Roman Studies and Digital Resources*

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I INTRODUCTION

There is hardly any aspect of scholarly work and teaching in Roman Studies today not marked by digital technology. We assume that readers regularly access digital images of Roman material culture, use digitised corpora of primary sources in the original language or translation or consult online books and articles. The availability of digital resources on the internet is also a welcome enabler of ongoing public interest and even participation in the field. This overall state of affairs is generally a positive development, but both general trends and specific digital resources deserve a critical appraisal.

Although we shall mention a considerable range of such resources, we are acutely conscious that, partly in an effort to make this review readable and not just a list, we have omitted an enormous number of worthwhile databases, digitised textual resources and other good things. As a counterbalance to our extreme selectivity, we recommend the *Ancient World Online* blog as a guide to new resources and *The Digital Classicist Wiki* as a well-organised collection of links.[1] There are other useful starting points, and we encourage exploration of this universe, now far too large for any individual to know.

We do not come at this survey from a detached perspective. We have both been active agents in various projects, and consultants and advisers in the case of others. We will note such connections. Readers can infer from this previous work that we are believers in the importance of creating and using digital resources. Nonetheless, our goal is mostly to report and critique, rather than to defend the digital enterprise.[2] In doing so, we are conscious that none of the projects that we ourselves have been involved in is free of the limitations and problems that we will observe below, whether because of shortage of funds, institutional constraints or human fallibility. We shall draw both positive and negative conclusions from our experiences. We have also tried to avoid assuming that all of our readers will have easy access to the same range of resources as we do through our affiliation with a relatively wealthy US-based research university. Our biases and circumstances inevitably inform our selection of digital resources and what we write about them; we therefore look forward to the additional perspectives that will come if this survey is the first of a series.

II THEMES, ISSUES AND CRITERIA

To a large degree, we have selected the resources we discuss in order to exemplify, illustrate and clarify a set of broader themes, the exploration of which sets out a view not only of where we are at present but where we should be headed. The nature of publication on the internet, the importance of permanence and sustainability, the recognition of widespread access to information as an essential outcome, modes of interaction with

* We thank Tom Elliott and the *Journal*'s two readers for their very helpful comments. All Web links cited here were checked in June 2018.

[1] http://ancientworldonline.blogspot.com and https://wiki.digitalclassicist.org/Main_Page.

[2] Bond *et al.* 2017.

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data, and connectivity across resources are the issues that guide us through the constantly expanding landscape of digital resources for the study of the Roman world.[3] We anticipate our conclusion by noting that these concerns come together in the overarching question whether the combined benefit of all digital resources is as great as it could be. To this, we answer 'no', in the sense that many digital resources are relatively insular in their relationship to others, and likewise 'no' to the extent that few projects have taken public steps to ensure the permanence and sustainability of the digital resources they have created. This last is a failure that puts the potential benefits of digital work at risk of disappearing. But we stress that we have chosen to discuss and criticise projects that represent some form of excellence when considering the contribution each makes on its own terms.

Of the guiding criteria listed above, permanence is both very important and the one by which many digital resources fall short. By 'permanence' we mean steps to ensure that the static content or underlying data associated with a website will continue to be accessible over the long term. A relatively straightforward approach is to deposit all content associated with a digital resource with a third party that can guarantee ongoing availability. A few such options are discussed below. We include in our review digital resources that lack any public declaration of how they will ensure ongoing access, despite their vulnerability; excluding such resources because of this deficiency would not serve our readers well. As scholarship becomes ever more dependent on digital resources provided via the web rather than by physical media, we risk not merely broken links but the disappearance of the foundations on which other work is based. While initiatives such as the *Internet Archive* capture much on the web that would otherwise be ephemeral, we can still insist that permanence is an essential characteristic of proper publication.[4] There will also be opportunities to recognise sustainability, by which we mean any institutional context or clear planning that will allow the ongoing allocation of financial resources, availability of personnel and provision of technical infrastructure necessary to support the continuing publication of digital content via a public website.[5] This is a higher bar. Some museum catalogues offer a prime example of how institutional sponsorship can meet this test, though even for these it is becoming best practice to also deposit data with third parties.

The term 'access' overlaps with 'publication' to the extent that we have defined the latter broadly. But content-creators make decisions that significantly affect the nature of access. Many sites are accessible at no cost but nonetheless restrict the use of their data. A good example is the Packard Humanities Institute (PHI) sites for Greek epigraphy and Latin literature, where not only does the obligatory licence agreement prohibit other uses of the data, but the technical structure does not allow downloading of data. *Trismegistos* and *Orbis* impose no licence on the user, but it is not possible to download the datasets from the website, although known scholars can get copies of the underlying Filemaker data files for *Trismegistos* on request. In contrast, sites like the *Papyrological Navigator* and *Pleiades* allow for user downloading and reuse of data, subject only to the Creative Commons licences in place, which mandate attribution to the source. But even sites like PHI are 'open' by comparison with the *Thesaurus Linguae Graecae*, which charges high licence fees for the full database, as well as imposing stringent restrictions on reuse of data. Other critical text databases are also walled.

When assessing functionality, we mostly intend to praise sites that make good use of Web capabilities: not only attractively displayed pages and simple keyword searching of texts, but enabling such interactions as generating and then using maps and other

[3] Gibbs 2011 and Thomas 2016 discuss rubrics for the evaluation of digital scholarship.
[4] http://archive.org, particularly the *Wayback Machine* at http://archive.org/web/.
[5] Posner 2016.

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visualisations or allowing users to rotate 3D models can fundamentally distinguish online from print experience. But even with basic functions there are widespread weaknesses: the experience of reading books online, for example, is poor, at least when paging through volumes accessed and viewed on library websites. There are multiple, incompatible search interfaces for textual corpora that impede effective research. To the extent we return to this theme, it is to encourage thoughtfulness on the part of providers.

Connectivity can be understood both generally as an ideal and specifically as a technical approach based on the principles of Linked Open Data, LOD. 'Does a digital resource encourage awareness of related resources?' is the general formulation. 'Does a digital resource make explicit links to definitions of the well-known concepts that also appear in other resources?' moves towards a more rigorous approach, which informs our discussion in Section VI.

With these themes in place, we first apply them to a few of the more widely used high-quality digital resources for Roman Studies. Following its first availability in 2012, *Orbis*, hosted at Stanford University, quickly gained recognition as a digital tool that enabled a new level of engagement with connectivity in the Roman Mediterranean.[6] Issues of cost and time of both travel and transport have a long historiography, but *Orbis* has made it possible to give more precision to this aspect of the Roman world. We can see this from the citations of *Orbis* in scholarly literature, ranging from brief acknowledgement that it was a source for observations about travel time to more sustained engagement with its calculations.[7] In this regard, *Orbis* is a great success. But not surprisingly, the scholarship that most directly relies on and engages with *Orbis* data has come from authors closely involved with the project.[8] We explain this phenomenon in part by noting that *Orbis* is primarily available to third-party researchers and to the public as a website that neither makes available the full data on which its calculations are based nor consistently offers the same analytical capabilities that have been developed for use in-house, a point the project has at times addressed.[9] This means that the versions of *Orbis* available to members of the project at the time they undertook their work cannot be reviewed here. More generally, statements based on calculations that are not repeatable (because the data and computational methods they rely on are not openly shared) fall short of allowing digital resources to contribute all that they might to scholarly discourse.[10]

Orbis additionally suffers from an inability even for principals in the project to address gaps in its core information-base.[11] The short-term significance of *Orbis* as an enabler of discussion about connectivity is proven. Will the website still exist and be usable in ten or fifteen years, when browsers have been updated and Javascript, on which much of its functionality depends, has evolved? We do not know, and that raises questions about it as a permanent scholarly publication.

In the interests of permanence, we advise against reliance on plug-ins such as Adobe Flash to deliver the core of a site's intellectual content, particularly if there is no mechanism to download that content. A case in point is the *Digital Augustan Rome* project.[12] The site is distinguished by excellent discussion of its aims and history, even if

[6] http://orbis.stanford.edu. Dunn 2012; Graham *et al.* 2015: 15–19.
[7] Russell 2014: 111; Mattern 2013: 16, n. 12; Concanon 2017: 61.
[8] Scheidel 2013; Scheidel 2014; and relevant discussion at Meeks 2015: 20. See the topic 'Research' at http://orbis.stanford.edu for additional working papers.
[9] Scheidel 2014: 9.
[10] Marwick 2016.
[11] For example, camels do not figure in the means of transportation considered, because they were available in antiquity in only some parts of the Roman world.
[12] http://digitalaugustanrome.org.

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this text is now outdated.[13] And there is a downloadable AutoCad file for the 'topography of Augustan Rome'. Nonetheless, the main functionality of interacting with a map showing Augustan-period structures requires the Flash Plug-in, which is less and less commonly installed in browsers and needs regular updating due to security risks. Another high-profile effort that relies on a proprietary plug-in is the work of the Gabii Excavations to publish a mid-republican house, in part through the use of 3D models in a digital version available only for $150.00.[14] Some of the archaeological data associated with this publication are available via an online database established by the project and in the archive *Open Context*.[15] The specifically 3D content, which we think is completely available only in the formally published version, relies on the Unity plug-in for delivery. A third high-profile project that uses a proprietary plug-in for delivery is the *Stanford Digital Forma Urbis Romae Project*.[16] Although this was very much a leader when first published, many of the 3D models of fragments that it makes available are not easily viewable because they require a proprietary application.[17] Fortunately, some of the models are available in standard formats and so are currently viewable and still very useful. For these three publications, each potentially excellent and permanent, it may be that standards-based approaches to delivery of interactive content will be further developed and adopted by the authors and publishers in the future.[18] Accordingly, we leave the task of considering their longevity and ongoing utility to subsequent reviews.

III ROMAN STUDIES IN THE LARGER DIGITAL CONTEXT

With these themes in mind, we continue to look at specific resources. We open with resources that are not narrowly Roman in scope but that contribute to supporting Roman Studies.

Academics with institutional access to *JSTOR* take its rich collection of articles and its growing collection of books for granted, and everyone has access to large numbers of open-access journals and many of the books in the *Internet Archive*, *HathiTrust* and *Google Books*.[19] *Persée*, hosted at the University of Lyon, is a model for the provision of access to scholarly journals on a national basis.[20] It is unfortunately the case that copyright restrictions still frustrate free (legal) access to most post-1923 books, and *Google Books* presents different content to users in different jurisdictions. Those who work in institutions with substantial budgets for digital resources have at their disposition rapidly increasing bodies of online books from the major commercial and university presses, as well as from the ACLS *Humanities E-Books* project.[21] Oxford University Press, Cambridge University Press and Wiley-Blackwell all provide online access to many of their specialised monographs, and also to the series of so-called

[13] Although we will not mention every instance, this is a common occurrence on many sites.
[14] Opitz *et al.* 2016, direct link: https://dx.doi.org/10.3998/mpub.9231782. For reviews see Campana 2017; O'Riordan 2017; Poehler 2018; Sapirstein 2017. That a digital publication received so many reviews is itself distinctive; only Campana did not mention the high price.
[15] Gabii in *Open Context*: https://opencontext.org/projects/3585b372-8d2d-436c-9a4c-b5c10fce3ccd. The project sponsored database is at https://quod.lib.umich.edu/g/gabii_1_data/.
[16] https://formaurbis.stanford.edu.
[17] http://graphics.stanford.edu/software/scanview/.
[18] The observations by O'Donnell 2013: 66 on the relative longevity of projects using plain HTML to deliver content are apposite here.
[19] http://jstor.org; http://archive.org; http://hathitrust.org; http://books.google.com.
[20] http://www.persee.fr.
[21] http://humanitiesebook.org.

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handbooks and companions that have become a feature of the scholarly landscape.[22] Collectively, these publications are a useful digital resource, as are the *Oxford Bibliographies* that cover many Roman topics.[23] Similar observations can be made for academic journals; for example, the *Journal of Roman Studies* is itself available to paying individual and institutional subscribers through *Cambridge Core*.[24] The *Journal of Roman Archaeology*, a latecomer to online access, is now also in *Cambridge Core*.[25]

Whole underground networks circulating PDFs of books and articles have grown up in response to the reality of unequal access to commercial vendors. More visible than such informal sharing are for-profit entities such as *Academia.edu*, currently the highest profile entity of its kind, and *ResearchGate*, both of which provide venues for scholars to post their own articles.[26] Both suffer from the perception that in the absence of institutional backing they may not be permanent, and from the not unfounded view that they are as interested in selling either information about users or premium services as they are in providing a community resource.[27] Recently, not-for-profit alternatives such as *Humanities Commons* and *Zenodo* have gained some traction.[28] The growth of commercial and non-profit archiving services highlights the reality that repositories set up by institutions of higher learning and available to affiliated faculty and staff have not entirely met the perceived need of a place for individual scholars to make their work both freely available and likely to be discovered by interested readers. Nor have scholarly societies in the discipline met this challenge.

While the current state of affairs in the distribution of scholarly articles and books is probably unstable, there is no road back. Particularly for journals, born-digital publication efforts surely have a bright future. *Internet Archaeology*, or *IA*, was a pioneer and now has an established record; its first issue from 1996 included the article *Roman Amphorae in Britain*.[29] The newer online journal *Mediterranean Archaeology and Archaeometry* is also a venue for interesting work, though we prefer *IA*'s choice to publish its articles as plain HTML that appears directly in browsers rather than as PDFs.[30] It is also useful that the most high-profile open-access digital journal, *PLOS One*, has published articles relevant to the broad field of Roman Studies.[31] The current authors initiated the digital journal *ISAW Papers*, which has also published research oriented to the Roman world.[32]

To move now towards matters more specifically Roman. In line with recent directions in the field, we take Roman Studies to include the vast arc of places and peoples from Britain to Mesopotamia along with their neighbours, as well as all the forms of evidence that can be used to study them. The digital resources for Roman Studies thus include a wide variety of things that once might not have been thought of as 'Roman'. An example is *Syriaca.org*, which describes itself as 'a digital project for the study of Syriac literature, culture, and history' and provides a useful starting point by which a Romanist can explore that very different but deeply relevant culture.[33] It is useful that the content here is published

[22] Cambridge University Press has collected its 'Companions' under the Cambridge Core brand at https://www.cambridge.org/core. Oxford University Press's 'Handbooks' are available to subscribers at http://www.oxfordhandbooks.com/. Wiley-Blackwell's are available to subscribers at http://www.blackwellreference.com/.
[23] http://www.oxfordbibliographies.com.
[24] https://www.cambridge.org/core/journals/journal-of-roman-studies.
[25] https://www.cambridge.org/core/journals/journal-of-roman-archaeology.
[26] https://academia.edu and https://researchgate.net.
[27] Bond 2017.
[28] https://hcommons.org and https://zenodo.org.
[29] Tyers 1996.
[30] http://www.maajournal.com/.
[31] Kilgrove and Montgomery 2016.
[32] e.g., Bransbourg 2012.
[33] http://syriaca.org.

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under a Creative Commons Attribution 3.0 licence.[34] The website *Sasanika*, which is devoted to the study of the Sasanian Empire, provides encyclopedia-style entries that offer a useful starting point for Romanists, though it should be noted that the text and images are published under a restrictive 'All rights reserved' copyright regime.[35] Stretching chronological bounds, more modern fields of study also contribute relevant digital resources.[36]

IV TEXTUAL RESOURCES

Although the digitisation of textual resources for the Greek and Roman world was the earliest area of computer applications to the Classics, and we are all accustomed to using digital texts, this area is far from having reached a satisfactory condition. Greek literature of all periods relevant to Roman Studies has for many years now been fully available at the *Thesaurus Linguae Graecae*,[37] but the inability to download large quantities of text, the limitations of the web interface and the high cost of licences have frustrated many users or would-be users. For the Latin of the Republic and Principate, the free Packard Humanities Institute (PHI) Latin database has allowed string searching but not a lot else; it too cannot be downloaded for user manipulation.[38] Far richer is the *Thesaurus Linguae Latinae* database on De Gruyter's website, but it also has substantial licence fees.[39] Similarly, the Brepols *Library of Latin Texts*, along with a number of other databases involving relevant textual material that Brepols provides, is available by paid subscription only.[40] *The Digital Loeb Classical Library* is another entry in the set of commercial services providing access to texts.[41] A project to digitise later Latin literature has begun in Piedmont, the *Biblioteca digitale di testi latini tardoantichi* (digilibLT). It picks up where the PHI database leaves off and offers many advantages, including free use and the ability to download texts in a variety of formats.[42] Its first phase is focusing on pagan prose works, and a considerable amount has already been entered.

A considerable, but far less complete, body of Greek and Latin texts has long been available at *Perseus*, along with some public domain translations.[43] *Perseus* also provides tools for morphological analysis that link to Greek lexica and Latin dictionaries. That many of *Perseus*' texts are available in open formats means that it has become an enabler of innovative digital approaches to working with a classical corpus.[44] The founder of *Perseus*, Gregory Crane, has more recently launched the ambitious *Open Philology Project*, with a subproject aimed at breaking the hold that licensed digital

[34] This licence allows the user to (re)use published material freely without seeking specific permission, requiring only citation of the source. (It thus excludes plagiarism.) Henceforth we will use the standard abbreviations for Creative Commons licences. See https://creativecommons.org/share-your-work/licensing-types-examples/.
[35] https://www.sasanika.org.
[36] The recent introduction to digital approaches to Medieval Studies by Birnbaum *et al.* 2017 has much to offer Romanists in terms of a useful framework and reference to specific resources.
[37] https://stephanus.tlg.uci.edu.
[38] http://latin.packhum.org.
[39] https://www.degruyter.com/view/db/tll.
[40] http://www.brepols.net/Pages/BrowseBySeries.aspx?TreeSeries=LLT-O.
[41] http://www.hup.harvard.edu/features/loeb/digital.html.
[42] http://digiliblt.lett.unipmn.it/.
[43] At this writing, the Greco-Roman materials in Perseus were available at http://www.perseus.tufts.edu/hopper/; this interface is reviewed at Lang 2018. See also https://scaife.perseus.org.
[44] https://www.dh.uni-leipzig.de/wo/projects/ancient-greek-and-latin-dependency-treebank-2-0/ is an example.

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resources hold on scholars' use of ancient Greek and Latin texts.[45] This has much work ahead of it, but its conception belongs to the digital thinking of the present rather than of the 1970s, when most of the legacy resources were conceived and begun. It is not a criticism of these foundational projects that they were initiated in another era, mostly even before the microcomputer revolution, not to speak of the Web. But their capacity to renew themselves in the face of important changes in the technological and social environment has been extremely variable. All such pressures are only likely to increase as computational packages such as the *Classical Languages Toolkit*, which works best with open content, become more capable and encourage more digital work with large corpora.[46]

In the area of ancient documents, pay-walls have not been an issue.[47] Even in their earliest forms, on CD-ROM, the *Duke Data Bank of Documentary Papyri* (DDbDP) and the *PHI Greek Epigraphy* database were made available at nominal cost, and as they moved to the Web they have always been free to users.[48] The same has been true of the databases in Latin epigraphy produced in a variety of centres. The result of this distributed, loosely controlled and free approach, it has to be said, has been an environment in which coordination, coherence of user experience and sustainability have been uncertain or lacking.[49] The papyri today offer a reasonably successful portal unifying texts, translations, metadata, images and bibliography in the *Papyrological Navigator* (PN).[50] It draws on resources managed in Heidelberg, Brussels and Leuven as well as at Duke, its technology host and manager. As discussed later in this review, it depends on crowdsourcing to keep parts of the content current. Other parts, more directly managed by partner institutions, remain vulnerable to future funding and staffing patterns. The new *Digital Corpus of Literary Papyri* will be fully integrated into the PN in the near future.[51] Its structural characteristics are similar to those of the PN. A vast array of metadata not yet integrated into the PN, including archives, names and topographic information, can be found at the Leuven site *Trismegistos*.[52] This invaluable site also has no long-term funding or sustainability plan.

The creation of an epigraphic equivalent to the PN, whether with similar technology or a more loosely structured approach, remains a desideratum. For the moment, apart from the PHI Greek epigraphy database, Latin inscriptions are served by several European databases largely federated (and with a barely serviceable web portal) in *EAGLE*.[53] But *EAGLE* has no ongoing infrastructure or funding, has poorly curated texts that are hard to access, and, depending on a researcher's interests, some of the existing sites offer more options for searching than *EAGLE* itself does; the *Epigraphische Datenbank Heidelberg* (EDH) is particularly rich in metadata.[54] It too has no continuing funding, but it has made its data more freely available than any of the others. The broadest assembly of texts for searching seems to be at the *Epigraphik-Datenbank Clauss-Slaby*, but unlike EDH and some of the other sites, it makes no claim to checking the texts it

[45] http://www.dh.uni-leipzig.de/wo/projects/open-greek-and-latin-project/; Crane 2010.
[46] http://cltk.org.
[47] See Bagnall 2016 for more extensive commentary on ancient documents.
[48] Elliott 2014 discusses further digital resources for epigraphy.
[49] Bagnall was co-founder (with Traianos Gagos and John Oates) of the Advanced Papyrological Information System (APIS), now part of the Papyrological Navigator, and played a role in the integration of digital resources in the field. He is also co-founder of the Digital Corpus of Literary Papyri (with Rodney Ast).
[50] http://www.papyri.info.
[51] For the moment, see http://litpap.info.
[52] http://trismegistos.org/.
[53] The home page of the E(lectronic) A(rchive of) G(reek and) L(atin) E(pigrapy) portal is https://www.eagle-network.eu/; for a list of the constituent databases https://www.eagle-network.eu/eagle-project/collections/. Orlandi 2016 is a discussion of the project.
[54] http://edh-www.adw.uni-heidelberg.de/home?lang=en.

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provides, and it does not offer metadata.[55] The situation is all the more unsatisfactory in that none of the resources really looks beyond simple word-searching to other possible uses of the data.

The wooden-tablets of Vindolanda are the subject of two websites. *Vindolanda Tablets Online* provides online editions of the texts published in Volumes I and II of the printed series.[56] This includes the unique birthday-party invitation that Claudia Severa sent to Sulpicia Lepidina. One can link to that document using the URL http://vindolanda.csad.ox.ac.uk/TVII-291, which follows the pattern for referring to all the documents on the site. But users are more likely to be shown a very long and unwieldy web address.[57] The accompanying picture of Claudia's letter is in black-and-white; we note that there is a better image in *Wikimedia Commons*.[58] It is also useful that TEI-encoded versions of the texts are available, though that ability is somewhat hidden.[59] The site *Vindolanda Tablets Online II* calls itself a 'sister site' and expands the corpus of available tablets.[60] More modern in appearance, it also provides useful browsing and searching of documents, with direct links to EpiDoc[61] versions of each text that are available under the CC BY-NC-SA licence. The CSAD website on which both Vindolanda digital text editions reside is currently in the planning phases of a complete overhaul, which will add much new content, including integrating the *Roman Inscriptions of Britain Online*.[62] The vision for this latter resource is for it to contain a digital version of every published Roman inscription from Britain, complete with detailed EpiDoc files to facilitate complex searching.

For the legal codes of Late Antiquity, there are several online options, which exist in isolation from other resources and with the most primitive of interfaces, but are freely available. The entire *Corpus Iuris Civilis* is available from the University of Grenoble, along with the *Theodosian Code* and a large amount of other Latin legal texts, but is searchable only in its subdivisions, not as a whole.[63] The same is true of the version in the *Latin Library*, which also has the *Theodosian Code*.[64]

The building of online textual and metadata resources is by no means limited to Greek and Latin. Coptic texts are becoming available through the work of the *Coptic Scriptorium*; and *Trismegistos* includes metadata for texts in Egyptian, including Demotic and Coptic.[65] *Syriaca.org* is in the process of developing rich metadata resources for Syriac, while a parallel project at Brigham Young University is creating a Syriac textual database.[66] These projects have been able to build on the experience of older resources and take advantage of recent developments.

[55] http://www.manfredclauss.de/gb/index.html.
[56] http://vindolanda.csad.ox.ac.uk.
[57] The URL http://vindolanda.csad.ox.ac.uk/4DLink2/4DACTION/WebRequestQuery?searchTerm=291&searchType=number&searchField=TVII suggests that the database software 'Fourth Dimension' is being (or at least was) used to implement the site. The choice of 4D, as it is commonly known, is not a problem in and of itself, but there is no need to expose this detail, especially when doing so comes at the cost of emphasising citation of the simpler URLs.
[58] https://commons.wikimedia.org/wiki/File:Vindolanda_tablet_291.jpg.
[59] http://vindolanda.csad.ox.ac.uk/tablets/TVdigital-1.shtml.
[60] http://vto2.classics.ox.ac.uk.
[61] EpiDoc is an initiative that provides standards and tools for encoding ancient documentary texts in XML, within the framework of the Text Encoding Initiative; see https://sourceforge.net/p/epidoc/wiki/Home/ for a fuller description. It is widely used for papyri and inscriptions.
[62] https://romaninscriptionsofbritain.org/.
[63] https://droitromain.univ-grenoble-alpes.fr/.
[64] http://www.thelatinlibrary.com/justinian.html; http://www.thelatinlibrary.com/theodosius.html.
[65] http://copticscriptorium.org.
[66] https://cpart.mi.byu.edu/home/sec/digital-texts/.

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V IMAGES, COLLECTIONS AND ARCHAEOLOGICAL DATA

Access to images of Roman material culture is one of the most profound results of the growth of networked resources.[67] We assume that many readers use *Google Images* to search for relevant visual resources by name of object or keyword. Online museum databases represent a class of digital resources that we recognise as permanently published due to the presumed stability of their host institutions. The Museum of Fine Arts in Boston was a leader in making its collections database online, with an abundance of Roman-period material usefully described and illustrated.[68] The British Museum and the Metropolitan Museum of Art in New York supplement their excellent searchable catalogues with extended thematic discussions linked to individual objects. The Metropolitan Museum's *Heilbrun Timeline of Art History* is a model in this regard.[69] When these catalogues first became online, images of objects were provided, but reproduction rights were often available only at significant cost.[70] The Metropolitan Museum has now placed many of its images of Roman objects under the CC0 licence, which is equivalent to the public domain.[71] In addition to these images, descriptive data are also freely available for download in bulk.[72] The British Museum makes many images available under a CC BY-NC-SA licence, which is more restrictive but still in the spirit of providing open data.[73] The Walters Art Gallery also makes its images available under a CC0 licence and has taken the additional step of uploading copies to *Wikimedia Commons*, itself an excellent source of images, particularly of archaeological sites and individual monuments.[74] The Museum of Fine Arts in Boston does not use a standard open licence for its images.[75]

Many museums do not yet allow effective online access to their collections. We assume this situation will improve. In the meantime, *ArtStor*, a companion to *JSTOR* that is also often accessed via an institutional affiliation, has a broad collection of images.[76] The Deutsches Archäologisches Institut co-sponsors *Arachne* as a central aggregator of images and descriptions of objects and sites.[77] *Europeana* has a much wider scope, but is also useful for discovery of digital content relevant to Roman Studies.[78] The *Google Arts and Culture* website is expanding its content and has much Roman material, with the British Museum being a high-profile partner.[79]

The websites of archaeological field projects are also a source of searchable online images as well as descriptions of material culture. The willingness of archaeologists to

[67] For reflections on this trend, see Coleman 2015.
[68] http://www.mfa.org/collections.
[69] https://www.metmuseum.org/toah/. The British Museum is another source of accessible introductions to Roman material culture that make use of a specific collection.
[70] A practical discussion of the impact that access to images can have on the study of Roman art is found at Stewart 2008: 8.
[71] As an example, see https://www.metmuseum.org/art/collection/search/254819, which is the online record for the Metropolitan Museum's well-known 'Marble sarcophagus with the Triumph of Dionysos and the Seasons' (Acc. No. 55.11.5).
[72] https://github.com/metmuseum/openaccess.
[73] http://www.britishmuseum.org/about_this_site/terms_of_use/copyright_and_permissions.aspx.
[74] https://thewalters.org/news/releases/article.aspx?e_id=385.
[75] See http://www.mfa.org/collections/mfa-images/licensing/frequently-asked-questions and http://www.mfa.org/collections/mfa-images/web-use-and-gallery-photography for information about re-using MFA images.
[76] http://artstor.org.
[77] http://arachne.uni-koeln.de.
[78] https://www.europeana.eu. The United States has no direct publicly-funded equivalent, though the Digital Public Library of America has similar goals and some content related to the Roman world (https://dp.la).
[79] https://artsandculture.google.com generally, and https://artsandculture.google.com/partner/the-british-museum. We may also mention here the Ancient World Image Bank at ISAW: http://isaw.nyu.edu/online-resources/ancient-world-image-bank.

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share their work is another beneficial side-effect of the growth of the Internet.[80] Unlike museum databases, sites sponsored by field projects often have the distinct advantage of providing detailed information about the archaeological context of the objects they publish. There are too many individual project websites to survey here, but we offer one well-executed example, the Athenian Agora Excavations, under the long-term sponsorship of the American School of Classical Studies at Athens.[81] This site provides a keyword search interface that is straightforward to use. It is distinctive for displaying rich internal links for each record it publishes. For example, the page for object 'P 33829', an African Red-Slip sherd, offers useful information based on original recording of this object found in 1937 and subsequent work.[82] Additionally, the linked text 'Deposit: B 14:4' brings up a brief description of the deposit in which P 33829 was found. Further internal links offer an admirable level of access to original records. There is, however, no central place to download all the data, and some unpublished information is only available to project members. We also note that it does not link extensively to related resources.

The website *Pompeiiinpictures* collects a large amount of imagery and organises it according to the conventional Region-Insula-Doorway system established, in varied forms, by the modern excavators of the site.[83] All content is delivered via static HTML pages that despite a slightly dated appearance offer a very usable presentation of Pompeii in its current state. Together these show the vigour that private initiative can provide. The *Pompeii Bibliography and Mapping Project* (PBMP) provides many layers of spatial data as ESRI shapefiles.[84] As with *Pompeiiinpictures*, PBMP is comprehensive in its coverage. The *Ancient Graffiti Project* (AGP), still in its early stages, is currently focused on Pompeii and Herculaneum.[85] AGP re-uses the PBMP to display locations for Pompeian inscriptions. There are, of course, many more digital resources relevant to first-century A.D. Campania, not least the rich visual documentation on *Wikipedia* and *Wikimedia Commons*.

The results of ongoing work at Portus in Italy are presented at the *Portus Project* website.[86] The discussions of different phases are a good starting point. There is a visually compelling 'Tour'. While not as closely associated with a current field project, *Ostia – Harbour City of Ancient Rome* presents a useful combination of general discussions and in-depth studies.[87] Both sites employ videos and other digital media effectively to communicate the ancient functioning and importance of Rome's harbours as well as the vitality of modern archaeological research. They are also specific examples of the welcome phenomenon of individual field projects sharing their results by maintaining websites.

Another approach to the availability of archaeological data, one which is likely to be more long lasting, is deposition in special-purpose archives. The *Archaeology Data Service* (ADS) hosted by the University of York, while not specifically a nationally-sponsored effort, is very rich for the archaeology of the United Kingdom (not only in

[80] Kansa 2012; Roosevelt *et al.* 2015.
[81] http://www.agathe.gr/.
[82] http://agora.ascsa.net/id/agora/object/p%2033829.
[83] http://pompeiiinpictures.com/pompeiiinpictures/index.htm. Digital resources for the study of Classical antiquity have long benefited from contributions from outside formal academic settings, Heath 2010. A companion site *HerculaneuminPictures* became available in the course of this writing: http://www.herculaneum.uk. See also https://sites.google.com/site/ad79eruption/home.
[84] https://digitalhumanities.umass.edu/pbmp/. Heath is collaborating with the editor of PBMP on an LOD-enabled successor.
[85] http://ancientgraffiti.org/.
[86] http://www.portusproject.org.
[87] http://www.ostia-antica.org.

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the Roman period) and for work undertaken by British scholars.[88] One very productive approach to finding Roman material is to restrict a search to that period.[89] Examples of specific publications in the ADS are *Roman Amphorae: A Digital Resource* and *The Rural Settlement of Roman Britain: An Online Resource*.[90] ADS does not provide a single unified search interface to the full contents of each collection of data that it archives. Descriptions of those projects are searchable, but full utilisation of the resource requires dedication and likely a pre-existing research project in mind. Without suggesting complete overlap of purpose, the portal provided by *Ariadne*, an effort to aggregate European archaeological research, is another useful starting point.[91]

The archaeological archive *Open Context* takes a different approach.[92] It does make the individual records of the projects whose data it ingests searchable, meaning that object descriptions and image captions appear directly in search results. *Open Context* includes substantial data from field projects that collected Roman material. The *Petra Temple Excavations* was an early contributor to *Open Context*.[93] *Rough Cilicia* provides documentation on architectural features recorded during regional survey.[94] The *Pyla-Koutsopetria Archaeological Project* is also a survey project, one that has published large amounts of ceramic data.[95] The *Murlo* project's data in *Open Context*, which is a complement to the project-specific website, are comprised of descriptions of small finds from this Etruscan-period site.[96] We have already mentioned that the Gabii Excavations use *Open Context*. For all these projects, *Open Context* provides a keyword search and a useful browsing-based interface. Each record has a stable URL, and a full citation is displayed on each screen. Additionally, all data are available for download and are distributed under a CC BY licence. When possible, *Open Context* links the data it ingests to existing vocabularies. Finally, *Open Context* contributes the data it hosts to the California Digital Library, which we recognise as a strong guarantee of ongoing availability.[97] *Open Context* is thus one of the few digital resources that explicitly satisfy our concerns about permanence and connectivity while meeting the fundamental goal of access.[98] It should be noted, however, that it is not a free service to depositors of data, charging a fee to cover operating costs.

So-called 'preliminary reports' remain a feature of archaeological literature. *Fasti Online* makes available a growing corpus, many of them from Italy, usually in the form of PDF files or HTML pages.[99] While not specifically focused on Roman material, *Chronique de Fouilles en Ligne*, jointly sponsored by the French and British Schools in Athens, is an additonal source of timely reports.[100] The digital version of *Hadashot Arkheologiyot: Excavations and Surveys in Israel* is another well-executed example of providing access to short notices of fieldwork.[101] It is likely that readers will be aware of similar resources relevant to their own study. The mere fact of easier access to specifically

[88] http://archaeologydataservice.ac.uk/.
[89] To achieve this, begin at http://archaeologydataservice.ac.uk/archive/archives.xhtml.
[90] http://archaeologydataservice.ac.uk/archives/view/amphora_ahrb_2005/ and http://archaeologydataservice.ac.uk/archives/view/romangl/index.cfm.
[91] http://portal.ariadne-infrastructure.eu; Ariadne 2014.
[92] https://opencontext.org. Heath serves on the *Open Context* editorial board, which is an advisory body.
[93] https://opencontext.org/projects/A5DDBEA2-B3C8-43F9-8151-33343CBDC857.
[94] https://opencontext.org/projects/21-rough-cilicia.
[95] https://opencontext.org/projects/3F6DCD13-A476-488E-ED10-47D25513FCB2.
[96] https://opencontext.org/projects/DF043419-F23B-41DA-7E4D-EE52AF22F92F and http://www.poggiocivitate.com.
[97] https://merritt.cdlib.org/m/ucb_open_context.
[98] *The Digital Archaeological Record* (tDAR), https://www.tdar.org, is another archaeological archive of note. Sheehan 2015 is a useful comparison of tDAR and *Open Context*.
[99] http://www.fastionline.org.
[100] http://chronique.efa.gr.
[101] http://www.hadashot-esi.org.il/.

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archaeological reports increases the likelihood of finding connections across Roman territory.

Technologies that represent the three-dimensional aspects of objects or virtual spaces are already having a great impact. In particular, the creation of 3D models has been revolutionised by photogrammetry, which allows the making of 3D models from photographs.[102] The British Museum has been a leader in sharing such models. It uses the commercial site Sketchfab to enable interaction, and some, though not all, of its models are available for download under a CC BY-NC-SA licence.[103] This open licencing of 3D content is very forward-looking, and we hope it continues.

There are non-commercial archives that also host interactive models. *Ancient Sundials* and *Digital Pantheon* are both part of the *TOPOI* initiative's *Editions TOPOI* repository.[104] These are admittedly very specialised datasets, but we mention them in part to recognise the internet as a great equaliser when it comes to publication; small projects or those with limited term that make effective choices about long-term archiving can have the same visibility as major and ongoing initiatives.

Photogrammetry and laser-scanning have both also been applied to archaeological sites. We draw particular attention to the use of both techniques to create 3D models of sites under threat from war. ICONEM is a commercial entity that partners with governments and not-for-profits. Its *Syrian Heritage* project links to models of threatened or destroyed sites hosted on Sketchfab.[105] More remarkably, the Arc/K project, a US-based not-for-profit, has used crowdsourced photography to reconstruct destroyed monuments at Palmyra.[106] This is important work, but the models are so far not downloadable from Sketchfab, where they are hosted.[107] Allowing them to be downloaded under open licences would strengthen claims to be serving global cultural heritage. Accordingly, the April 2018 announcement by the non-profit CyArk that it has partnered with Google to share its 3D scans is a step in the right direction.[108]

Many projects have posted impressive videos of virtually reconstructed Roman-period spaces to YouTube, and those are powerful teaching tools, but few represent shareable data. An early leader was the *Rome Reborn* project, which set a high standard for documenting its work. The current online presence for the project suggests it is in flux.[109] The videos that are available online are useful, particularly those re-used within the Khan Academy's resource for studying Rome.[110] *Byzantium 1200* is a private site that also offers compelling animated reconstructions of that city.[111] The commercial firm Altair4 Multimedia has produced a large number of high-quality videos of Roman-period cities, especially of Rome itself and other Italian sites.[112] Among the

[102] Photogrammetry as a technique is becoming a fundamental tool for archaeology and for the study of material culture more generally. There are many relevant discussions, including Olson *et al.* 2013; Sapirstein and Murray 2017.

[103] http://sketchfab.com/britishmuseum. By way of example, https://skfb.ly/UTWB is a downloadable portrait of Septimius Severus.

[104] http://repository.edition-topoi.org/collection/BSDP and http://repository.edition-topoi.org/collection/BDPP/search.

[105] http://syrianheritagerevival.org/; and particularly http://syrianheritagerevival.org/temple-of-bel/.

[106] https://blog.sketchfab.com/cultural-heritage-spotlight-reconstructing-destruction-palmyra-arck/.

[107] https://sketchfab.com/models/38315a821d0342a5a1189a7144f18b25.

[108] See https://artsandculture.google.com/project/cyark. On Google's role in digital scholarship for the visual arts see Mansfield 2014.

[109] We say this on the basis of visiting http://romereborn.org, which has a link to http://romereborn.squarespace.com/. A relatively new FaceBook page for the project came to our attention during this writing, https://www.facebook.com/romerebornvr.

[110] https://www.khanacademy.org/humanities/world-history/ancient-medieval/roman-empire-survey/v/a-tour-through-ancient-rome-in-320-c-e.

[111] http://www.byzantium1200.com.

[112] See https://www.youtube.com/channel/UCsExQmvowbygZFJAtuGgBxw under 'VIDEOS'.

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more interesting individual projects is the remarkable reconstruction of Pergamon made with the open source software Blender.[113] If 3D data follow the same trajectory as digital photography, meaning increasing distribution under open licences, then it may be that a future survey in this journal can point to very widespread adoption in research, teaching and publication of Virtual Reality, Augmented Reality and game-based approaches.[114] We hope that will be the case.

VI LINKED OPEN DATA, CROWDSOURCING AND WIKIPEDIA

In Section II we highlighted 'connectivity' as an important criterion by which to judge digital resources. Here we draw attention to some resources that encourage integration across multiple projects through the use of stable digital identifiers for well-known concepts. Publishing such identifiers is one aspect of the set of practices known as Linked Open Data (LOD).[115] Using them is another. We focus here on how the publication and use of identifiers bring coherence to the public internet and benefit users, rather than on the technical aspects of LOD.

Pleiades is a gazetteer of historical sites, with its roots in the *Barrington Atlas*, that is working to provide identifiers for all ancient places.[116] As with any project with such broad scope, a large number of the places it identifies are in some sense Roman. While *Pleiades* can be used to find Roman sites in a particular region, a more important role is allowing other projects to unambiguously refer to places by using *Pleiades* IDs; *Digital Atlas of Roman and Medieval Civilization*, *Open Context*, *Orbis*, *Syriaca.org* and *Trismegistos*, all mentioned in this survey, provide examples of this practice. A demonstration of shared use is the page in *Pleiades* for Gortyn, accessible at the succinct URL https://pleiades.stoa.org/places/589796. At the right side there is notice that 109 coins in the collection of the American Numismatic Society use this identifier, as do 13 records in the *Epigraphic Database Heidelberg*. This information, which can grow as more references to that specific web address appear, is drawn from the *Pelagios Commons*, which aggregates usage of publicly available identifiers, with *Pleiades* being a major source.[117] *Pelagios* provides its own map-based interface in a tool it calls *Peripleo*.[118]

While *Pleiades* is the most prominent historical gazetteer for the ancient world, there are other similar resources that either focus on Roman-period sites or provide much relevant information. The *Digital Atlas of the Roman Empire* (DARE) provides stable and short URLs for many locations and has a flexible search tool that allows searching by partial ancient and modern names.[119] A distinguishing feature is the excellent base-map it uses, one that presents rich detail and takes account of changes in shoreline.[120] The DARE project also has a clear institutional home at Lund University, and it provides downloadable data under a CC BY-SA licence. *Vici.org* describes itself as 'a community driven archaeological map, inspired by and modelled after Wikipedia'.[121] Users can

[113] https://youtu.be/XTMoW185tLk.
[114] Reinhard 2018 places archaeological content in games, including ones with a Roman theme, in a broad context.
[115] Bizer *et al.* 2009; Elliott *et al.* 2014; Gezer 2016.
[116] https://pleiades.stoa.org. Elliott and Gillies 2009. Bagnall is a senior editor of Pleiades, which is co-sponsored by ISAW.
[117] http://commons.pelagios.org.
[118] http://peripleo.pelagios.org. Simon *et al.* 2016.
[119] http://dare.ht.lu.se.
[120] http://commons.pelagios.org/2017/11/building-the-roman-empire-vector-tile-map/ and https://github.com/klokantech/roman-empire.
[121] http://vici.org.

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make edits or submit new sites. The combined implication of *Pleiades*, DARE and *Vici.org* is that it is now very easy to find the location of Roman-period toponyms, or to display toponyms occurring in a particular region. The Getty Research Institute's *Thesaurus of Geographic Names* (TGN) is a long-standing project that deserves recognition as an early example of a geographic gazetteer.[122] For sites for which only a modern name is known, *geonames.org* can play a useful role in archaeological work.[123]

The *Ancient World Mapping Center* provides locations of specific toponyms through its Antiquity à-la-carte application.[124] A strength of the site is the selection of precompiled maps, some of which are freely downloadable under a CC BY-NC licence. It also provides a set of ESRI Shapefiles. Of particular interest are those that give outlines of Roman territory at specific dates. There are additionally shapefiles for Roman-period roads and aqueducts derived from the *Barrington Atlas* (which is itself now available in an inexpensive app for iPad from Princeton University Press).[125]

Ancient locations are thus well served by individual projects that have adopted at least some aspects of Linked Open Data. There is also ongoing work to bring personal identity and time into the set of connected resources using shared identifiers. For time there is the *Perio.do* project, which is giving unique identifiers to chronological spans as defined in existing literature.[126] *Trismegistos People* defines identifiers for individuals in Greco-Roman Egypt, and the *Digital Prosopography of the Roman Republic* has brought important resources together using Linked Open Data.[127] The project *Standards for Networking Ancient People* is making progress on the vocabularies that will enable further work on this front.[128] In addition to 'people, places and dates' — to use more colloquial terms — Classicists have long used clearly specified references to ancient texts as unique identifiers for individual passages.[129] The Canonical Text Services (CTS) provides important infrastructure for adapting this practice to digitally linked environments.[130] If unique identifiers can become pervasive and be presented in a manageable interface, that should both ease the discovery of relevant resources and provide the basis for computational approaches such as large-scale visualisation of relationships based on current information. It would be particularly interesting to see well-known identifiers used in established sites such as *Lacus Curtius* and *VROMA* as well as in newer ones such as *WIRE: Women in the Roman East*.[131]

Numismatics has already made substantial progress in this direction.[132] A starting point is the site *Nomisma.org*, which defines its goal as providing 'stable digital representations of numismatic concepts'.[133] This means, in part, publishing URLs for the definitions of numismatic terms. See http://nomisma.org/id/denarius. That page provides links to specific Roman coin types that are examples of the denarius denomination, including those in *Coinage of the Roman Republic Online* (CRRO) and *Online Coins of the*

[122] http://www.getty.edu/research/tools/vocabularies/tgn/index.html.
[123] http://geonames.org.
[124] http://awmc.unc.edu and http://awmc.unc.edu/awmc/applications/alacarte/.
[125] Digital elevation data for all of Roman territory are available for free online. Among many sources, The European Union's Copernicus Land Monitoring System provides very detailed DEMs, https://land.copernicus.eu/pan-european/satellite-derived-products/eu-dem/view.
[126] http://perio.do. Rabinowitz *et al.* 2016.
[127] https://www.trismegistos.org/ref/index.php; http://romanrepublic.ac.uk/.
[128] Bodard *et al.* 2017.
[129] See for example the Classical Works Knowledge Base concordance to canons at http://www.cwkb.org and the Perseus Catalog at http://catalog.perseus.org.
[130] Blackwell *et al.* 2017 and Romanello 2016.
[131] http://penelope.uchicago.edu/Thayer/e/roman/home.html, http://vroma.org, http://wireproject.org.
[132] Meadows and Gruber 2014.
[133] http://nomisma.org. Heath is a founding editor of Nomisma.org and remains on the steering committee. Meadows and Gruber 2014; Wigg-Wolf and Duyrat 2017.

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Roman Empire (OCRE).[134] Both link to descriptions of individual coins in numismatic collections and use standardised vocabularies, including *Pleiades*. And beyond these closely related sites is a rich collection of digital numismatic data. This includes the United Kingdom's *Portable Antiquities Scheme* database, itself a vast repository for Roman finds.[135] It is unfortunate that its funding has occasionally come under threat.[136]

There are many opportunities to expand the set of interconnected sites that use well established identifiers. *Artefacts: Online Collaborative Encyclopedia of Archaeological Small Finds* provides a detailed typology, with more than 5,800 entries assigned to the 'Roman' period, but the individual records do not use standard vocabularies and do not link to other resources extensively.[137] The files and data hosted by the *Digital Atlas of Roman and Medieval Civilization* and those from the *Oxford Roman Economy Project* meet the needs of specialists, but would be more useful if they incorporated more standardised links, especially if those links could be automatically collected for aggregated display.[138] The same can often be said for digital resources related to the study of Roman pottery. There are many excellent sites, with some links between them. The ADS' *Roman Amphorae* has already been mentioned. It links to the *CEIPAC* corpora of amphoras inscribed with Greek and Latin.[139] Unfortunately, these sites, which require registration, were not working consistently at the time of this writing. *Potsherd – Atlas of Roman Pottery* has links to the ADS.[140] Outside this set of related sites, the *Levantine Ceramics Project* provides information on many Roman-period ceramic types.[141] But overall, studies of connections within the Roman world can be enhanced by greater connectivity among all the sources of data that we mention.

Crowdsourcing has played an important role in the development of a number of the resources we have referred to, including *Pleiades*. *Recogito*, another subproject of *Pelagios*, has an increasingly capable interface that allows collaborative annotation of the places and connections within texts.[142] Openness to broad participation is, however, by no means a comprehensive solution to the problem of developing and maintaining digital resources. Our experience with *Pleiades* and *papyri.info* suggests that they are subject to some of the problems that affect common goods more generally. Free riders are numerous; they value the resource and complain vigorously if it is not kept current and accurate, but see no reason to invest their own time in helping maintain it. Even among contributors, work tends to be distributed in a power-law fashion, with a small number of scholars responsible for the bulk of the improvements and additions. But both do have strong editorial boards that check contributions before they become canonical content; these are sometimes overwhelmed by the traffic and fall behind in approving submissions. Perhaps more serious is the lack of coordination of the addition of new content, particularly with *papyri.info*. No one is really in charge of content strategy, coordinating volunteers and assigning work. This has been identified as a priority for the coming years by both projects. Such issues are likely to be characteristic of most resources that depend on crowdsourcing.

Some of the same issues, but also different ones, affect that behemoth of crowdsourced resources, *Wikipedia* and its offshoots. It has many great virtues, and even academics who were initially hostile or indifferent find it hard to escape. It is often a ready source of freely

[134] http://numismatics.org/crro/ and http://numismatics.org/ocre/.
[135] https://finds.org.uk/.
[136] Kennedy 2015.
[137] http://artefacts.mom.fr/.
[138] http://oxrep.classics.ox.ac.uk/databases/ and https://darmc.harvard.edu/data-availability.
[139] http://ceipac.gh.ub.es/proyectos/corpus_db.html and http://ceipac.ub.edu/proyectos/corpusgrec_es.html.
[140] http://potsherd.net.
[141] https://www.levantineceramics.org.
[142] https://recogito.pelagios.org.

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usable images, it exists in multiple languages (with articles often much better in one language than in others), and it can be used as a form of authority for use in Linked Open Data when there is not a better reference point. The *WikiData* project, which gives unique and stable identifiers for the concepts in *Wikipedia*, is an important enabler of this approach.[143] On the other hand, *Wikipedia*'s quality is extremely uneven, ranging from cursory or inaccurate to detailed, documented and scholarly. It lacks true editorial scrutiny. Content is often taken without acknowledgement from other sources, particularly online, and may be seriously out of date; though many of these problems are caught and corrected, sooner or later, by the large editorial community. Given our emphasis on permanence, we encourage direct citation of the time-stamped version of a page or image that is referenced or reproduced.[144] Links to these archived versions are likely to work over the long term.

VII SOME CONCLUDING REFLECTIONS

In general, it is our observation that commercial sites tend to be better capitalised than non-profit-based sites, and they thus have glossier interfaces. But they also typically depend on using homogenised search interfaces and toolkits deployed across an array of resources in different fields, rather than interfaces optimised for a particular resource. These are often primitive from the point of view of the actual potential of a particular resource and are driven by corporate needs rather than scholarly choices. They thus underperform against measurements of potential to improve scholarship and education.

But it is, to be fair, not only in the commercial sphere where such strategies of isolation diminish the potential of online resources. The *Humanities E-Book Project* (HEB), originally for history but later widened, was a venture of the American Council of Learned Societies, launched in fact by a Roman historian, John D'Arms. His vision was both for the digitisation of published books for online use and for the commissioning of new books that would use more imaginatively the capabilities of digital technology. But again, the latter, more ambitious goals were left by the side after D'Arms' premature death, and Bagnall's experience, as an author of a new book, was that nothing but text and images could really be contemplated; even with those, the print version of *Women's Letters from Ancient Egypt* was given priority over the digital one. The non-profit ownership of *L'Année philologique* has not saved it from an unimaginative user interface, as the previous commercial publisher has not taken this on as a priority; it remains to be seen if its move to another commercial firm, Brepols, will be a liberation or a straitjacket within generic interfaces.

The glass is definitely more than half full. There remains much to do at the most basic level of digitisation of resources: texts unavailable, excavations without online databases, museum collections only partly available (or even not at all) and so on. These activities no longer seem innovative, making them harder to fund. But it is increasingly true that for our students, what is not online does not exist. The imperative to complete the job is real. But it is only part of the task. The quality of the user experience at many, if not most, of the resources we have mentioned ranges from fair to awful. Often, once a project is completed, there is no more money to keep improving the interface and respond to user desires. The data can be used only in ways the creator thought of; and none of us, fortunately, can think of all of the ways in which our creations might be used. We do not exempt most of the projects we have been involved in from this judgement.

[143] https://www.wikidata.org/entity/Q1405 is the permanent identifier for Augustus.
[144] https://en.wikipedia.org/w/index.php?title=Augustus&oldid=846595547 is the link to the version of the article on Augustus available at the time of this writing.

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This conundrum is unlikely to be solved in any direct fashion. We suggest that the only plausible way forward lies in opening up data for free use by others. There is no reason why there should be only one way of accessing and using a body of data, or why a database or textual corpus should be imprisoned by the limits of the imagination or resources of an individual or a team. Why not have multiple modes of access to these bodies of material? In the long run, control is the enemy of sustainability. In general, even with much material still to be digitised, connectivity, integration and authority are going to be the key arenas of progress for the digital resources for antiquity.

We must also recognise that we are virtually certain to live in a mixed economy of resources for the foreseeable future. The commercial and quasi-commercial publishers (in the latter category we include the big university presses) are not likely to disappear, nor do they seem to have a vision of a generalised open access future, although many of them are experimenting with forms of open access for their publications where authors or their institutions are willing to pay up-front to make that possible. But the big databases seem unlikely to become free. Of course, all other resources in the world are unequally distributed also. But we can be supportive of efforts to create alternative means of access to (for example) the core bodies of Greek and Latin texts, like *Open Philology*. It is likely that fee-supported resources will retain some advantages from their more ample financial backing; that cannot be helped. But there is a difference between having access only to an older edition of a text and having no access at all.

Finally, all this is not simply a matter of research. It impinges on our teaching at every level. Teaching undergraduates to use the internet critically has never been more important. At the graduate level, every young scholar in our field needs some degree of proficiency in digital resources and tools. Advertisements for faculty positions are increasingly insisting on such competence. Not everyone will have the same level of expertise, but looking forward, everyone will be a maker, not just a user. Of course, in many cases the students are already far ahead of us; but it is part of our task to make sure that they are.

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BIBLIOGRAPHY

Ariadne 2014: *Ariadne: The Way Forward to Digital Archaeology in Europe*, http://www.ariadne-infrastructure.eu/About/Ariadne-Booklet-The-Way-Forward-to-Digital-Archaeology-in-Europe

Bagnall, R. 2016: 'Materializing ancient documents', *Daedalus* 145(2), 79–87.

Birnbaum, D., Bonde, S., and Kestemont, M. 2017: 'The digital Middle Ages: an introduction', *Speculum* 92(S1), 1–38. https://doi.org/10.1086/694236

Bizer, C., Heath, T., and Berners-Lee, T. 2009: 'Linked data – the story so far', *International Journal on Semantic Web and Information Systems* 5(3), 1–22.

Blackwell, C., Roughan, C., and Smith, N. 2017: 'Citation and alignment: scholarship outside and inside the Codex', *Manuscript Studies* 1.1. https://repository.upenn.edu/mss_sims/vol1/iss1/2

Bodard, G., Cayless, H., Depauw, M., Isaksen, L., Lawrence, K., and Rahtz, S. 2017: 'Standards for networking ancient person data: digital approaches to problems in prosopographical space', *Digital Classics Online* 3(2). http://nbn-resolving.de/urn:nbn:de:bsz:16-dco-379754

Bond, S. 2017: 'Dear scholars, delete your account at Academia.Edu', https://www.forbes.com/sites/drsarahbond/2017/01/23/dear-scholars-delete-your-account-at-academia-edu/

Bond, S., Long, H., and Underwood, T. 2017: '"Digital" is not the opposite of "Humanities"', *Chronicle of Higher Education* Nov. 1, 2017. https://www.chronicle.com/article/Digital-Is-Not-the/241634

Bransbourg, G. 2012: 'Rome and the economic integration of Empire', *ISAW Papers* 3. http://dlib.nyu.edu/awdl/isaw/isaw-papers/3

https://doi.org/10.1017/S0075435818000874 Published online by Cambridge University Press

Campana, S. 2017: 'Rachel Opitz, Marcello Mogetta & Nicola Terrenato (ed.). *A mid-Republican house from Gabii*. Ann Arbor. https://doi.org/10.3998/mpub.9231782#150', *Antiquity* 91(359), 1396–7.
Coleman, K. M. (ed.) 2015: *Images for Classicists*, Cambridge, MA.
Concanon, C. 2017: *Assembling Early Christianity: Trade, Networks, and the Letters of Dionysios of Corinth*, Cambridge.
Crane, G. 2010: 'Give us editors! Re-inventing the edition and re-thinking the Humanities', in J. McGann (ed.), *Online Humanities Scholarship: The Shape of Things to Come*, Houston, 81–97.
Dunn, S. 2012: 'Review of ORBIS', *Journal of Digital Humanities* 1(3). http://journalofdigitalhumanities.org/1-3/review-of-orbis-project-by-stuart-dunn/
Elliott, T. 2014: 'Epigraphy and digital resources', in C. Bruun and J. Edmondson (eds), *The Oxford Handbook of Roman Epigraphy*, Oxford, 78–85.
Elliott, T., and Gillies, S. 2009: 'Digital geography and classics', *Digital Humanities Quarterly* 3.1 http://www.digitalhumanities.org/dhq/vol/3/1/000031.html
Elliott, T., Heath, S., and Muccigrosso, J. 2014: 'Current practice in linked open data for the ancient world', *ISAW Papers* 7. http://doi.org/2333.1/gxd256w7
Gezer, G. 2016: *Towards a Web of Archaeological Linked Open Data*. http://www.ariadne-infrastructure.eu/News/Study-Towards-a-Web-of-Archaeological-Linked-Open-Data
Gibbs, F. 2011: 'Critical discourse in the Humanities', *Journal of Digital Humanities* 12, online. http://journalofdigitalhumanities.org/1-1/critical-discourse-in-digital-humanities-by-fred-gibbs/
Graham, S., Milligan, I., and Weingart, S. 2015: *Exploring Big Historical Data: The Historian's Macroscope*, London.
Heath, S. 2010: 'Diversity and reuse of digital resources for ancient Mediterranean material culture', in S. Mahony and G. Bodard (eds), *Digital Research in the Study of Classical Antiquity*, Farnham, 35–52.
Kansa, E. 2012: 'Openness and archaeology's information ecosystem', *World Archaeology* 44(4), 498–520.
Kennedy, M. 2015: 'UK treasures endangered by museum cuts', *The Guardian* Feb. 2, 2015. https://www.theguardian.com/science/2015/feb/10/uk-treasures-under-threat-british-museum-cuts
Kilgrove, K., and Montgomery, J. 2016: 'All roads lead to Rome: exploring human migration to the eternal city through biochemistry of skeletons from two imperial-era cemeteries (1st–3rd c AD)', *PLOS One*. https://doi.org/10.1371/journal.pone.0147585
Lang, S. 2018: 'Review of Perseus Digital Library', *RIDE: Review Journal for Digital Editions and Resources* 8. https://ride.i-d-e.de/issues/issue-8/perseus/
Mansfield, E. C. 2014: 'Google Art Project and digital scholarship in the visual arts—http://www.google.com/culturalinstitute/project/art-project', *Visual Resources* 30, 110–17.
Marwick, B. 2016: 'Computational reproducibility in archaeological research: basic principles and a case study of their implementation', *Journal of Archaeological Method and Theory* 24(1), 424–50.
Mattern, S. 2013: *The Prince of Medicine: Galen in the Roman Empire*, Oxford.
Meadows, A., and Gruber, E. 2014: 'Coinage and numismatic methods. A case study of linking a discipline', *ISAW Papers* 7.15. http://dlib.nyu.edu/awdl/isaw/isaw-papers/7/meadows-gruber/
Meeks, E. 2015: 'The design and implementation of ORBIS: The Stanford geospatial network model of the Roman world', *Bulletin of the Association for Information Science and Technology* 41.2, 17–21.
O'Donnell, D. 2013: 'Disciplinary impact and technological obsolescence in digital medieval studies', in R. Siemens and S. Shreibman (eds), *A Companion to Digital Literary Studies*, Oxford, 65–81.
Olson, B., Placchetti, R., Quartermaine, J., and Killebrew, A. 2013: 'The Tel Akko Total Archaeology Project (Akko, Israel): assessing the suitability of multi-scale 3D field recording in archaeology', *Journal of Field Archaeology* 38, 244–62.
Opitz, R., Mogetta, M., and Terranato, M. (eds) 2016: *A Mid-Republican House from Gabii*, Ann Arbor.
O'Riordan, E. 2017: 'A review of "Mid Republican House from Gabii" [digital publication]', *Internet Archaeology* 45. https://doi.org/10.11141/ia.45.8
Orlandi, S. 2016: 'Ancient inscriptions between citizens and scholars', in G. Bodard and M. Romanello (eds), *Digital Classics Outside the Echo Chamber*, London, 205–21.
Poehler, E. 2018: 'Review of R. Opitz , M. Mogetta and N. Terrenato (eds), *A Mid-Republican House from Gabii*. University of Michigan, 2016. Online resource. DOI: 10.3998/

https://doi.org/10.1017/S0075435818000874 Published online by Cambridge University Press

mpub.9231782. isbn 9780472999002. US$150.00', *Journal of Roman Studies* 108. doi:10.1017/S0075435818000205.
Posner, M. 2016: 'Here and there: creating DH community', in M. Gold and L. Klein (eds), *Debates in the Digital Humanities 2016*, London, 265–73.
Rabinowitz, A., Shaw, R., Buchanan, S., Golden, P., and Kansa, E. 2016: 'Making sense of the ways we make sense of the past: The PeriodO Project', *Bulletin of the Institute of Classical Studies* 59 (2), 42–55.
Reinhard, A. 2018: *Archaeogaming: An Introduction to Archaeology in and of Video Games*, New York.
Romanello, M. 2016: 'Exploring citation networks to study intertextuality in Classics', *Digital Humanities Quarterly* 10(2). http://www.digitalhumanities.org/dhq/vol/10/2/000255/000255.html
Roosevelt, C., Cobb, P., Moss, E., Olson, B., and Ünlüsoy, S. 2015: 'Excavation is destruction digitization: advances in archaeological practice', *Journal of Field Archaeology* 40(3), 325–46.
Russell, B. 2014: *The Economics of the Roman Stone Trade*, Oxford.
Sapirstein, P. 2017: 'Review: A Mid-Republican House at Gabii', *SCS Blog*. https://classicalstudies.org/scs-blog/philip-sapirstein/review-mid-republican-house-gabii
Sapirstein, P., and Murray, S. 2017: 'Establishing best practices for photogrammetric recording during archaeological fieldwork', *Journal of Field Archaeology* 42(4), 337–50.
Scheidel, W. 2013: 'Explaining the maritime freight charges in Diocletian's Prices Edict', *Journal of Roman Archaeology* 26, 464–8.
Scheidel, W. 2014: 'The shape of the Roman world: modelling imperial connectivity', *Journal of Roman Archaeology* 27, 7–32.
Sheehan, B. 2015: 'Comparing digital archaeological repositories: tDAR versus OpenContext', *Behavioral and Social Sciences Librarian* 4, 173–213.
Simon, R., Isaksen, L., Barker, E., and de Soto, P. 2016: 'Peripleo: a tool for exploring heterogeneous data through the dimensions of space and time', *Code4Lib Journal* 31. http://journal.code4lib.org/articles/11144
Stewart, P. 2008: *The Social History of Roman Art*, Cambridge.
Thomas, W. 2016: 'The promise of the digital humanities and the contested nature of digital scholarship', in S. Schreibman, R. Siemens and J. Unsworth (eds), *A New Companion to Digital Humanities*, Chichester, 524–37.
Tyers, P. 1996: 'Roman amphoras in Britain', *Internet Archaeology* 1. https://doi.org/10.11141/ia.1.6
Wigg-Wolf, D., and Duyrat, F. 2017: 'La révolution des Linked Open Data en numismatique: les exemples de nomisma.org et Online Greek Coinage', *Archéologies numériques* 1.1 https://dx.doi.org/10.21494/ISTE.OP.2017.0171

https://doi.org/10.1017/S0075435818000874 Published online by Cambridge University Press