

## An overview of Open Access publishing in palaeontology

Jonathan P. Tennant and Dean R. Lomax

### ABSTRACT

Open Access (OA) describes the free, unrestricted access to and re-use of published research articles. Recently, the announcement of 'Plan S' has catalysed a new wave of interest, debate, and practice surrounding OA. Here, we provide a simple overview of the 'OA status' of palaeontology journals within this rapidly shifting landscape. In particular, we focus on aspects such as whether or not there are author-facing charges for Open Access, what embargo periods or restrictions on 'self-archiving' policies are in place, and whether or not the sharing of preprints is permitted. The majority of journals have self-archiving policies that allow authors to share their peer reviewed work via 'green OA' without charge. There is a clear relationship between 'journal impact' and higher charges levied for OA. The most expensive journals are typically published by the large, commercial, publishing houses, rather than the palaeontology community themselves. However, there are a number of article processing charge (APC)-free (diamond) OA journals that can also be considered to be of moderate impact. Until the palaeontology community makes the decision to move away from journal-based evaluation criteria (e.g., the impact factor), it is likely that such high costs will continue to impose financial inequities upon the research community. However, until such culture change occurs, palaeontologists could more widely embrace legal self-archiving as an equitable and sustainable way to progress communication of their research.

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## INTRODUCTION

Most published research articles still remain legally inaccessible to the majority of people on this planet (Piwowar et al., 2018). For more than two decades now, members of the wider scholarly community have been making various cases for wider public accessibility to published research, typically referred to in English as Open Access (OA; Matheka et al., 2014; Tennant et al., 2016; Björk, 2016; Bacevic and Muellerleile, 2018). Open Access to research forms an important part of increasing calls for greater public engagement with science (Bates et al., 2009; Stilgoe et al., 2014). Therefore, there is a strong imperative for the palaeontology research community to ensure that there is broad-scale access to the research that they produce (Macleod and Patterson, 1998; Cunningham et al., 2014; Louys, 2015; Louys, et al., 2017; Davies et al., 2017; Tennant and Farke, 2019). However, with this comes significant challenges for palaeontologists, largely focused around choice of publication venue and potential consequences around research assessment.

The overall rate of growth towards Open Access is increasing at a systemic level (Piwowar et al., 2018). However, many seem to feel that this growth is not fast enough. Most recently, this has catalysed a new movement around 'Plan S', a funder-led initiative launched in September 2018 to accelerate the full transition towards Open Access (Else, 2018). According to their website, "The plan is supported by cOAlition S, an international consortium of research funders. Plan S requires that, from 2020, scientific publications that result from research funded by public grants must be published in compliant Open Access journals or platforms." Across Latin America, AmeliCA is a progressive initiative announced in early 2019 (<http://www.amelica.org/en/>), thus placing OA firmly on the global agenda. These high-level initiatives have opened up discussions about the ability of journals and research communities to appropriately and sustainably shift towards a dominantly OA world, especially within the proposed time frames (Johnson, 2019). Palaeontology, like other disciplines, now has a range of publishing options available to authors, including 'born OA' titles, 'hybrid' titles, OA 'platforms', and are operated by a range of non-profits, commercial publishers, and learned societies, presenting an overall complex publishing landscape (Laakso et al., 2011; Laakso and Björk, 2016; Ross-Hellauer et al., 2018).

Now, more than ever, it is imperative that individual research communities understand the schol-

arly publishing landscape, the impact of shifting policies, and the options available to them. To help with this, here we provide an overview of the OA policies and status for a comprehensive selection of journals that publish palaeontology research. This evaluation of the 'openness' of journals can be useful in helping with decision making processes around OA publishing in the future for the palaeontology community (Chen and Olijhoek, 2016). Despite well-known issues with citation-based metrics such as the impact factor (Editors, 2006; Falagas and Alexiou, 2008; Lariviere and Gingras, 2010; Lariviere and Sugimoto, 2018), we also recognise the importance that these often hold within research evaluation processes (Alperin et al., 2018), and thus also provide some analysis and discussion on the impact factor in palaeontology journals.

## METHODS

An original list of 227 journals that publish palaeontological research was constructed based on an exhaustive Web search, followed by cross-checking with the Directory of Open Access Journals (DOAJ). We did not use common databases such as Scopus or Web of Sciences, as these reveal a very biased picture of the 'global' research landscape (Ciarli et al., 2014; Mongeon and Paul-Hus, 2016). This list includes discipline-specific journals, but also a number of interdisciplinary 'megajournals' that have proven reasonably popular within some areas of the palaeontology community and now represent a huge diversity of potential journals for palaeontologists to publish in. The following data were originally gathered in summer 2017, based on three main sources (Sherpa/RoMEO; Web search; clarification through email). The information quality in Sherpa/RoMEO was also of varying quality, and often key data were missing, and so the data were checked manually (i.e., by gathering information directly from journal websites) again in February 2019 to make sure they are as up-to-date as possible and are available as supplementary files included in the Appendix.

For article version terminology, we use that described by Tennant et al. (2018):

**Preprint.** Version of a research paper, typically prior to peer review and publication in a journal.

**Postprint.** Version of a research paper subsequent to peer review (and acceptance), but before any type-setting or copy-editing by the publisher. Also, sometimes called a 'peer reviewed accepted manuscript'.

**Version of Record (VOR).** The final published version of a scholarly research paper, after undergoing formatting (and any other additions) by the publisher.

The data we collected include:

- Journal name;
- Whether or not the journal permits sharing of preprints;
- Whether or not the journal permits sharing of postprints;
- Whether there is an embargo period or not (where there is more than one option, this represents a different embargo based on a different repository type);
- Whether or not the publisher version (VOR) can be shared;
- Whether or not an option for 'gold' OA exists (i.e., instant availability at the point of journal publication; including 'hybrid OA');
- What the article processing charge (APC) for the gold option is (zero denotes 'diamond' OA);
- Source of information from Sherpa/RoMEO;
- Source of information from main website;
- Sherpa/RoMEO colour status;
- 2017 Source Normalised Impact per Publication (SNIP, source: <http://www.journalindicators.com/methodology>) (n=182);
- 2017 impact factor (n=163); and
- Publisher.

For all journals where information on these were not available, the editors of the journal in question were contacted directly by email. However, the response rate for this was exceptionally low, and there is a large proportion of missing data; especially from smaller journals. Thus, the number of journals used in each sub-analysis is different each time depending on data availability (see specific results below for more detail).

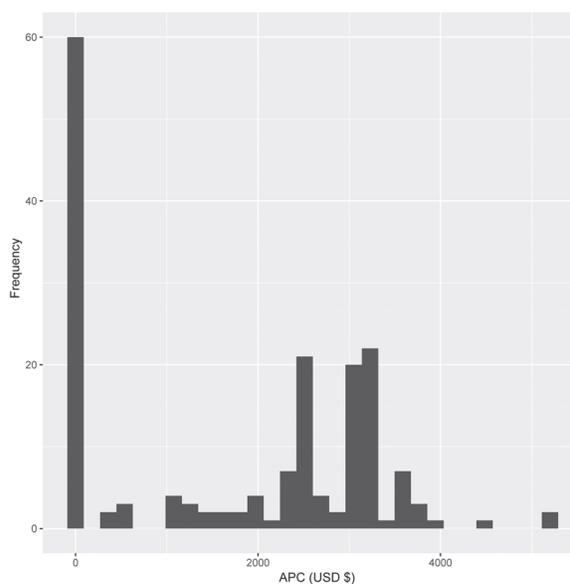
For APC data, some publishers (e.g., Taylor and Francis) vary prices based on geographic location and article type. For consistency, in these cases we set our country to the United Kingdom, and selected normal peer reviewed articles. All prices were then converted to USD and exclude tax. For the impact factor data, availability was also a common issue. Where the 2017 IF was not readily available online, we simply used the next most recently reported value. Furthermore, some article processing charges (APCs) are reported on a by-page basis, and to avoid confusion we simply state this as NA. For bivariate correlation tests (Spearman's rank correlation rho) between APCs, impact factors (IF), and SNIP scores, the default functions

built into R (version 3.5.2) were used (R Core Team, 2018).

## RESULTS AND DISCUSSION

Most of the journals we analysed (185/227; 81%) have a 'gold' OA policy, either as a fully OA journal or hybrid title. Often, discussions around gold OA incorrectly communicate or specify exclusively that this is an 'author pays' model, which is clearly not universal in the case of palaeontology, as many journals (60/227; 26%) do not have author-facing costs (i.e., OA at these journals is funded via other means) (Figure 1). These journals comprise mostly community-led initiatives from within societies, universities, or museums. Furthermore, 84 journals (37%) allow sharing of the final, published Version of Record (VOR), often irrespective of whether the journal levies an APC. Of the 104 journals, 46% explicitly prohibit sharing of the VoR, and 39 do not have a clear policy on this matter (17%).

In our sample, 114 journals do charge APCs, and for the remaining 53 they either do not have a gold OA option or the status is unclear. APCs range from \$5200 USD (before tax) for journals such as *Nature Communications* and *Current Biology* (owned by Springer Nature and Elsevier, respectively), to \$300 USD for *Ameghiniana*, which is published via Open Journal Systems. Of the journals that do charge APCs, there are very few journals that charge less than \$1000 per article (5),



**FIGURE 1.** APC distribution for all journals that have a 'gold' OA option. An APC of zero denotes a 'diamond' OA journal.

and most seem to charge between \$2500 and \$3500 per article (70). The lower end of this intermediate part of the spectrum contains journals mostly published by the Geological Society of America and Taylor and Francis. Elsevier has a number of journals within this range, and the UK-based university presses all charge just under \$3000 per paper. The higher cost end of the spectrum is dominated by the large commercial publishers, Wiley, Springer Nature, and Elsevier (as well as those jointly published by the American Geophysical Union and Wiley).

While the general state of the scholarly publishing industry can be described as an oligopoly, with a few large actors dominating the scene (Larivière et al., 2015), this does not seem to be the case in palaeontology. Elsevier publishes the highest number of palaeontology journals (25), followed closely by Springer Nature and Wiley (22 each; with Springer Open having two more with academic partnerships). Together, this represents around one-third of the total number of palaeontology journals. The next largest publishers in terms of number of journals published are Taylor and Francis (10), De Gruyter Open (6), Cambridge University Press (5), and Oxford University Press, Schweizerbart Science Publishers, and The Royal Society (four each, with those by The Royal Society being multi-disciplinary). This case for palaeontology is likely unique, as there are a huge number of small museum-led journals, mostly from Europe and South America, as well as from the learned societies from around the world. Of note is that there do not appear to be any journals that are led from African organisations. This creates a very heterogeneous global landscape for palaeontology journals. However, how this is reflected in the number of articles published per journal remains to be investigated and does not prevent the fact that there are a number of inherent issues that create a highly dysfunctional scholarly publishing landscape (e.g., non-disclosure clauses on library-publisher contracts; pressure to publish in ‘high impact journals’; lack of substitutability and buyer power; Tennant and Brembs, 2018).

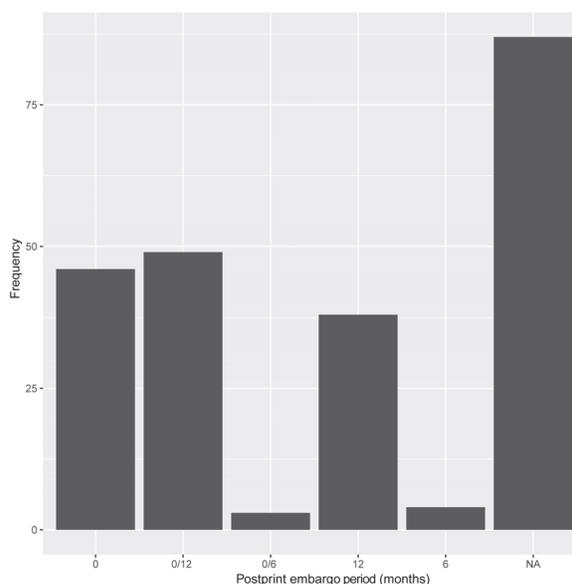
Just over half (61%) of the journals in our sample allow authors to share preprints of their articles (139/227) (Table 1). Only 14 journals do not permit sharing (6%), and of these, many are journals which focus on taxonomy. Taxonomical literature is a special case scenario that requires specific policies, mostly revolving around the International Commission on Zoological Nomenclature (ICZN) and issues that can arise due to association

**TABLE 1.** The number of journals that allow sharing of preprints and postprints.

| Article type | No | Yes | NA |
|--------------|----|-----|----|
| Preprints    | 14 | 139 | 74 |
| Postprints   | 17 | 143 | 67 |

of naming priority with the date of publication (Bénichou et al., 2018). Seventy-four journals in our sample did not have an explicit preprint policy (33%), which likely reflects the relatively recent emergence of preprints in palaeontology. For postprints, the story is largely similar. Of the journals, 143 allow the sharing of postprints in one form or another (63%), and only 17 explicitly prohibit this sharing (7%). Sixty-seven journals do not have a clear postprint sharing policy (30%). Of the 17 journals that prohibit sharing of postprints, this includes 10 of the 14 journals that also prohibit sharing of preprints. Virtually all journals from the large commercial publishing houses (e.g., Elsevier, Springer Nature, Taylor and Francis, Wiley), and learned societies, permit sharing of postprints in one form or another.

For journals that do allow sharing of postprints, the embargo periods are complex and highly variable (Figure 2). They often differ between publishers, and have policies that vary between what licenses can be applied, and the sort of venue or repository in which works are allowed to be shared. This complexity might be one reason why the uptake of ‘green’ OA among palaeontolo-

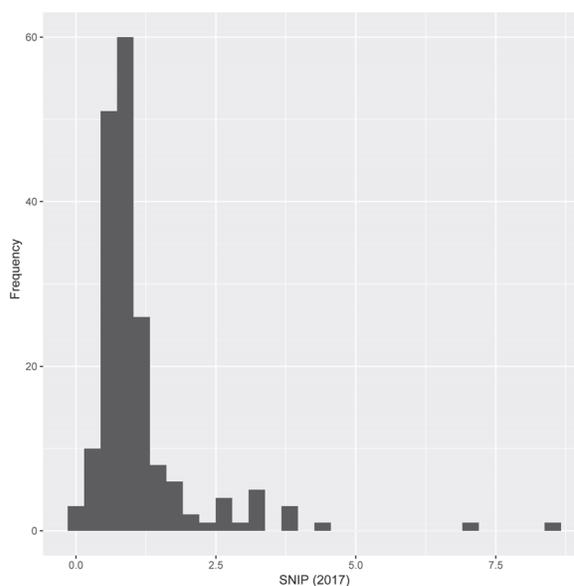


**FIGURE 2.** Publisher-imposed embargo periods on sharing of postprints (months).

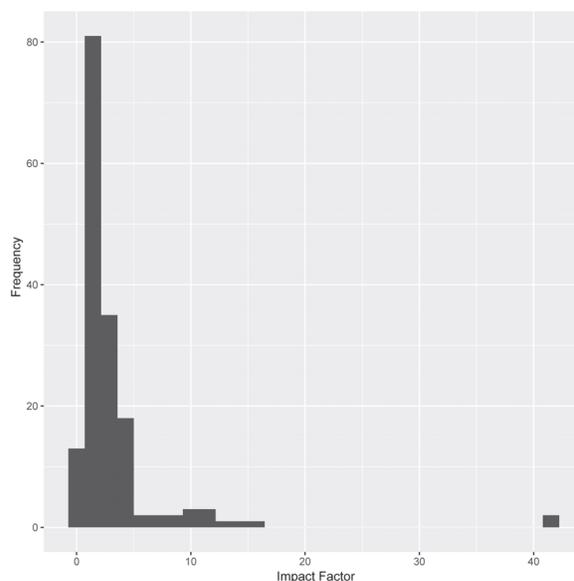
gists seems to be fairly limited (Tennant and Farke, 2019). The majority (82%) of journals that have zero-embargo (i.e., sharing is usually allowed upon acceptance) are labelled as ‘green’ within SHERPA/RoMEO. Six month embargoes are not common and confined to the *Nature*-branded journals as well as *Science*. Twelve month embargoes, typically associated with a SHERPA/RoMEO ‘yellow’ status, are common among publishers such as Wiley and the UK-based university presses (72% of all journals with a ‘yellow’ status). Major publishers such as Taylor and Francis and Elsevier are those which offer more complex postprint sharing policies, which seems to be reflected in a very low uptake of this option among palaeontologists in the journals they publish (Tennant and Farke, 2019). A large number of journals do not have a postprint or embargo policy (29% and 38%, respectively), which is clearly reflected in their absence from the SHERPA/RoMEO database. Overall, 146/227 journals (64%) have an entry in SHERPA/RoMEO.

Most palaeontology journals group towards the lower end of the SNIP spectrum, with scores between 0 and 1 (Figure 3). Outliers to this pattern include the interdisciplinary magazines *Science* and *Nature*, as well as review journals (e.g., *Biological Reviews*), which tend to inherently accrue more citations and are often considered to be ‘higher impact’. This pattern is almost exactly replicated by the distribution of journal impact factors (Figure 4). The SNIP and IF scores show a very strong correlation (Figure 5), with a Spearman’s correlation strength of 0.848 ( $p < 0.0001$ ), indicating a high degree of cross-correlation between the two statistics.

The relationship between both SNIP and IF and APCs is remarkably similar (Figures 6, 7). In both cases, there is a positive relationship where APCs scale with both measures, but with a wide degree of scattering. Only a single journal with a SNIP above 2 does not charge an APC, *Proceedings of the Linnean Society of New South Wales*, published by the University of Sydney. This correlation between SNIP and APC (Spearman’s  $\text{cor} = 0.402$ ,  $p < 0.0001$ ) is also broadly reflected in the relationship between IF and APC (Spearman’s  $\text{cor} = 0.542$ ,  $p < 0.0001$ ). In our sample, there is only one journal with an IF above 2 that also does not charge an APC, the *Journal of Paleogeography*. Besides this journal, the highest IF and APC free journals are *Contributions to Zoology* and *Acta Palaeontologica Polonica*. This relationship is troubling, as it suggests that many journals define their APCs based on journal-branding criteria, rather

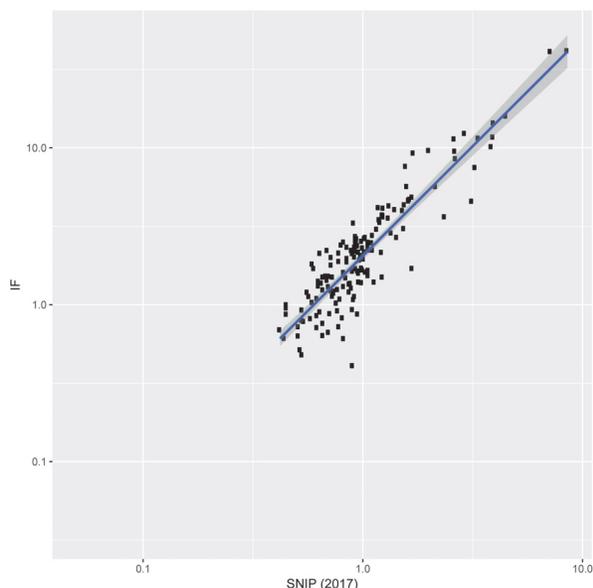


**FIGURE 3.** Histogram of SNIP scores for palaeontology journals.

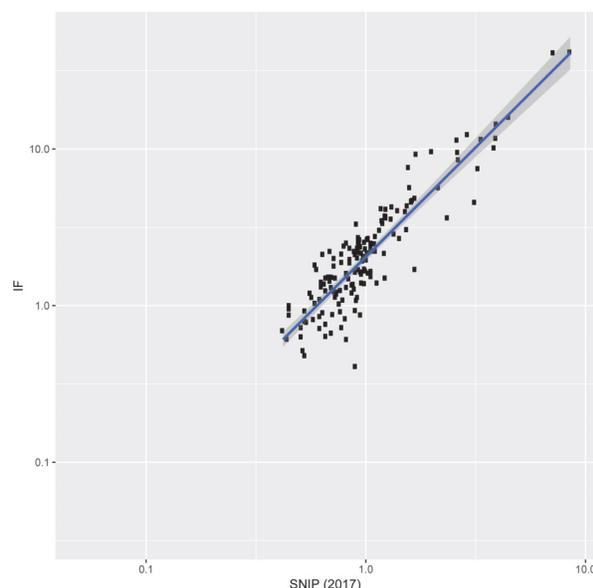


**FIGURE 4.** Histogram of impact factor scores for palaeontology journals.

than any inherent quality, value, or cost of the production process; indeed, justification for APCs is non-existent for any journal which we sampled, with the exception of eLIFE (<https://openaccess.mpg.de/2203014/elife-to-introduce-apc>). As the top end of the APC spectrum is dominated by the more commercial publishers, this represents a worrying state of the ‘market’ in which both research evaluation and OA affordability are being,



**FIGURE 5.** Relationship between SNIP and IF for palaeontology journals, with a fitted linear regression (the grey shaded area represents the 95% confidence intervals for the model). R-squared = 0.899.

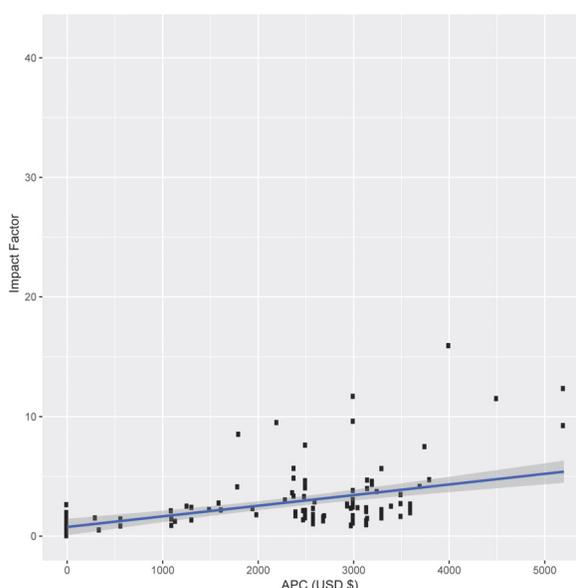


**FIGURE 6.** Relationship between SNIP and APC. R-squared = 0.135.

to a large extent, controlled by commercial entities outside of the palaeontology community.

### Impact of OA on the Palaeontology Community

In this OA transitional phase, things have been difficult for many authors due to the financial discrimination imposed by the APC system; irre-



**FIGURE 7.** Relationship between IF and APC. R-squared = 0.227.

spective of any potential waiver or discount systems in place. This is especially difficult for those individuals who do not have funding, either directly or via their institutions (if applicable). Such a problem is particularly relevant to those individuals who are not employed in the university, museum or professional sector and thus do not have any (potential) access to funding that will ensure their research will be made OA in an APC-dependent venue. Thus, the APC-driven elements of OA constrain journal choice for those individuals who want to (or have to) publish OA, but have restricted or zero funds. Consequently, in this situation, the only option for having their research specifically in a high(er) 'impact' journal, without paying an APC charge from their own pocket, is to place, often reluctantly, their work behind a paywall.

Ultimately this APC-dominated culture has created a two-tier system around OA – not because of any of the inherent principles underlying it, but due to the way in which it has been implemented by many parts of the industry sector. In this system, you have one group of researchers who can afford to publish in OA journals, and especially those which charge high APCs (which tend to be 'higher impact' venues) – not because of any intrinsic properties of their research, but simply due to the financial privileges afforded to them. Then there is the other group which does not benefit from such financial security, who – while options are certainly still available to them – suffer from

constrained choice due to the affordability of APCs, and the importance of journal choice for career progression. Future research should investigate the impact that constraints around APCs have had on publication choices for researchers, and the potential impact this can have on the visibility and re-use of palaeontology research (Piwowar et al., 2018; Tennant and Farke, 2019).

Thus, there is a clear role for ‘green’ OA here (i.e., self-archiving of peer reviewed, accepted manuscripts), which acts in parallel to traditional journal publication and is cost-free for authors. This helps to level the playing field, and a number of platforms now exist for authors who wish to pursue this route to OA, such as institutional repositories and the community-driven paleorXiv (<https://paleorxiv.org/>). Evidently, irrespective of whether or not one agrees with journal-based evaluation practices, the current APC model imposed by many palaeontology journals can have deleterious effects on researchers who have less (or no) access to funding.

## CONCLUSIONS

Here, we have presented an overview of the current journal landscape in palaeontology, with a special focus on Open Access policies. With more than 220 journals that publish palaeontological research, this presents a complex system for palaeontologists to understand, and affects a number of important decision-making processes. A number of key points stand out from our analysis.

- Most palaeontology journals allow free sharing of preprints.
- Most palaeontology journals allow free sharing of postprints, often with an embargo period, depending on the locality shared.
- There is a clear relationship between journal impact and prices levied by journals for publishing OA.
- A large number of APC-free ‘diamond OA’ journals exist, many of which are of equal ‘impact’ to their APC-driven counterparts.
- The most expensive journals are those operated by large commercial publishers.
- There is scope for many journals we analysed to clarify their OA policies, which will help to guide author choices during this rapidly changing ‘transformative’ OA period.

Overall, we hope that the palaeontology community finds this overview useful in helping to illuminate some elements of the complex scholarly publishing ecosystem, as well as to catalyse more

research into this system. Until the relationship between venue of publication and career progression stops being perpetuated by the wider research community, the damaging nature of APC-driven OA will continue to have a negative impact on authors. While Plan S encourages a shift away from this pervasive monoculture, it is up to individuals themselves to adopt and advocate for more rigorous practices of research evaluation, as well as to understand the options available to them for publishing (especially those which do not require APCs; <https://101innovations.wordpress.com/2018/11/30/nine-routes-towards-plan-s-compliance/>). Steps towards this can include, for example, signing and adopting the principles outlined in the San Francisco Declaration on Research Assessment (<https://sfedora.org/>), and for senior researchers in a position of responsibility for career advancement to not evaluate candidates based on where they have published. Future research could also focus how journals are transitioning historically towards an OA system (e.g., which have ‘flipped’ to hybrid or full OA models, and when), as well as the proportion of research articles in different journals that have been made OA, and at what cost.

We see the widespread uptake of green OA as a potential solution to this problem, until a shift towards more progressive research evaluation is adopted as normative by the palaeontology community. Such a practice represents a more universally equitable form of OA than APC-driven ‘gold’, and overcomes the constraints or pressures that authors might face in journal choice. Finally, we wish to note that OA is a rapidly changing landscape. During this transformative period around ‘Plan S’, we do not advocate for any individual researcher to potentially put themselves at risk or compromise their potential future career; rather, we only seek to help the community understand the landscape better, so that together we can help to make more efficient, and evidence-informed, decisions that benefit us all.

## CONFLICTS OF INTEREST

JPT is the founder of paleorXiv, the Executive Editor for the OA journal *Geoscience Communication*, and Editor for the OA journal *Publications*. He receives no income from either of these activities. As an open-access journal, *Palaeontologia Electronica* was included in the dataset for this study, but was not otherwise involved in the research or writing.

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## APPENDIX

Supplementary file 1: Primary data sources used. (968\_SI\_\_1\_3.rar)

Supplementary file 2: Database of self-archiving policies for palaeontology journals. (Supplementary files 2-4 are combined into one zipped file 968\_s2\_3\_4.zip)

Supplementary file 3: R project file. (Supplementary files 2-4 are combined into one zipped file 968\_s2\_3\_4.zip)

Supplementary file 4: R script for creating figures. (Supplementary files 2-4 are combined into one zipped file 968\_s2\_3\_4.zip)

Supplementary file 5: All supplementary files zipped. (968\_appendix.zip)