anonymity, Foucault argues, and there is a certain moral quality in the stoical acceptance of this fact (Foucault, 1994, p. 789). To the extent that there is a tension with the traditional focus of academic institutions on individual authorship, especially in the context of acknowledgement and reward (e.g. decisions about tenure or promotion), we should not see this as an argument against CA, but rather as an indication that time has come to give more attention (in academic acknowledgement and reward practices) to collaboration, collegiality, interdisciplinarity and team science.

Practical Implications

What does this imply for scientific publishing in practice? Academic journals evidently play an important role in quality control, but also in shaping authorship practices. The *International Committee of Medical Journal Editors* publishes recommendations for the conduct, reporting, editing and publication of scholarly work on its website that are regularly updated.[9] Here consortium authorship ("group authorship") is explicitly discussed, indicating that "some multi-author groups designate authorship by a group name, with or without the names of individual authors." Yet, although the ICMJE authorship criteria mention group authorship as a possibility, the tendency to reduce team work to distinguishable individual contributions is still leading: "When submitting a manuscript authored by a group, the corresponding author should specify the group name if one exists, and clearly identify the group members who can take credit and responsibility for the work as authors."[10] Researchers revert to CA, however, precisely when clear demarcations of individual contributions are no longer possible. Moreover, these recommendations also indicate that there are differences in how CA is handled, by journals, but also by databases such as PubMed, MEDLINE, SCOPUS, Web of Science and Google Scholar. Sometimes, members of a consortium are treated as authors, sometimes as non-author contributors. It would be helpful if journals would

[9] https://www.icmje.org/recommendations/browse/about-the-recommendations/history-of-the-recommendations.html.

[10] https://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html.

develop transparent and consistent practices for dealing with CA, for instance by adopting Persistent Identifiers (PIDs) for consortia that can be linked to the ORCIDs of group members together with their contributions to the published DOI (Hosseini et al., 2024).

When we submitted our paper to the *Journal of Academic Ethics*, we added the Consortium of the HMA project as consortium author. The editors informed us, however, that the HMA Consortium does not meet the criteria outlined in the authorship policy of the journal. Therefore, the editors requested us to remove the consortium from the author list and, as we evidently respect the policies of the journal, we complied with this. Nonetheless, we see this as an experience directly relevant for the argument made in our paper, for while CA is accepted and acknowledged by many journals in the biomedical field, journals in SSH fields such as JAET are less open to CA as an authorship practice, emphasising the cons rather than the pros, although the use of CA may increase in the future in these areas of research as well.

Suggestions for Future Research

Most participants in our deliberative workshop were members of the Human Microbiome Action consortium, which means that their input was based on the practical ('lived') experience of being a member of a consortium. Not everyone in the academic community has this experience, and an important motive for publishing this paper was to trigger more reflection and to collect a broader range of informed views about this topic. Besides literature review, deliberative workshops and journal policies, it would also be relevant to conduct a systematic review of blogs, online fora and the grey literature, where different views about CA may be raised. Exploring these outlets and including larger groups of participants in empirical efforts and surveys could offer interesting avenues for future research.

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Declarations

Ethical Approval As indicated, most of the paper consists of a conceptual analysis and an analysis of journal information available on journal websites. As indicated, participants in the self-reflection workshop were members of the consortium and invited experts who agreed to participate and were offered co-authorship or acknowledgement for their contribution. No informed consent forms were used.

Conflict of Interest No conflict of interests.

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