

# Authorship decisions in ecology, evolution, organismal biology and natural resource management: who, why, and how

G. D. Grossman, D. R. DeVries

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## Abstract

*Authorship decisions in ecology, evolution, organismal biology and natural resource management: who, why, and how.* Publication in peer-reviewed journals is essential for scientific progress including: (1) advancement of knowledge, (2) societal benefits including scientifically-based decision-making, (3) evaluation of researcher productivity, and (4) obtaining and retaining a research or faculty position and facilitating future scientific contributions. As science becomes increasingly complex so do the results necessary for publication, which frequently necessitates collaboration among scientists from multiple and diverse fields. Nevertheless, collaborative publication always includes the possibility of misunderstandings and differences of opinion. Here we first review the published literature on authorship determination for scientific publications in ecology, evolution, organismal biology and natural resource management, including consideration of what constitutes authorship, consideration of author contributions, author order in a byline, and power relationships, after which we provide several examples of realistic authorship conflict scenarios for purposes of pedagogy and discussion with colleagues and students.

Key words: Ghost authorship, Gift authorship, Power differentials in science, Multiple-authorship, Sole authorship, Scientific writing

## Resumen

*Decisiones sobre autoría en ecología, evolución, biología de organismos y gestión de recursos naturales; quién, cómo y por qué.* La publicación en revistas con revisión crítica es fundamental para lograr progresos científicos como: 1) la mejora del conocimiento, 2) beneficios sociales como la toma de decisiones basada en datos científicos, 3) la evaluación de la productividad de los investigadores, y 4) la obtención y el mantenimiento de un puesto de docente universitario, y la facilitación de futuras contribuciones científicas. A medida que la ciencia se vuelve más compleja, también lo hacen los resultados necesarios para la publicación, que frecuentemente requieren la colaboración de científicos de distintos campos. No obstante, la publicación colaborativa siempre incluye la posibilidad de que se produzcan malentendidos y diferentes opiniones. En este estudio, primero examinamos los artículos publicados sobre la determinación de la autoría de publicaciones científicas en materia de ecología, evolución, biología de los organismos y gestión de recursos naturales, y luego se estudió en qué consiste la autoría y se analizaron las contribuciones del autor, el orden de los autores en la línea de firma y las relaciones de poder, tras lo cual proporcionamos varios ejemplos de situaciones realistas de conflictos de autoría con fines pedagógicos y para entablar un debate con compañeros y estudiantes.

Palabras clave: Autoría fantasma, Autoría honorífica, Diferencias de poder en ciencia, Autoría colectiva, Autoría individual, Redacción científica

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Gary D. Grossman, Warnell School of Forestry and Natural Resources, University of Georgia, Athens, GA 30606 U.S.A.– Dennis R. DeVries, School of Fisheries, Aquaculture and Aquatic Sciences, Auburn University, Auburn, AL 36849 U.S.A.

Corresponding author: G. Grossman. E-mail: [gdgrossman@gmail.com](mailto:gdgrossman@gmail.com)

## Introduction

Scientific progress is dependent upon publication of research results. Publication in peer-reviewed journals is essential for multiple reasons including: (1) advancement of accurate knowledge, (2) societal benefits including scientifically-based decision-making, (3) evaluation of scholarly productivity, (4) obtaining and retaining a research or faculty position, and (5) facilitating continued productivity. Given the benefits and potential rewards of scientific publication, it is not surprising that a variety of contentious issues may arise when determining who should and should not be an author on peer-reviewed publications. This problem has been recognized previously (see references) and valuable general resources on authorship determination are available on both the Committee on Publication Ethics website <https://publicationethics.org/authorship> and the CRediT website <https://www.casrai.org/credit.html>. Nonetheless, the potential problems involved in authorship determination have become more challenging as the numbers of authors per paper continues to increase (exponentially in ecological journals from 1.4 co-authors/paper in 1950 to 4.8 co-authors/paper in 2015: Logan, 2016; for examples from other fields, see Erlen et al., 1997; Cronin, 2001; Cronin et al., 2003; Papatheodorou et al., 2008; Dotson et al., 2011) and have become even more important when one considers that significant monetary rewards (i.e., grants and salary increases) may be tied to publications (Abritis and McCook, 2017; Quan et al., 2017). Here we review published work on authorship issues from diverse fields, and summarize conclusions and recommendations for researchers in ecology, evolution, organismal biology, and natural resource management (herefore EEONR), where these issues are not well studied. Finally, to provide a locus for increased discussion, strategy derivation and improved resolution of these issues, we elucidate several actual authorship conflict scenarios and describe their outcomes. These scenarios are certainly not exhaustive, but represent potentially common situations faced by researchers in EEONR. An informal poll of members of the listserve Ecolog in December 2018 indicated that conflicts over authorship likely are not uncommon, which suggests that existing publications on the topic (mostly in the biomedical field) may not be well known, or have not effectively dealt with the issues specific to EEONR.

## A review of issues encountered in determining authorship on scientific papers

At the broadest level, there are two distinct groups of authorship issues: (1) inclusion of an author who has not earned authorship (commonly referred to as 'honorary authorship' or 'gift authorship'), and (2) exclusion of someone who has earned authorship (commonly referred to as 'ghost authorship'). Honorary or gift authorship may result from the belief that inclusion of a more senior author will improve chances of manuscript acceptance, especially in a prestigious

journal, or may occur when a person in a superior power position forces a subordinate to include their name on a paper, even though they have not made a substantive contribution to the research. It also may result from a 'payback' scenario where authors exchange authorships to increase their publication rates (Feeseer and Simon, 2008). Honorary or gift authorship is inappropriate, because gift authors receive publication credit that is undeserved, because it violates contemporary ethical standards of science. In addition, honorary/gift authors typically cannot explain the paper's contents nor address post-publication issues, particularly those arising from methodological or interpretational errors. In contrast, ghost authorship may result from: (1) exclusion of someone who has since left a laboratory, (2) professional or personal disagreements leading to author exclusion, or (3) omissions to obscure potential conflicts of interest. Less commonly, ghost authorship results from use of a professional writer to compose a paper (particularly where an author may have biases that they do not want to be apparent). The prevalence of honorary and ghost authorship may be surprisingly large, particularly in biomedical fields, with percentages ranging up to 19% for honorary authorship in medical journals (Flannigan et al., 1998; Wislar et al., 2011) to between 8–75% for ghost authorship (8–11% in medical journals: Flannigan et al., 1998; Wislar et al., 2011; 64% in hospital clinical research: Pignatelli et al., 2005; 75% in industry-initiated trials, most often due to statisticians: Gotzsche et al., 2007). As one would likely expect, differences exist among disciplines in the percentage of ghost authorship, being similar in biology (56%) versus all disciplines combined (55%), but interestingly were lower for graduate (15%) and undergraduate (9%) students serving as ghost authors in biology versus other disciplines (22% and 13%, respectively; Jabbehdari and Walsh, 2017).

## Criteria and considerations for inclusion/exclusion of authors

Although there is little published work on authorship disputes in EEONR, a variety of criteria have been proposed to determine authorship in the biomedical/health sciences, including the Vancouver Guidelines (International Committee of Medical Journal Editors, ICMJE, 2017). The Guidelines include four criteria, all of which are required for coauthorship. These criteria are (ICMJE, 2017): (1) substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; (2) drafting the work or revising it critically for important intellectual content; (3) final approval of the version to be published; and (4) agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The use of these guidelines varies across disciplines and a current list of journals that follow ICMJE recommendations can be found at <http://www.icmje.org/journals-following-the-icmje-recommendations/>.

Despite the widespread use of the ICMJE guidelines, they are not immune from problems and salient criticisms. Perhaps the most significant issue with the guidelines is the requirement for authors to meet all four authorship criteria; in particular the broadly-worded accountability criterion. Not surprisingly, as the complexity of our studies continues to increase, the number of researchers/coauthors required to generate a scientific paper also has increased (Cronin 2001; Cronin et al. 2003; Dotson et al., 2011; Gorham and Kelly, 2014; Sugrue and Carroll, 2015; Logan, 2016; Barlow et al., 2018; but see Papatheodorou et al., 2008 for an alternate view). This requisite rise in the number of authors makes it difficult for every author to be accountable for all aspects of the work, especially those portions outside of their own areas of expertise. The alternative to a more thorough and complete multi-authored paper is a series of short individual papers with fewer authors that certainly would stand a higher overall chance of rejection, as well as making it more difficult for readers to integrate and synthesize what is likely a very complex story.

As examples, we surveyed criteria for authorship posed by several relevant scientific societies and journals relevant to EONR, and not surprisingly, these criteria vary (see other examples in COPE, 2014). For example, the American Institute of Biological Sciences restricts authorship to individuals who have met three criteria: "(1) made a significant contribution to the conception and design or the analysis and interpretation of data or other scholarly effort, (2) participated in drafting the article or reviewing and/or revising it for content, and (3) approved the final version of the manuscript" ([https://www.aibs.org/bioscience/authors\\_and\\_reviewers.html](https://www.aibs.org/bioscience/authors_and_reviewers.html)). In addition, the senior author is responsible for: (1) ensuring that all potential authors that meet the criteria are offered co-authorship, (2) preventing those who do not meet the criteria from obtaining authorship, and (3) obtaining approval of the final version of the manuscript from all co-authors. Co-authors assume full responsibility for all work submitted under their names.

The American Fisheries Society has dealt with the authorship problem by requiring that authorship be restricted to individuals "making a significant contribution to the work such as: determining or developing study objectives, designing experimental, statistical, or analytical approaches, collecting data, analyzing data and interpreting outcomes, and preparing the paper (organizing, writing, revising, and proofreading the text)" and that "Each author should make two or more significant contributions that produce new information (<https://fisheries.org/books-journals/writing-tools/authorship-guidelines/>)".

Similarly, guidelines from the Ecological Society of America's Code of Ethics state that "researchers will claim authorship of a paper only if they have made a substantial contribution. Authorship may legitimately be claimed if researchers (1) conceived the ideas or experimental design, (2) participated actively in execution of the study, (3) analyzed and interpreted the data, or (4) wrote the manuscript" (note the use of the conjunction 'or'; <https://www.esa.org/about/>

code-of-ethics/). These examples illustrate the cross-discipline variation that exists in authorship requirements even when explicitly detailed. Certainly part of this variation may be attributed to cultural differences among scientific societies with respect to authorship (Penders, 2016; Moffatt, 2018).

To explore the effectiveness of the widely used ICMJE authorship guidelines, we consider published information on their performance. Multiple studies have identified issues associated with adherence to these guidelines including: (1) authors' general lack of awareness or familiarity with the guidelines (Bhopal et al., 1997; Hoen et al., 1998), and (2) failure to follow the guidelines even when publishing in journals that adhere to them (Bhopal et al., 1997; Marusic et al., 2011; Fong and Wilhite, 2017). Just determining whether an individual meets the requirements of the ICMJE Guidelines differs when criteria are evaluated on a 'percent participation', e.g. ordinal (i.e., using a scale that ranged from 0 = none to 4 = full participation in a category) versus a binary (i.e., a 'yes' or 'no' response) basis (Ivanis et al., 2008), making authorship determinations even more problematic (see Guallar (2007) for an alternative scaling system). Adding to this criterion bricolage is the aforementioned fact that guidelines differ among professional societies and their journals (Osborne and Holland, 2009; Bosch et al., 2012; Bosnjak and Marusic, 2012); in fact, da Silva and Dobranszki (2016) state that "scientists have the inherent right to determine who is an author of an article according to the ethical guidelines of their institutes, but these may differ from the guidelines indicated by publishers, while editors and publishers have the right to verify authorship". Given the diversity of methodological practices in the sciences, clearly it is difficult to erect an all-encompassing scaffolding upon which various levels of authorship can be hung.

However, the one consistent criterion among societies and journals is that authors must make a 'significant' or 'substantial' contribution to earn authorship. The difficulty arises in defining a 'significant contribution' and whether that contribution must be made in a single or multiple areas. Most published examinations of authorship guidelines, rules, or scoring approaches refer to the ICMJE Guidelines, but as previously mentioned, these guidelines yield very different outcomes if the criteria are linked by an 'or' rather than an 'and' or require some arbitrary minimum percentage of contribution. In addition, there are other contributions that researchers typically consider significant, including: (1) conception of the ideas, (2) substantive input on experimental design, (3) data analysis, (4) interpretation of the data or results, (5) writing the entire or substantial portions of the manuscript, (6) revision of the manuscript in response to reviewer comments, and (7) review and approval of the final draft before submission (Schmidt, 1987; Ahmed et al., 1997; Osborne and Holland, 2009; Clement, 2014). Additional considerations include obtaining funding and the need for input from external specialists (Hunt, 1991; Benson and Silver, 2013). The CRediT guidelines even specify 14 potential areas of contribution to a scientific work (<https://www>

casrai.org/credit.html; see also Brand et al. 2015) in an attempt at an official or approved approach to generate contributor statements in those journals that require them (see below). Another approach to clarify the diverse ways in which individuals may contribute to a paper and perhaps help to determine inclusion as an author included a list of 25 research activities used by the National Institutes of Health (Patience et al., 2019). In many scientific fields, funding may be primarily obtained via extensive grant proposals (NSF, USDA, NIH) that require elucidation of the conceptual background and structure of the research, experimental design, and statistical analyses of the proposed research. Although securing funding alone would not guarantee authorship, if the research upon which the paper was based included elements included in the grant proposal (e.g., conceptual ideas, experimental design, statistical techniques, etc.), then securing funding itself could constitute a 'significant contribution'; however, this would need to be discussed and concluded by all co-authors.

### **Assessment and explicit descriptions of author's contributions**

Several authors (Schmidt, 1987; Ahmed et al., 1997; Guallar, 2007; Clement, 2014) advocate the use of assessment systems that presumably lead to more objective decisions regarding authorship. Assessment occurs via assignation of percentages or weights for the tasks associated with the completion and publication of a research study in combination with some minimum value established for authorship (e.g., Schmidt, 1987; Hunt, 1991; Galindo-Leal, 1996; Guallar, 2007). Typically, contributions for each potential author are assigned numerical scores (1–5 scale, Ahmed et al., 1997), and a matrix of tasks and contributions are then constructed for the project (e.g., Guallar, 2007; Clement, 2014; Roberts, 2017). Despite the desire for an objective approach to determining authorship, the instructions for authors or codes of ethics for few journals in organismal EONR currently incorporate these approaches. In addition, the degree of objectivity of scoring approaches may be unclear; Ilakovic et al. (2007) found that survey responses regarding research contributions from corresponding authors differed through time, and also differed from their co-authors, documenting the presence of a high degree of subjectivity among coauthors. One example of this phenomenon is 'autobiographical memory', the subjectivity inherent in the memory and representation of what authors recalled about their own contributions. These phenomena might readily confound individual contribution scores.

In an effort to increase author accountability, some journals now require that authors provide statements detailing their respective contributions to the publication (e.g., Lundberg and Flanagan, 1989), including: (1) performance of the research, (2) data analysis, (3) writing, (4) manuscript submission, and (5) revision of the paper (Weltzin et al., 2006; Feeser and Simon, 2008). As noted earlier, one group (CRedit;

<https://www.casrai.org/credit.html>) has specified 14 potential areas of contribution that could be used in such contribution statements. To date, however, the inclusion of contribution statements has not been widely implemented, and still suffers from subjective memory issues both within and among individuals (Ilakovic et al., 2007) and from authors failing to draft contribution statements (Sauermann and Haeussler, 2017). In addition, it appears that responses may be influenced by the structure of the questions and form itself that is used to gather the information (Marusic et al., 2006). Consequently, this approach may not provide desired benefits for determining or justifying choice of authorship; however, enhanced communication among journals and/or publishers could lead to a more standardized approach to contribution statements that could be more broadly adopted and provide for more effective application of this approach (Sauermann and Haeussler 2017). The general approach of requiring some form of contribution statement at manuscript submission holds promise for the future, if for no other reason but that it requires research groups to discuss issues surrounding authorship.

### **The order of authors and power-relationships**

Two additional issues associated with authorship determinations are: (1) decisions regarding the order of authorship, and (2) the role of differential power relationships (e.g., faculty, researchers, staff and students) in authorship decision-making. Given that the authorship inclusion or exclusion process is complex and full of subjectivity, one can only imagine the complexities of gaining author agreement on the order of all authors in a byline! Certainly some of the complexity in author order decisions arises because of different interpretations of the role and/or importance of the first author, the corresponding author, and the last author in a byline (Wren et al., 2007). Except for the case where a journal requires authors to be listed in alphabetical order (a practice that comes with its own set of consequences, such as reduced recognition of authors whose names occur later in the alphabet, Weber, 2018), there is general agreement that the first author of a paper is the person who contributed the most to a project, including production of the manuscript (Kempers, 2002; Tschardt et al., 2007; Strange, 2008; Duffy, 2017; Logan et al., 2017; Tarkang et al., 2017). Nonetheless, first authors are not always corresponding authors (Duffy, 2017), especially in cases where a current or former student is the first author. As one might expect, the perceived importance of the corresponding author varies among individuals and disciplines. In addition, in many cases the position of last author is significant because it represents the person in whose lab the work has been completed. But sometimes the order of authors merely represents the declining order of contributions to the work (Feeser and Simon, 2008; Mulligan et al., 2014; Marusic et al., 2011). A survey of ecologists indicated some support for the last author being perceived as the most important author (Duffy, 2017), which likely

reflects the view that this position typically represents the most senior author. Nonetheless, this response was not universal (Duffy, 2017) and is similarly not consistent across other disciplines (Kempers, 2002; Tschamtker et al., 2007; IWCSA, 2012; Logan et al., 2017; reviewed in Marusic et al., 2011). The ICMJE guidelines simply state that the order of authors should be a 'joint decision of the co-authors'.

Clearly one effective mechanism for reducing authorship conflicts involves early discussions of authorship expectation among individuals with different levels of power such as students and their faculty advisors, or researchers and their staffs (Heffner, 1979; Guallar, 2007). Because students are typically relatively inexperienced in research and publication compared to their mentors, students may be at a disadvantage regarding decisions concerning author inclusion and order (Kwok, 2005; Maursic et al., 2011). This makes them potentially vulnerable to exploitation by superiors (Oberlander and Spencer, 2006). In addition, given that students are undergoing training, it may be unclear whether research tasks unrelated to their theses represent training or work warranting authorship. The field of psychology has published guidelines regarding authorship decisions involving dissertations (Costa and Gatz, 1992) which can be found in the current American Psychological Association's Ethical Principles of Psychologists and Code of Conduct. These guidelines state that a multi-authored paper based on a student's doctoral dissertation should list the student as senior author (<http://www.apa.org/ethics/code/>), which certainly is a good general rule. Nonetheless, this code does not address other student-supervisor situations, such as Master's theses or undergraduate students (Burks and Chumchal, 2009). Other fields and disciplines might consider following the APA's example in adopting policies that protect the rights of students in the publication process, as well as suggesting that individual institutions consider drafting their own guidelines for student co-authors. At a broad level, Fine and Kurdek (1993) provide three ethical principles for dealing with authorship in faculty-student projects: (1) beneficence (i.e., abstaining from injuring others, helping others further their important and legitimate interests by preventing or removing possible harms), (2) justice (the ethical duty to treat others fairly and to give them what they deserve), and (3) parentalism (treatment that restricts the liberty of individuals without their consent where the justification is either the prevention of some harm they might do to themselves or the production of some benefit they might not otherwise secure). These three principles should be considered by faculty/mentors (and perhaps more importantly by professional societies and universities) when working with student co-authors.

There are many more authorship situations involving power imbalances, such as those between supervising administrators (e.g., Research Unit Heads, Deans or Department Heads) and more junior researchers/faculty, between untenured and tenured faculty, and between faculty and staff. To our knowledge, these cases have not been addressed in

the published literature. Probably the most common of these power imbalance situations is between faculty and paid laboratory staff. Many researchers feel that laboratory staff perform research duties as part of their paid responsibilities, and hence, should not be considered coauthors. In our own labs, we use the principle that authorship is warranted when a staff member assumes a higher-level research role such as conceptualizing research projects, designing and performing experiments, and writing significant amounts of a manuscript. Nonetheless, clearly these are subjective decisions. Similarly, if a graduate student's stipend requires performance of research duties unrelated to their own graduate work, at what point do they earn authorship on papers resulting from their performance of these mandatory, yet non-thesis, duties? It seems logical that performance of higher-level duties to earn co-authorship, apply here as well.

As with all creative ventures involving collaboration, discussions regarding research responsibilities and authorship should take place before the research project is started (Oberlander and Spencer, 2006; Guallar 2007). One approach is to generate a written plan complete with specification of who is responsible for each task (e.g., table 1), complete with temporal benchmarks to ensure that the project progresses as planned. Other examples of such systems are available on CRediT (<https://www.casrai.org/credit.html>) and Guallar (2007). The written plan should be evaluated by the research group quarterly or semiannually, and updated as needed. This should clarify research expectations and performance and facilitate early identification of performance problems. In addition to agreeing on satisfactory performance, participants should discuss potential consequences for unsatisfactory performance, including loss of authorship. If after multiple attempts to rectify and resolve a problem the responsible party(ies) decide to remove a coauthor, that collaborator should be notified in writing with confirmation of receipt of the message. Such steps will minimize future misunderstandings.

### **Examples of authorship disputes and problematic situations**

Perhaps the most important point we would like to make is that members of a research group need to agree on standards both before and during a research project, and that these discussions need to incorporate or at least acknowledge differences in power. To illustrate potential problems that may be encountered as a research program progresses or even after fieldwork and analyses are completed, we provide three scenarios below, and discuss possible paths to their subsequent resolution or lack thereof. We describe these situations with two resolution perspectives in mind: 1) the strictly 'ethical' perspective in which a 'contract' is broken, and 2) the 'conflict resolution' perspective in which the goal is not necessarily to employ a strictly ethical solution (about which there might be great differences of opinion) but rather to reach a mutually agreed upon solution to a 'broken

contract' (Beer and Packard, 2012; Moore, 2014). The latter perspective allows greater latitude in dealing with mistakes, such as those that might be made by inexperienced researchers, in a non-punitive manner. These scenarios are real-world situations and their discussion has stimulated fruitful deliberations in GDG's graduate classes. Although we discuss resolution of these cases from both perspectives, our main purpose is to provide examples of authorship conflict scenarios for classroom and research group discussion. We recognize that these examples are presented from our perspective alone and that the circumstances of many authorship conflicts are too idiosyncratic and subjective to suggest that a single 'correct' resolution is possible.

#### Scenario one

A new PhD (first a Post-Doc, then an Assistant Professor) is conducting a poorly funded post-doctoral research program in community ecology when they are approached by a student who has just graduated with a bachelor's degree. The bachelor-level graduate (Volunteer) plans to remain in the locale and asks to volunteer on the project for 'experience' and as a potential springboard for graduate school. The Post-Doc can use the extra help and is also interested in maximizing the educational benefits for the Volunteer. Little is known about the organisms in this system so even basic biological information is likely publishable. The Post-Doc and the Volunteer hold several discussions regarding the project and reach an agreement that if the Volunteer fulfills a series of responsibilities that are defined and deemed reasonable by both individuals, they will be able to use a subset of specimens for a publishable study. The responsibilities are as follows: (1) the Volunteer will help on all collecting trips, (2) the Volunteer will learn how to perform the required lab analyses with the help of the Post-Doc, (3) the Volunteer will conduct the lab work, analyze the data, and perform statistical analyses with the aid of the Post-Doc, and (4) the Volunteer will write the first draft of a publishable manuscript on the species of interest, again with the help of the Post-Doc. The Post-Doc agrees to help with all aspects of the Volunteer's project, but the Volunteer must perform most of the work and therefore, will assume senior authorship on the manuscript.

Without any discussion with the Post-Doc, the Volunteer abruptly goes overseas (for several years) before 50% of the samples are collected. The Volunteer does no subsequent work on the project and the Post-Doc completes sampling with other team members. Two and a half years later, the Volunteer contacts the Post-Doc (now an Assistant Professor at a geographically distant university) and asks for 'their data'. However the Assistant Professor, having heard nothing from the Volunteer in the interim, has completed the research work with a different collaborator and a manuscript already has been submitted for publication. The Assistant Professor has included the Volunteer in the Acknowledgement section of the manuscript but given that the Volunteer did not satisfy

the terms of the research agreement, they were not included as a coauthor. Unfortunately, the Assistant Professor did not contact the Volunteer to discuss the decision, although the Volunteer had not provided any contact information and was overseas at the time. The Volunteer then contacted the Assistant Professor's former advisor claiming they have been cheated out of authorship on the project.

After discussions with the Assistant Professor's former advisor (at this point the Volunteer refuses to communicate with the Assistant Professor), the following potential solutions are proposed by the various parties (certainly other possibilities exist and should be fodder for discussion by those using this paper in a teaching context): (1) the Volunteer should be given senior authorship on the submitted manuscript, (2) the Volunteer should be added as a co-author on the submitted manuscript, but then has to complete subsequent work to produce sufficient data for a second publishable manuscript; which they will write (with the help of the Assistant Professor) and be senior author, and (3) the situation will be left as it currently stands with the Volunteer's help acknowledged, and the Assistant Professor and their collaborator as senior and junior authors, respectively. From a strictly ethical perspective we believe that Solution 3 is the correct outcome, given that the Volunteer clearly failed to meet the responsibilities specified in the original agreement. However, from a conflict resolution perspective the Volunteer should interact with the Assistant Professor (possibly including the Assistant Professor's former advisor as a sort of 'mediator') and work out a mutually agreeable plan to receive some level of recognition/compensation. Solution 2 (and other potential alternatives) would satisfy this perspective, and provide an option to senior author a different paper. Nonetheless, the Volunteer refused to work to resolve the issue (or even communicate) with the Assistant Professor so the ultimate solution was Solution 3. Although in this case, 'ownership' of the data is relatively clear, in other situations it may not be (i.e., it could be owned by the PI, by the PI's institution, by the funding agency, or by combinations of individuals and organizations).

#### Scenario two

A Professor who is an editor for a prominent scientific journal would like to give a promising graduate student (henceforth Student) experience in reviewing scientific manuscripts. Over several months, the Professor gives the Student several manuscripts from the journal to review. For each review, the Professor assesses and edits the drafts of the review and then meets with the Student to discuss how the text should be modified to provide more appropriate and constructive criticisms for the authors. Each review assessment by the Professor involves several hours of their time not including the meetings with the Student. By the end of the 'tutorial' the Student has become a very good reviewer. Approximately six months later, and without telling the Professor, the Student submits and publishes a short article in a national journal on

Table 1. A potential chart for assigning responsibilities and assessing authorship.

*Tabla 1. Una posible tabla para asignar responsabilidades y evaluar la autoría.*

Aspect	Author 1 % contribution	Author 2 % contribution	Author 3 % contribution	Author 4 % contribution
Research idea				
Design				
Data collection				
Data analysis				
interpretation				
Writing/revising				
Financial				
Other				

'how to review a paper'. The article contains many pieces of advice regarding manuscript reviewing that the Student obtained from the Professor, but the Professor is not a coauthor nor even mentioned in the acknowledgements. From a strictly ethical perspective it is clear that the student should have coauthored the paper with the Professor, however, that is no longer an option. Consequently, the student should publish an addendum clarifying that much of the information in the article came from the Professor. From a conflict resolution standpoint, a number of possibilities exist, although none are completely satisfactory given that the article already is published and it is unlikely that a second article on the subject would be publishable. Nonetheless, the participants could agree to work on a different coauthored paper as a form of compensation as per Solution 2 in the previous scenario. Clearly this is an imperfect solution but as per current mediation practices it would at least represent a mutually agreed upon resolution. In addition, some organizations have advocated procedures where wronged authors might be added post-publication (Committee on Publication Ethics: <https://publicationethics.org/> and <https://www.casrai.org/credit.html>).

### Scenario three

A graduate student completes a strong PhD working on a problem that is part of a larger research program run for many years by his Professor. The Professor has provided some salary support (most support was from a fellowship won by the Student) for the former Student as well as providing expensive specialized equipment required for the study. The PhD leaves, and now five years later is employed in a professional position. Nevertheless, the PhD has not published any papers from their dissertation. Given the time that has passed, the manuscripts will require substantial editing for publication, including an updated literature

review. Although the Professor has repeatedly tried to contact the PhD, the former student has never responded. In discussion with his colleagues, the Professor suggests the following solutions: (1) the Professor edits and updates the manuscripts and is junior author. He then sends them to the PhD for review, with a time constraint stating that the manuscripts will be submitted if there is no further contact by a reasonable deadline, (2) the same constraints listed in Solution 1, but the Professor edits and updates the manuscripts and assumes the role of senior author; the PhD is moved to junior author, (3) the manuscripts are left unpublished, harming the both the PhD's and the Professor's career, and inhibiting the Professor's ability to obtain future funding. It is unclear whether there are any purely ethically-based solutions to this case; however, the most charitable would be for the Professor to employ Solution 1. Ideally, the PhD would be an active participant in the process and thus would satisfy the requirements of a mutually-agreed conflict-resolution solution as well. Depending on the amount of work required for revision, and the origin of the ideas in the manuscript, Solution 2 might be ethically appropriate as well. Both authors have experienced this situation. In one case, Solution 3 was what actually occurred, but only because the Professor was not interested in employing Solution 2 for concern regarding potential personal and professional conflicts. And in the other case, Solution 1 was what actually occurred, with minimal response from the former graduate student.

Some faculty have tried to avoid these situations by requiring students to sign informal contracts stating that after a certain amount of time, say three years after graduation, the advisor has the right to update and submit the manuscript as first author. One of us (GDG) has used such contracts and found they do remove any ambiguity about the advisor's right to submit the manuscripts after a reasonable amount of

time has passed. Nonetheless, GDG did not experience any increase in manuscript production by former students that could be attributed to use of a contract, nor increased resolution of who should update a manuscript and be senior author. Depending on the student, such an approach could appear unduly formal and legalistic, particularly given the power–structure difference between faculty and student, so such a practice must be approached carefully.

## Conclusions

Peer-reviewed scientific publication is, and likely will continue to be, the standard mode for communicating important research results to research scientists, managers, teachers, and policy-makers, as well as an important metric by which scientific professionals are evaluated. Nonetheless, collaborative ventures are always open to misunderstandings and differences of opinion, and the increasing complexity of collaborative work only makes these issues more problematical. In our review of the literature, we described criteria for inclusion and ordering of individuals as authors for scientific publications, as well as techniques used by journals and publishers to better account for authorship in their published papers. In addition, for pedagogical purposes and discussion, we provided several realistic conflict scenarios. There are many valid opinions regarding how to decide authorship, some of which conflict, and praxis does not always follow the norms of a field. Some summary points and recommendations from our paper include:

1. Despite the importance of publication and authorship across all fields, the literature concerning authorship issues are contained in diverse and widely distributed publications, some of which may not be easily accessible. Consequently, there is a need for increased awareness of these issues among scientists and potential authors, as well as professional societies, journals, publishers, and employers. In fact, that is the purpose of our review of the literature.

2. Journals, publishers, and professional societies need to consider whether contribution statements may be used effectively, and if so, work to standardize their use to ensure they become a more effective tool for describing the roles of authors included in a byline (e.g., as suggested by CRediT).

3. Employers (e.g., agencies, universities) should also develop criteria for authorship decisions, perhaps involving standardization and use of contribution statements by students and employees.

4. Discussion of authorship issues needs to take place in both informal lab group settings and with professional societies, employers, etc. The scenarios we provide are intended to contribute to this pedagogical need.

5. Discussion among individuals should take place before a study is initiated and continued throughout the study so that all who should be considered as an author are considered, and no one is included as an author who has not satisfied the group's agreed-upon requirements for authorship.

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