DANISH JOURNAL OF ARCHAEOLOGY, 2015
VOL. 4, NO. 2, 125–139
http://dx.doi.org/10.1080/21662282.2016.1190508

Routledge
Taylor & Francis Group

RESEARCH ARTICLE

Typifying scientific output: a bibliometric analysis of archaeological publishing across the science/humanities spectrum (2009–2013)

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ABSTRACT

This article presents the results of a bibliometric analysis conducted on all original research papers published in six high-ranking archaeological journals between 2009 and 2013, consisting of 926 papers. The purpose is to identify the general features characterizing the output of archaeological publishing within the given time frame and to discuss the results in light of the science/humanities divide of archaeology. It expands previous work, covering not just scientific *or* humanistic parts of archaeology, but sub-disciplinary niches *across* the science/humanities-spectrum. Significant differences are identified amongst the journals on an array of parameters, including journal statistics, citation network, thematic distribution, the application of methods and the direction of relevance to other sub-fields. Most significantly, established correlations of academic publishing are for the first time identified in archaeology, regarding the structure of citation networks, the connectedness of high-ranking journals and how specific affiliations to either side of the science/humanities divide affect publishing. In the end, these results are taken to represent a sub-optimal division of labor between archaeological sub-fields, tentatively explained by the continued relevance of the science/humanities divide in archaeology, by providing diverse epistemic underpinnings.

ARTICLE HISTORY
Received 8 September 2015
Accepted 21 February 2016

KEYWORDS
Archaeology; bibliometrics; citation analysis; division of labor; epistemology; science/humanities divide

1. Introduction

What characterizes the current state of archaeological publishing? In trying to answer this general question, this article presents a bibliometric analysis of established correlations regarding the connectedness of high-ranking journals, the relation between types of papers and methods used, and how different affiliations to the science/humanities divide affect archaeological publishing. Bibliometrics – the application of quantitative methods to analyze academic literature and publishing (Bellis 2009, p. xi, 417) – is next to non-existent within archaeology, and is utilized here with the aim of better understanding archaeological publishing, confirming for the first time correlations observable in other parts of academic publishing.

Bibliometric studies of specific sections of the archaeological discipline have already been attempted (Marriner 2009, Palomar *et al.* 2009, Leydesdorff *et al.* 2011). On the occasion of the *Journal of Archaeological Science´s* 35th anniversary, a bibliometric assessment was made of publishing trends amongst the archaeological sciences (Marriner 2009). The current article aims at expanding such previous works by assessing what characterizes both scientifically and humanistic oriented archaeological publications during the past 5 years. The data set comprises all the 926 original research papers published between 2009 and 2013 by six top-ranking archaeological journals, which cover sub-disciplinary niches across the science/humanities spectrum. This data is submitted to a set of bibliometric analyses – covering journal statistics, citation network, thematic distribution, the application of methods and the direction of relevance to other sub-fields.

Aiming for the bigger picture by including different sub-fields of archaeology might be fruitful, taking into account the general diversification of archaeological conduct since the 1960s and the theoretical diversification especially since the 1990s (Trigger 2006, p. 484, 497, Webmoor 2007, p. 568, Fahlander 2012, pp. 122–123, Hodder 2012, Kristiansen 2014, p. 15). Both methodological and theoretical diversity is illustrated by an ever-

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expanding panoply of archaeological journals. There is also a shared perception of archaeology as being a multifaceted discipline, operating at the intersection between historical and social sciences, utilizing methods corresponding to the whole range of natural sciences to the aesthetics (Jones 2004). This goes for the application of theory as well. Though social and anthropological theory have received most attention, natural scientific theorizing is of fundamental importance to questions of dating, site formation, taphonomy, ecology, climate reconstruction etc. Archaeological diversity is also mirrored by the various ways in which the discipline has been institutionalized around the globe. By a rough typology, archaeology has been the smaller sister of history in Northern Europe (Trigger 2006, p. 164), as part of the anthropological project in North America (cf. Binford 1962, Trigger 2006, p. 410), and as one of many humanistic disciplines within classical studies (cf. Whitley 2001, p. 3), especially for the Mediterranean region. The unequal weighting of the empirical record and prioritization of prehistoric periods, has led archaeologists to internalize a variety of academic profiles as a response to a multitude of educational and institutional affiliations (a point made early on by Polanyi (1958, p. 151)). The prominence of such differences have a long history of being debated, yet they may today be expressed on a different arena and scale – namely in the world of digital academic publishing. Through quantitative analyses, this article finds that archaeological publishing is significantly affected by the affiliation of sub-disciplines with specific epistemic outlooks on science. Based on the results a short argument is presented for the continued relevance of the science/humanities divide in archaeology, claiming that the observable differences in publishing practices may point to a sub-optimal division of labor within archaeology.

2. Bibliometrics

Bibliometrics is essentially a set of methods to investigate quantitative properties of academic literature (De Bellis 2009. p. xi, 417), applying 'mathematics and statistical methods to books and other media of communication' (Pritchard 1969, p. 348). The most common and well-known application of bibliometrics is through the analysis of cites, their frequencies, patterns and relation to other variables (see Rubin 2010, Garfield 1983) – a method widely used for ranking journals, institutions and scholars on impact-indexes. The common goal of bibliometric methods is to 'investigate the formal properties of the scholarly publication system', and thereby making science itself the subject of inquiry (Bellis 2009, p. xi; for an excellent example, see Fanelli and Glänzel 2013). Bibliometrics came into being during the 1920s but was not consolidated until the 1960s. Its development and dissemination has since evolved in accordance with advances of information technology (Glänzel 2002; for the development and history of bibliometrics, see Broadus 1987, Brookes 1990, Gross and Gross 1927, Lotka 1926, Nalimov and Mulchenko 1971, Price 1961, 1963, Ravichandra 1983). Today bibliometrics constitutes its own field of study, mainly directed at methodological development, providing numeric and evaluative input to scientific disciplines, as well as to policy-making, and to grant and application management. Although an established tool in informatics, mathematics, quantitative science studies and library science, bibliometrics has seen almost no application in archaeology (for exceptions, see Mallía and Vidal 2009, Mays 2010). As such, there is an untapped potential in applying bibliometrics to archaeology.

3. Procedure

The selection of data for this study has been made on the basis of its representativeness, thereby facilitating the identification of general features in archaeological publishing. The data set consists of 926 papers, covering the five-year period of 2009–2013. The specified time slot is of interest both in presenting recent data points, as well as in covering the marked upswing of publishing during this period (compared to preceding years). Furthermore, bibliometric studies exist only prior to this period and the signified period allows the inclusion of some archaeometric journals that came into being just in advance.

This article exclusively presents data from 'regular' journals. That is, journals with less than 15 articles per issue, and 2–4 issues a year, published on paper (in contrast to exclusively online and open source publishing). Given these criteria, I have avoided some of the biggest and top-rated journals.

These being primarily digital, with a much higher number of articles per issue and with up to four times the number of issues per year. When mapping trends in archaeological publishing, this omission is an unfortunate but necessary measure taken to control the volume of data. Only original research papers are included, thereby excluding editorials, reviews, discussions, book reviews, errata and otherwise non-original studies. The main directive for selecting journals is their ability to be representative of archaeological sub-fields such as historical, anthropological, social, scientific, environmental and general archaeology. It might be helpful to review the statement of purpose as presented by the respective journals.

- *Antiquity ([A])*: 'a quarterly review of World Archaeology interested in all research questions, in all periods and all parts of the world'.
- *Archaeological and Anthropological Sciences (AAS)*: 'covers the full spectrum of natural scientific methods with an emphasis on the archaeological contexts and the questions being studied. It bridges the gap between archaeologists and natural scientists providing a forum to encourage the continued integration of scientific methodologies in archaeological research'.
- *Journal of Anthropological Archaeology (JAA)*: 'devoted to the development of theory and, in a broad sense, methodology for the systematic and rigorous understanding of the organization, operation, and evolution of human societies'.
- *Journal of Social Archaeology (JSA)*: 'promotes interdisciplinary research, focused on social approaches in archaeology, it champions innovative social interpretations of the past and encourages exploration of contemporary politics and heritage issues'.
- *Environmental Archaeology (EA)*: 'consider the interaction between humans and their environment in the archaeological and historical past'.
- *International Journal of Historical Archaeology (IJHA)*: 'focuses on the post-1492 period and includes studies reaching into the Late Medieval period … [and] present the latest theoretical, methodological, and site-specific research'.

One could just as well have included journals representing classical, heritage, computational, evolutionary or any other archaeological sub-field. These have been omitted only for the sake of feasibility. Though taken to represent some general attributes of archaeological publishing, the data reflect (some might say suffer) from a geographic dislocation as only journals based in Britain and the United States are included, respectively three American and three British journals (meaning those published *in* the given regions).

Even so, the most important criterion for selection has been the journals´ iconic status vis-a-vis given sub-specialities.. As the data selection is based on topic instead of geographical affiliation, no region-specific journals are included. The lack of geographically diverse journals should not be impairing as the included journals publish research from all over the world, and are all high- to top-ranking amongst specialized *archaeological* journals. The quantity of articles and metrics of the journals included in this study are summarized in Table 1.

The information value of such metrics is disputed. They are nonetheless listed here to provide a basic overview of the included journals. The dispute concerns whether such metrics present a fruitful way of evaluating the output of scientific research. Critical voices claim that particularly the impact factor (originally a device for helping libraries select the most important journals for their collections) does not function properly as an indicator of the importance of individual papers, but rather represents a mix-up of a scientist's reputation with the ranking of a journal (cf. The San Francisco Declaration on Research Assessment; Batista *et al.* 2006, Penfield *et al.* 2014; explicating the connections to open access publishing, see Norris *et al.* 2008, Solomon *et al.* 2013).

3.1. Source critical factors

It has been necessary to quantify *qualitative* variables as no existing database contains the data needed for this study. A problem connected to this line of work is the unfortunate result of having to catalog each paper manually. Looking at already quantified parameters would enable the use of preexisting, bibliometric analyzers such as *Web of Science, Publish or Perish* and *Scopus*. These ready-made bibliometric

Table 1. Summarized metrics for the journals included in the bibliometric analyses.

Journal	Papers (n)	Cites	*AM* cites, Pr paper	% of n With 0 cites	Max cites, Total amount of years	h5-index	h5-median	SJR	5 year Impact factor
Journal of Social Archaeology	82	241 (550)	3,05 (6,11)	44.46%	23 (65)	7	-	0.688	1
Journal of Anthropological Archaeology	181	1044 (1680)	5,77 (8,65)	17.79%	29 (43)	19	25	1.333	2.453
International Journal of Historical Archaeology	164	186 (399)	1,15 (2,33)	68.19%	12 (22)	8	10	0.264	(0,44)* -
Archaeological and Anthropological Sciences	112	492 (913)	4,47 (5,67)	43.65%	52 (73)	14	25	0.649	1.06
Environmental Archaeology	70	182 (357)	2,53 (2,36)	49.39%	16 (16)	9	14	0.588	0.974
Antiquity	317	1421 (2554)	4,41 (8,05)	46.13%	53 (76)	21	29	0.873	1.43

The differing values presented under cites, average cites (AM) per paper and max cites correspond to the values provided by Web of Science above and Publish or Perish below, in brackets (). The h5- index and- median are procured from Google Scholars ranking metrics, while the 5-year impact factor is provided by the journals themselves. The SJR is Scopus'' take on the impact factor, calculated using the same algorithm, but over a shorter time span. *The h5-median of JSA, and the 5-year impact factor for IJHA could not be obtained. I have calculated an estimated value for the latter, using a scatter plot and best-fit-to-curve function, which seems reasonable when correcting it with a ration of 2:3 between SJR and the 5-year impact factor. This value is therefore unofficial, and has been included in order to give the reader a relative sense of the journal's impact factor in order to make comparison easier.

programs allow for direct statistical queries of a given data set. Even so, there are problems related to the interpretation of such queries, if used uncritically. For instance, it would be possible (yet misleading) to catalog a paper under a given subject, based solely on the occurrence of a corresponding word in the paper's title, abstract or the main text. Instead it is necessary to evaluate each paper individually when identifying the main purpose of research.

The thematic data were collected directly from the online homepage of each journal and then plotted into an Excel sheet. Citation data and journal metrics (the analyses of which are presented in Table 1) were collected using two sources: *ISI Web of Science* (WoS) and *Publish or Perish* (PoP). The metrics were then calculated manually, correcting the values provided by the WoS and PoP databases. It was necessary to combine and correct the two manually, as they provided quite diverging results. WoS produces overly conservative estimates, while the opposite is true for PoP. In short, the reason for this is unequal access to appropriate databases and different ways of calculating the metrics. At the time of writing, a whole range of journals are not included in the WoS catalog. PoP on the other hand, collects data from Google Scholar, which in itself provides some issues for the analysis presented below, that needs mentioning: PoP provides a much wider array of sources for citation analysis, by collecting data from journals, books, internet journals and other digitized (or otherwise online registered) media, in all languages. The downside is the inclusion of 'unofficial' cites, such as non-peer-reviewed blog entries. In order to balance this, I have listed the metrics collected from both WoS and PoP in Table 1. Despite my best effort to remove false and unofficial cites, there is still going to be a certain margin of error in the numbers presented here. Even so, the extent of such erroneous cites constitute a very small fraction of the data set (in the range of ≤1%).

Timing is another important factor that needs mentioning as metrics are dynamic values. The metrics presented here are but a snapshot of archaeological publishing and discourse, representing the very period for which the data was collected. Also, no age-weighted metrics are included, as the aim of this analysis is to compare results *within* the given time frame (2009–2013).

3.2. Classification

A database was built be codifying the (1) topic being examined, (2) application of methods and (3) citation network for every single paper published by the six journals over the 5-year period. The thematic considerations of each paper were classified into a manageable number of categories, thereby reducing the vast variation of topics. The classification was made with some initial categories thought to be prevalent in the data set. Over time, the growing number of categories was integrated in the further

Table 2. The 29 thematic categories employed in the bibliometric analysis.

Class 1: Phenomena	Class 2: Environment	Class 3: Meta
Art/Symbolism	*Agriculture/Husbandry*	*Conceptual*
Civilization/Culture history (urbanism)	*Dating/Age/Chronology*	*Heritage*
Class/Inequality	*Diet/Subsistence*	*Method*
Colonialism/Indigenous	*Ecology/Climate*	*Research history/Critique*
Cosmology/Identity/Ritual	*Evolution*	*Theory/Interpretation*
Death/Burial	*Formation/Taphonomy/Preservation*	
Economy/Exchange/Production	*Health*	
Gender	*Human impact*	
Infrastructure/Monuments	*Hunter-gatherers*	
Population/Mobility	*Provenience*	
Power/Politics/Conflict	*Settlement/Land use*	
Technology/Function	*Zooarch/Animal*	

description of papers, before a full correction of the data set was made, employing the entire set of categories to the complete database. I have complied with the guidelines provided by the international classification of academic literature used in libraries, the Dewey system, and used the classification of *EBSCO Anthropology Plus* for calibration (see http://www.ebsco.com/about). Table 2 illustrates the analytic schema applied in the analysis.

The categories have been divided into a primary and a secondary level. The primary level consists of three major groups of categorical classes, each containing a number of secondary level categories. *Phenomena* includes the most recurring research on past phenomena. This class represents topics researched in 'traditional' archaeology, that is, papers presenting new findings on the assorted topic. *Meta* on the other hand, encompasses those papers somehow reflecting on archaeology itself, either through the development of new methods and theories, or through critique. *Environmental* refers to categories that in some way are oriented toward natural processes, for instance matters of ecology, evolution, biology and dating. Though also presenting 'immediate' results on past phenomena (thereby overlapping with *Phenomena*), these categories are oriented toward the interplay between culture and nature/habitat/landscape.

Representing a more fine grained classification, the secondary level contains a total of 29 categories. The function of this division is to counteract any subjective bias that might affect the classification itself, as there may occur significant overlap between the categories. It thereby secures the correct weighting of variables in the analysis presented below, as any incorrect classification on the secondary level should be counteracted by the classification on the primary level. The allocation of categorical membership has been made according to a set of rules:

- Categorization is based on a combination of the information provided by title, abstract and keywords. If difficult to ascribe a category, introduction and conclusion are read. If still unclear, a skimming of the main text is done. The reason for not basing the analysis entirely on the keywords provided by the authors themselves is the need to compress the thematic variation to a manageable number. Heavy emphasis has still been put on the keywords providing vital information regarding the main topic of the papers.
- Papers are categorized by the area of knowledge the papers aim at.
- If an article incorporates elements attributed to two distinct categories (according to the above schema), it is assigned to the category most dominantly present.
- Papers on contemporary issues concerning archaeology and society, such as power, politics and policy, are classified as *Heritage*, not *Power/Politics*, as the latter is reserved for papers focusing on power and politics as a prehistoric phenomenon.
- *Antiquity* has its own specific section on 'method'. These articles are also included here, and are classified as *Method*.
- It will always be possible to question the categorizations made here, if emphasizing other aspects. This is an unavoidable weakness of quantifying essentially qualitative variables. Despite the risk of categorical overlap and errors of codification on my part, the two-leveled classification should counteract possible incorrect categorizing.

4. Results

4.1. Thematic distribution

Table 3 shows the full data range of thematic distribution. Only highlights relevant to the further analysis will be discussed here.

The journals publish papers very much in accordance with their stated purposes. An example is *EA*'s almost exclusive appearance under the (first-level) class *Environment*, by nearly 80%. *JSA* provides the direct opposite – 0% of its papers belonging to the environmental class. Instead, *JSA* has the highest values for the *Meta*-class (60%), and its most numerous themes are *Theory/Interpretation* = 23.17%, *Cosmology/Identity/Ritual* = 20.73% and *Heritage* = 15.86%

Method constitutes *AAS*'s most prominent theme, which amounts to 23.21% of its papers. *[A]* also present a high amount of papers belonging to *Method*, 20.18% of its total. Even so, there are significant differences in the qualitative aspects of the papers concerning method in these two journals. Whereas *AAS* presents papers on the technical development and improvement on scientific methods, *[A]* mainly presents the results of scientific methods applied to archaeology.

[A] stands out with a general culture-historical profile. Interestingly, articles belonging to the category *Civilization/Culture history* exclusively come from *[A]* and, even more specific, the studies are mainly conducted in China. What causes this is not clear. It might point at some national differences and the continued relevance of methodological nationalism, or more interestingly, an effect of the need for basic research in an otherwise under-explored area – what earlier was also the case for the Indus valley. This pattern is also supported by *[A]* being alone in presenting papers on *Infrastructure/Monuments*, in the sense of describing roads, ditches, earthworks, standing monuments etc. in themselves.

4.2. Methods used

The ways in which the research has been conducted might be as informative as the thematic distribution.

Table 3. Metrics for the distribution of primary and secondary category levels.

	Journal of Social Archaeology		Journal of Anthropological Archaeology		International Journal of Historical Archaeology		Archaeological and Anthropological Sciences		Environmental Archaeology		Antiquity	
	%	n	%	n	%	n	%	n	%	n	%	n
Class 1: Phenomena Total	40,24%%	33	51.93%	93	57.24%	94	25.00%	28	7.14	5	48.89%	155
Art/Symbolism	2.43%	2	1.10%	2	0.60%	1	3.57%	4	1.42%	1	8.20%	26
Civilization/Culture history	-	-	-	-	-		-	-	-		4.73%	15
Class/Inequality	-	-	0.55%	1	15.24%	25	-	-	-	-	-	-
Colonialism/Indigenous	6.09%	5	1.10%	2	12.19%	20	-	-	-	-	0.94%	3
Cosmology/Identity/Ritual	20.73%	17	3.31%	6	8.53%	14	0.89%	1	1.42%	1	4.10%	13
Death/Burial	2.43%	2	3.86%	7	6.09%	10	2.67%	3	-	-	6.30%	20
Economy/Exchange/Production	-	-	4.41%	8	5.48%	9	-	-	-	-	5.04%	16
Gender	1.21%	1	0.55%	1	0.60%	1	-	-	-	-	-	-
Infrastructure/Monuments	-	-	1.10%	2	-	-	-	-	-	-	3.78%	12
Population/Mobility	-	-	8.28%	15	1.21%	2	3.57%	4	1.42%	1	4.41%	14
Power/Politics/Conflict	4.87%	4	12.70%	23	3.65%	6	-	-	-	-	3.15%	10
Technology/Function	2.43%	2	14.36%	26	3.65%	6	14.28%	16	2.85%	2	8.20%	26
Class 2: Environment Total	0.00%	0	40.33%	73	10.97%	18	49.10%	55	78.57%	55	24.92%	79
Agriculture/Husbandry	-	-	4.97%	9	-	-	8.92%	10	21.42%	15	5.67%	18
Dating/Age/Chronology	-	-	-	-	-	-	4.46%	5	2.85%	2	9.46%	30
Diet/Subsistence	-	-	6.62%	12	1.21%	2	10.17%	12	11.42%	8	1.26%	4
Ecology/Climate (environ. Recon)	-	-	3.86%	7	-	-	2.67%	3	10.00%	7	-	-
Evolution	-	-	2.76%	5	-	-	0.89%	1	-	-	1.57%	5
Formation/Taphonomy/Preservation	-	-	1.10%	2	0.60%	1	5.35%	6	2.85%	2	-	-
Health	-	-	1.10%	2	0.60%	1	-	-	-	-	-	-
Human impact	-	-	-	-	-	-	0.89%	1	5.71%	4	-	-
Hunter-gatherers	-	-	6.07%	11	-	-	-	-	-	-	1.26%	4
Provenience	-	-	-	-	-	-	9.82%	11	-	-	-	-
Settlement/Land use	-	-	12.70%	23	8.53%	14	2.67%	3	12.85%	9	5.04%	16
Zooarch/Animal	-	-	1.10%	2	-	-	2.67%	3	11.42%	8	0.63%	2
Class 3: Meta Total	59.76%	49	8.28%	15	31.70%	52	25.89%	29	14.28%	10	26.18%	83
Conceptual	6.09%	5	1.10%	2	7.31%	12	-	-	-	-	0.31%	1
Heritage	15.85%	13	-	-	10.36%	17	-	-	-	-	0.31%	1
Method	6.09%	5	6.07%	11	5.48%	9	23.21%	26	11.42%	8	20.18%	64
Research history/Critique	8.53%	7	-	-	3.65%	6	-	-	1.42%	1	1.26%	4
Theory/Interpretation	23.17%	19	1.10%	2	5.48%	8	2.67%	3	1.42%	1	4.10%	13
Total:	*100.00%*	*82*	*100.00%*	*181*	*100.00%*	*164*	*100.00%*	*112*	*100.00%*	*70*	*100.00%*	*317*

A marker for this parameter is signified by [Method used], classified per paper. This might indicate the most significant difference between the journals, as there seems to be clear-cut and distinctive boundaries between them. As shown by Table 4 and Figure 1, the number of theoretical and discussion papers form an almost perfect fall-off curve, corresponding to a descending number of archaeometric methods – an inversely proportional relation.

It is interesting to note that this pattern quite resembles the hierarchy of sciences (Fanelli and Glänzel 2013). This is evident from the 'concentric' pyramid-like shapes in Figure 1, the first corresponding to the methods used by *JSA*, restricted to the methods of the lower half of Table 4. Next, *IJHA* has a somewhat bigger scope, while *A* and *JAA* utilize the whole range of methods (included in this typology). These two are the most comprehensive and highest ranked journals in this analysis, which is also reflected in the broader scope of interests and methods used. It therefore seems like we can introduce the following rule of thumb: a broader scope of interest of a journal results in a wider application of methods.

4.3. Citation analysis: cross-references

It is possible to map the connections between variables at both the level of papers and the level of journals. This can be done by identifying the patterns of citing amongst papers and between journals, thus allowing the citation-network to be studied (cf. Brughmans 2013). As shown in Table 1, and graphically reproduced in Figures 2 and 3, the journals exhibit large differences in their number of papers, number of cites per paper and the percentage of papers with zero cites.

Reviewing the percentage of cites coming from the other journals within the given time frame, may indicate to what extent occurs across sub-disciplinary units. As illustrated by Table 5, there are no large differences in the sum of cross-references, that is, cites coming from the other journals included here. The one exception is *IJHA*, which has less than half of its cites coming from the five other journals. This is probably due to its multidisciplinary profile, producing a citation network overlapping with historical journals. Once again *JAA* and *A* stand out, in this case with high degrees of self-citing. There are several potential explanations for

Table 4. Bibliometric data for the methods used in the 926 papers.

	Social	Historical	Antiquity	Anthropological	Environmental	Sciences
Physical Archaeometry	-	-	11.35%	3.31%	5.71%	50.89%
Bioarchaeology	-	3.00%	9.46%	27.61%	75.71%	25.00%
Computer modeling	-	1.83%	2.52%	11.60%	0.89%	
Excavation/Survey	2.43%	8.00%	14.82%	10.49%	-	1.78%
Material Study	11.00%	16.46%	10.00%	18.23%	1.43%	-
Discussion/Theoretical	79.26%	65.00%	38.00%	22.65%	5.73%	11.60%
Experimental	-	-	2.83%	0.55%	8.57%	1.78%
Other	-	5.00%	10.41%	5.52%	2.85%	9.00%

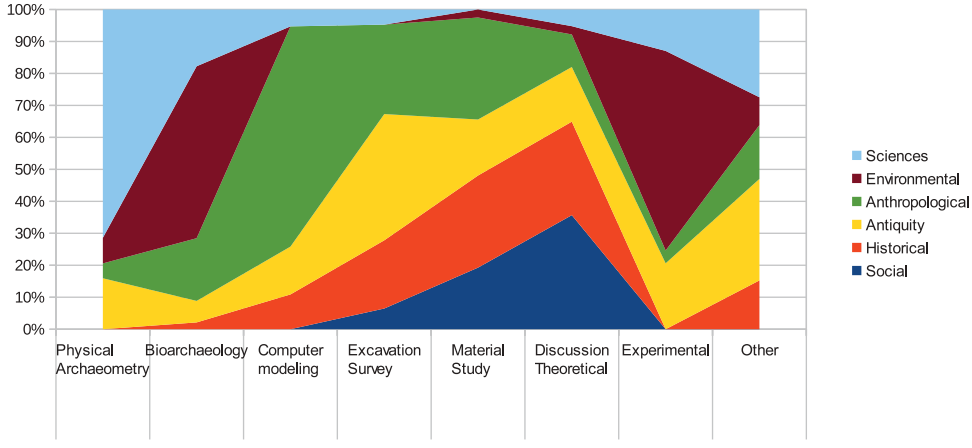

Figure 1. Graphical representation of Table 4, in a 'stacked percentage' diagram.

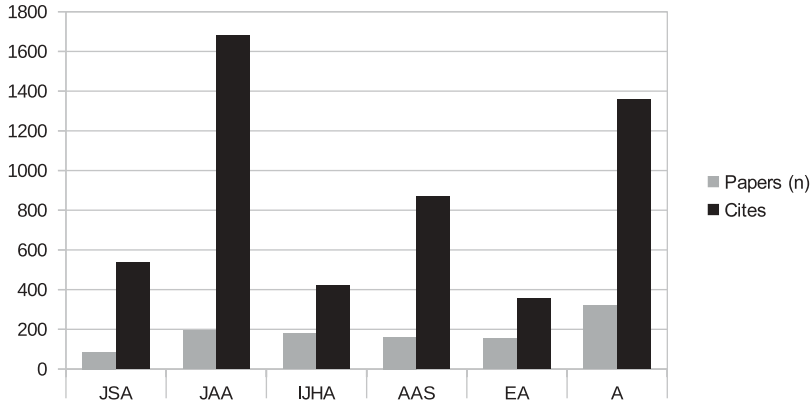

Figure 2. Relation between total number of papers and cites.

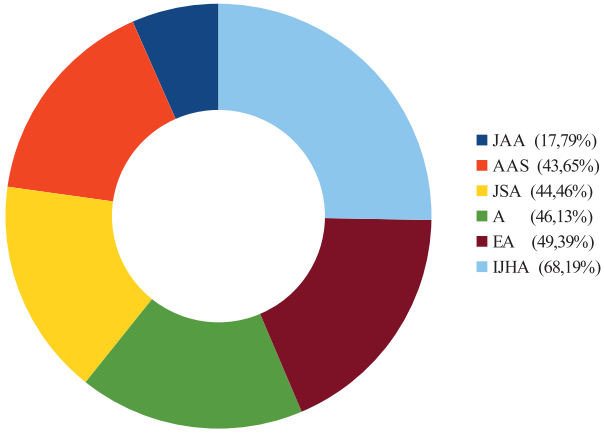

Figure 3. Percentage (%) of papers (n = 926) that have been cited zero times, covering only 2009–2012. The values for this particular diagram were collected from *SCImago Journal & Country Rank (SJR)*, as no reliable data was otherwise available.

this, but it might be attributed to the all-round function of these journals (as witnessed by their broad-scoped statement of purpose – cf. Section 3), constituting a lively community for debate.

When the results in Table 5 are transformed into graphical expressions of the citation network, some points of interest appear (see Figure 4). As illustrated by the figure, the journals form connections of

Table 5. The extent of cross-referencing between the included journals.

Social	Times cited	% of n (82)	Environmental	Times cited	% of n (70)	Antiqiuty	Times cited	% of n (317)
Antiqiuty	2	2.43%	Antiqiuty	1	1.42%	Antiqiuty (self)	92	29.00%
Environ.	0	0.00%	Environ.(self)	11	15.71%	Environ.	6	1.89%
Historical	7	8.53%	Historical	1	1.42%	Historical	4	1.26%
Anthro arc	3	3.65%	Anthro arc	4	5.71%	Anthro arc	25	7.88%
Social (self)	15	18.29%	Social	0	0.00%	Social	5	1.57%
Sciences	0	0.00%	Sciences	3	4.28%	Sciences	13	4.10%
Sum total		*33.00%*	*Sum total*		*28.50%*	*Sum total*		*45.70%*
Sum of others		*14.61%*	*Sum of others*		*12.83%*	*Sum of others*		*16.70%*
Historical	Times cited	% of n (164)	Anthro. Arc.	Times cited	% of n (181)	A. A. Sciences	Times cited	% of n (112)
Antiqiuty	2	1.21%	Antiqiuty	16	8.83%	Antiqiuty	10	8.92%
Environ.	0	0.00%	Environ.	1	0.55%	Environ.	2	1.78%
Historical (self)	16	9.75%	Historical	1	0.55%	Historical	1	0.89%
Anthro arc	0	0.00%	Anthro arc (self)	50	27.62%	Anthro arc	6	5.35%
Social	7	4.26%	Social	4	2.20%	Social	0	0.00%
Sciences	1	0.60%	Sciences	6	3.30%	Sciences (self)	17	15.17%
Sum total		*16.00%*	*Sum total*		*43.00%*	*Sum total*		*32.00%*
Sum of others		*6.07%*	*Sum of others*		*15.43%*	*Sum of others*		*16.94%*

Highest external cites (blue), and self-cites (red). These numbers should be reliable, as the WoS databases include all the journals analyzed in this article. As such, the number of cites amongst the respective six journals should therefore amount to the actual coverage made up of cross-citation (given in %). Color representation is only available in the online version. Please consult the according version.

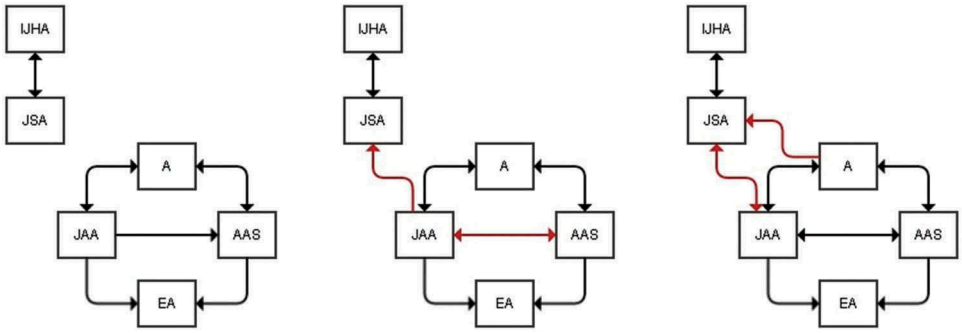

Figure 4. Citation networks according to the confidence interval of >4% (left), >3% (middle) and >2% (right). The direction of arrows denotes the directionality of citing. Double-headed arrows indicate cross-referencing, according to the given confidence interval. Red arrows mark new nodes in the network compared to the former interval.

different kinds depending on what confidence interval (percentage of cites explained by a journal *X*) is applied. Even though the interval of >4% is not too significant, the bar could be raised to 8% and a simplified (less connected) version of the central cluster would still remain, thereby being the most stable and significant network.

What is most profound is the central cluster, as it prevails different levels of testing – which underpins the representativeness of the observable patterns (at least for *JAA-A-AAS*). If we extrapolate the position of these results into the network that would arise from a complete analysis of all archaeological journals, I find it reasonable to assume that the central cluster of Figure 4 would still represent a vital part of the actual central cluster, if all relevant journals were included. Some common denominators for the central cluster are *Journal of Archaeological Science, Archaeometry, World Archaeology, Current Anthropology* – in short, topmost ranked journals. This means that proximity to the center (in terms of cross-referencing) seems to correspond to the ranking of journals. Thus, the higher the rank of a journal, the more connected through cites. This is a confirmed correlation (described by Bradford's law and Zipf's law), though subjected to a recent weakening whereby highly cited research no longer is reserved for a handful of top journals (Lozano *et al.* 2012, Larivière *et al.* 2014, cf. Weale *et al.* 2004).

5. Discussion

What might be expected of the bibliometric results if they were to indicate an optimal and efficient division of labor within archaeology, unaffected by the science/humanities divide? First of all, a very low number of papers would be left without making any contribution to the professional discourse, by way of not receiving any cites. Second, there would be a high degree of cross-referencing between journals. If the division of labor functions smoothly, one sub-field would build on the work being done in other sub-fields (Weisberg and Muldoon 2009), evident by an extensive citing between sub-disciplinary journals. As a result, all parts of the citation-network would become interconnected, and the degree of integration would increase with thematic proximity. Third, the thematic distribution of subjects per journal should take the form of a spectrum of relevance by which a topic of high relevance to a specific journal, is of decreasing relevance to the adjacent journal in the spectrum, until we arrive at the journal where the topic is not relevant. What is relevant to any particular journal would be proscribed by their statement of purpose, and importantly, the very purpose of every single journal would be attuned to the division of labor between archaeological journals. In this way a discipline may foster the most effective allocation of resources, as specific research areas strictly correspond to an associated journal. Fourth, there would be a substantial overlap between journals in what methods are being used. Despite the various goals of journals, given by their statement of purpose, they all have in common the ambition of explaining/interpreting the past. The main differences should not be in the utilization of methods, but in how they are put to use (corresponding to the journal-specific focus on periodic or geographical area). Notwithstanding, the results of the current analysis point to some deviation from this idealized condition.

5.1. Zero-cites

The number of papers that received zero cites in this time period ranges between 17.79% and 68.19%, with an average of 44.94%. This seems to be within normal range of zero-cites amongst the highest ranked archaeological journals (Scopus). The number of zero-cites therefore support the centrality of the journals in the citation network described above, as the highest ranked journals also tend to receive the most cites. Still, almost half of the papers presented are not cited at all. A large review showed that levels of zero-cites correspond to different branches of science, placing these results closer to the social (32%) and natural sciences (27%), than the humanities (82%), for this parameter (Larivière *et al.* 2009). A spectrum appears when dissecting the results: Whereas *JAA* has very few zero-cites (17.19% – close to the ultimate low of 12% set by medical journals, thus falling below the average for natural science journals), *IJHA* stands out with a particularly high amount (68.19%), closer to the humanistic average.

The rate of zero-cites must be kept in mind when reviewing a journal's impact factor, as it is based on the average number of cites per paper, not the median. Therefore, a journal with a high percentage of zero-cites and some highly cited papers, can give the impression of most papers being well cited. In regard to the journals included for analysis in this article, about half of the papers have not been cited – a fact which affect the journals' impact factor/SJR as presented in Table 1. When coupled with the values for zero-cites, there is a strong inverse correlation with the impact factor, making high ranking correspond with low number of zero-cites. This is confirmed by the highest ranked journal *JAA*, having the lowest percentage of zero-cites. Conversely the lowest ranked journal *IJHA*, has the highest percentage of zero-cites.

5.2. Cross-references

The citation network (cf. Figure 4) provides an illustration of what we may call *the direction of relevance*. It describes the general direction most of the cites are oriented toward – that is, in what journals the papers (from the original set) are considered relevant. When checking for external citing (cites coming from journals not included here) *JSA* predominately gets cited by anthropological journals, but also some heritage and literary reviews. *IJHA*, naturally gets cited by other historical and contemporary archaeology journals to a high degree, but also social matters such as by slavery, theater and art reviews. Both diverge from the other four, in being more specifically oriented toward humanistic journals. A massive study of citing amongst specifically humanistic journals has identified archaeology as highly connected to classics and religion studies, and secondarily to history (Leydesdorff *et al.* 2011, pp. 2420–2421).

The situation is a bit different when it comes to *EA, JAA* and *AAS*, as they are all directed toward scientific journals such as *Archaeometry* and *Journal of Archaeological Science*. The bulk of all their cites comes from these two, together with journals of physical, chemical and biological science. Internally, both *JAA* and *AAS* cite *EA*. The relation does not work the other way around, *EA* being a link toward the environmental sciences. Being a specialist journal, these factors may explain *EA´s* low rate of cites (both absolute and amongst the included journals), its modest metrics (cf. Table 1) and ranking (SJR). In sum, there are weak ties between the two clusters (as shown in Figure 4), and some one-way connections amongst the archaeometric journals. Ideally this would not happen, as a fully integrated discipline with a well-functioning division of labor amongst its sub-fields, relies on a steady exchange of information between its sub-fields. This would have become visible in the network analysis as regular cross-referencing amongst the journals.

Another factor that seems to influence the distribution of cites is geography: the main bulk of cites to a specific journal are given by journals that originate in the same country. As such, the majority of American journals' citation network stems from other American journals. The same pattern goes for British journals.

It might seem unfair comparing such recent cites as of the previous five years, due to the distribution of cites being time dependent. One might therefore claim that journals exhibit unequal 'output profiles', that is, accumulating cites at different rates. Some journals receive a steady number of cites between year *x* and *y*, while others might have a decreasing or increasing output profile over time. If so, a journal with an increasing output profile will be underrepresented in

this analysis due to the lack of time to accumulate cites. Even so, different output profiles pose no challenge to this article. Rather it's the opposite: the differences in the time it takes to manifest the direction of relevance to other journals only demonstrate the different characteristics of the journals.

5.3. Thematic and methodical distribution

The thematic distribution exhibits large differences (cf. Table 2). *JAA* and *[A]* seems most all-round with a general coverage of most categories, with main emphasis on past phenomena. *EA* and *AAS* clearly discriminate against the [Environment]-class, while *JSA* and *IJHA* are the only journals with significant emphasis on [Meta]-class (when not counting technical, methodological development).

Some topics come out as exclusive to particular journals. Even though this may follow naturally from the journals representing specialized sub-fields within archaeology (such as *EA*'s correspondence with environmental topics), it is still noteworthy that some topics that by no means are necessarily bound up with the program statements of a specific journal, only occur in some journals and not in others. For instance, a singular treatment of topics arises from *IJHA*'s take on *Class/Inequality* = 15.24% and *Colonialism/Indigenous* = 12.19%. Despite some occurrence in *JSA*, I can see no apparent reason for the very small portion of total coverage of such topics, as they are very much in accordance with the stated purpose of *JSA*. The same sort of monopolizing of topics has already been mentioned regarding the exclusive occurrence of *Infrastructure/Monuments* and *Civilization/Culture history* in *[A]*. Furthermore, *AAS* is the sole journal with papers on provenience, e.g. identifying the point of origin of raw materials. There is nothing in the stated purpose hindering the publication of provenience studies in any of the journals. This absence is particularly striking for *[A]* and *JAA*. Such singularities may only point to the limited scope of this analysis, restricted to a five year period. Still, the total absence of a topic over five years (i.e. a substantial number of issues and papers) might be telling for the general practice of that journal.

A distinct distribution of traits amongst the six journals also goes for the application of methods. Contrary to the thought-experiment that predicted a substantial overlap in methodological applications, there are distinct connections between type of journal and the utilization of methods.

5.4. What's at stake? The epistemic viewpoint

In sum, when a constellation of the above four parameters form separate and unconnected clusters, it might result in 'islands' in the sea of knowledge. These are characterized by several factors, such as very low cross-referencing, treatment of unique topics and a narrow scope of utilized methods. There seems to occur some form of island formation, particularly amongst *JSA* (and to some degree) *IJHA*. Without any evaluative statement intended, it is safe to say that *JSA* and *IJHA* form one end of a hypothetical continuum ranging from basic science to externally oriented, socially engaged research. This is evident from their main reliance upon discussion as a favored method, that these two journals are the only ones dealing with heritage, making policy papers, raising normative research-questions, and they have the fewest connections to archaeometric journals – less than 1% of their cites comes from *AAS* and *EA*.

As discussed earlier, disciplinary fragmentation is bibliometrically indicated by a singular focus on research topics, a singular reliance on methods and by the abrupt transition between journals in regard to thematic and methodological scope. What is more, the direction of relevance of each journal may belong to general areas of similar research interests. Such connections often transcend disciplinary boundaries, and may therefore form clusters of interdisciplinary bonds that are more closely epistemically related *across* disciplines than between archaeological sub-fields.

Taken together, the findings presented above hint at some differences in conduct, and it is my claim that they result from differing orientations toward explanatory ideals facilitated by the science/humanities divide. The affiliation of different branches of science with specific modes of explanation is well established, and was described early on by Whewell (1840). In its basic form, the argument states that as disciplines study different phenomena, and different phenomena may best be described by specific types of explanations, different disciplines will adhere to different explanatory ideals. The most common distinction is made between nomothetic and ideographic explanations.

This dichotomy concerns the degree to which a statement has general validity, ranging on a continuum between specificity and generality (Windelband 1921, 1998, Lyman and O'Brien 2004). *Ideography*, representing an ideal of specificity in explanations, seeks to describe what is distinct, unique, particular, local in space and time. On the other end of the analytic continuum, we find the *nomothetic* ideal, seeking general and possibly law-like descriptions of materials, events and phenomena, which has a large distribution across time and space. A typical example of the former is humanistic research. The physical sciences may stand for the latter. As different parts of the archaeological enterprise trace their purpose and origin back to multiple traditions, as well as the engagement with other disciplines vary, it is reasonable to assume that it does affect the outlook on archaeology as a scientific or a humanistic endeavor.

The important point I wish to emphasize is that differing explanatory ideals are generally proscribed by specific epistemological outlooks. As such, opposing directions of relevance might be the best practical indicator of diversification, potential fragmentation and incompatibility in archaeology. At this point it is necessary to briefly touch upon the fundamental evaluative question motivating this inquiry: is the ideal of a unified archaeology worth striving for? Though clearly a topic lacking consensus in archaeology (and arguably also lacking in interest since the 1980s), it is my strong belief that all knowledge production necessitates a common epistemological footing – which is exactly what might be provided by a well-integrated discipline. I take diverging orientations toward scientific and humanistic ideals to represent different and opposing epistemologies, that is – different ways of knowing, which proscribe different ways of procuring and evaluating knowledge. Though practices may fruitfully vary and methods may be differently applied, this is of less importance as they can be compared and it is therefore possible to integrate the results of slightly variable practices. On the other hand, differing epistemologies proscribe different worldviews and scientific outlooks that can be more or less in accordance with the aims of archaeology as an enterprise procuring knowledge of the past.

If granting archaeology the objective of procuring knowledge of the past, it becomes vital that the archaeological community reflects upon the impact of multiple and opposing epistemologies underpinning the everyday practice of archaeology around the globe – be it lab-based archaeometry, postmodernist discourse analysis or culture historical deliberations. Clearing out such epistemic inconsistencies is important because stronger integration provides more efficient communication amongst archaeologists of different epistemological positions, as well as in the cooperation with practitioners of external disciplines. Second, integration provides a more effective framework for comparing results, which is the precondition for knowledge accumulation. Furthermore, the comparison of results constitutes the very backbone of scientific quality assessment and the peer review process, by which scientific progress is made possible and reliable.

Some attempts have been made at analyzing the epistemic divide of archaeological traditions (Kristiansen 2004, 2014, Trigger 1998, 2006, p. 485, 2008, cf. O'Brien *et al.* 1998). In a Scandinavian context, maybe the most significant attempt was made by Kristian Kristiansen (2004, p. 77) in his plea for archaeologists to rally behind a common understanding of archaeology as a historical discipline. This idea might be taken a step further by suggesting an inclusion of archaeology under the umbrella of the historical sciences (Davidson 2010). This is taking up the established notion that historical phenomena share some vital properties that transcend the disciplinary boundaries traditionally separating the sciences and humanities, and that such phenomena require special measures (Clarke 1968, p. 20, Shennan 2004, p. 5). Historical phenomena have in common being fundamentally transformative and in being spatio-temporally particularistic, be they geophysical, biochemical or cultural, on a small or big scale. By this conception, archaeology fits together with geology, paleontology, astronomy, evolutionary biology and historical linguistics (Cleland 2001, 2002, 2011, Cleland and Brindell 2013). To me this is what seems to be the most coherent and promising approach to handling the epistemic discrepancy of scientific and humanistic archaeology. Despite Kristiansen's program presenting a somewhat weaker claim, I fully support his ambition in reviving the debate on the epistemic underpinnings of archaeology. I think a public and broadly inclusive debate is the only way to first reveal, then improve

and finally agree on matters of disciplinary epistemology. Though inherently controversial subjects, the alternative (insularity) seems far less appealing.

6. Conclusion

The bibliometric data presented in this article point to some significant differences in the practical conduct of archaeological sub-fields, identified as variations in:

- the number of zero-cites (pointing in the direction of a science/humanities-spectrum)
- directions of relevance
- citation-networks (cross-referencing)
- thematic distributions
- unequal application of methods
- scope of journals dictated by the respective statements of purpose

Furthermore, the established relation that proximity to the center cluster (in terms of cross-referencing) corresponds to the ranking of journals, was confirmed by the citation-analysis. Thus, the correlation of 'the higher the rank of a journal, the more connected' (through cites), also has its bearing in archaeology. In concluding this article, I wish to remark that the direct accumulation and comparison of research results in archaeology might be hindered by the variability in practical conduct. A result of special interest corroborating this, is the inversely proportional relation between increasing numbers of theoretical and discussion papers in a journal correlating with a descending utilization of archaeometric methods. In other words, the more papers a journal publishes on theoretical discussions, the fewer the connections made to archaeometric papers. This points to a discontinuity in the intercommunication between different archaeological sub-fields, and I have argued that this lack of integration might be the result of various archaeological sub-field relying on diverse epistemic positions. As this pattern is what would be expected of a somewhat fragmented discipline, I have claimed that the cause of such a potential fragmentation could be ascribed to the continued relevance of the science/humanities divide in providing sub-fields with opposing explanatory ideals (e.g. nomothetic/ideographic). Despite the many factors influencing the outcome of academic publishing, such as editorial priorities, competition between journals, the selective pressure of authors in choosing where to publish and financial restraints, the results of the analyzed sub-field journals may point to a sub-optimal division of labor in archaeological publishing. This, diverse archaeological practice resembles a double-edged sword: At once stimulating creativity and innovation, while at the same time hindering the effectiveness of a normal science to solve problems. Further research is needed in order to evaluate the consequences of such a disciplinary situation.

References

Batista, P.D., Campiteli, M.G., and Kinouchi, O., 2006. Is it possible to compare researchers with different scientific interests? *Scientometrics*, 68 (1), 179–189. doi:10.1007/s11192-006-0090-4

Bellis, N.D., 2009. *Bibliometrics and citation analysis: from the science citation index to cybermetrics*. Lanham, MD: The Scarecrow Press, Inc.

Binford, L.R., 1962. Archaeology as anthropology. *American Antiquity*, 28 (2), 217–225. doi:10.2307/278380

Broadus, R.N., 1987. Toward a definition of "bibliometrics.". *Scientometrics*, 12 (5–6), 373–379. doi:10.1007/BF02016680

Brookes, B. C., 1990 Biblio-, sciento-, infor-metrics??? What are we talking about. In: L. Egghe and R. Rousseau (eds). *Proceedings 1st International Conference on Bibliometrics and Theoretical Aspects of Information Retrieval*. London: Reuters Ltd.

Brughmans, T., 2013. Networks of networks: a citation network analysis of the adoption, use, and adaptation of formal network techniques in archaeology. *Literary and Linguistic Computing*, 28 (4), 538–562. doi:10.1093/llc/fqt048

Butzer, K.W., 2009. Evolution of an interdisciplinary enterprise: the Journal of Archaeological Science at 35 years. *Journal of Archaeological Science*, 36 (9), 1842–1846. doi:10.1016/j.jas.2009.04.011

Clarke, D.L., 1968. *Analytical Archaeology*. London: Methuen.

Cleland, C.E., 2001. Historical science, experimental science, and the scientific method. *Geology*, 29 (11), 987. doi:10.1130/0091-7613(2001)029<0987:HSESAT>2.0.CO;2

Cleland, C.E., 2002. Methodological and epistemic differences between historical science and experimental science. *Philosophy of Science*, 69 (3), 447–451. doi:10.1086/342455

Cleland, C.E., 2011. Prediction and explanation in historical natural science. *The British Journal for the Philosophy of Science*, 62 (3), 551–582. doi:10.1093/bjps/axq024

Cleland, C.E. and Brindell, S., 2013. Science and the messy, uncontrollable world of nature. *In*: M. Pigliucci and M. Boudry, eds.. *Philosophy of pseudoscience: reconsidering the demarcation problem*. Chicago: University of Chicago Press, 183.

Davidson, I., 2010. A lecture by the returning chair of Australian studies, Harvard University 2008–09. *Journal of Australian Studies*, 34 (3), 377–398. doi:10.1080/14443058.2010.498494

Fahlander, F., 2012. ARE WE THERE YET? Archaeology and the postmodern in the new millennium. *Current Swedish Archaeology*, 20, 109–129.

Fanelli, D. and Glänzel, W., 2013. Bibliometric evidence for a hierarchy of the sciences. *PLoS ONE*, 8 (6), e66938. doi:10.1371/journal.pone.0066938

Garfield, E., 1979. *Citation Indexing: Its Theory and Application in Science, Technology, and Humanities*. Philadelphia: Isi Press.

Glänzel, W., 2002. *A concise introduction to bibliometrics & its history*. Available from: https://www.ecoom.be/en/research/bibliometrics [Accessed 28 October 2014].

Gross, P.L.K. and Gross, E.M., 1927. College libraries and chemical education. *Science*, 66 (1713), 385–389. doi:10.1126/science.66.1713.385

Hodder, I., 2012. *Archaeological Theory Today*. Cambridge: Polity Press.

Jones, A., 2004. Archaeometry and materiality: materials-based analysis in theory and practice*. *Archaeometry*, 46 (3), 327–338. doi:10.1111/j.1475-4754.2004.00161.x

Kristiansen, K., 2004. Genes versus agents. A discussion of the widening theoretical gap in archaeology. *Archaeological Dialogues*, 11 (2), 77–99. doi:10.1017/S1380203805211509

Kristiansen, K., 2014, Towards a new paradigm? The third science revolution and its possible consequences in archaeology. *Current Swedish Archaeology*, 22 (1), 11–40.

Larivière, V., Gingras, Y., and Archambault, É., 2009. The decline in the concentration of citations, 1900–2007. *Journal of the American Society for Information Science and Technology*, 60 (4), 858–862. doi:10.1002/asi.21011

Larivière, V., Lozano, G.A., and Gingras, Y., 2014. Are elite journals declining?. *Journal of the Association for Information Science and Technology*, 65 (4), 649–655. doi:10.1002/asi.23005

Leydesdorff, L., Hammarfelt, B., and Salah, A., 2011. The structure of the arts & humanities citation index: A mapping on the basis of aggregated citations among 1,157 journals. *Journal of the American Society for Information Science and Technology*, 62 (12), 2414–2426. doi:10.1002/asi.21636

Lotka, A.J., 1926, The frequency distribution of scientific productivity. *Journal of the Washington Academy of Sciences*, 16 (12), 317–324.

Lozano, G.A., Larivière, V., and Gingras, Y., 2012. The weakening relationship between the impact factor and papers' citations in the digital age. *Journal of the American Society for Information Science and Technology*, 63 (11), 2140–2145. doi:10.1002/asi.22731

Lyman, R.L. and O'Brien, M.J., 2004. Nomothetic science and idiographic history in twentieth-century Americanist anthropology. *Journal of the History of the Behavioral Sciences*, 40 (1), 77–96. doi:10.1002/(ISSN)1520-6696

Mallía, M.S. and Vidal, A.S., 2009. From the opposite corner: a bibliometric analysis of research on American archaeology in European publications. *Archaeologies*, 5 (3), 446–467. doi:10.1007/s11759-009-9118-8

Marriner, N., 2009. Currents and trends in the archaeological sciences. *Journal of Archaeological Science*, 36 (12), 2811–2815. doi:10.1016/j.jas.2009.09.009

Mays, S., 2010. Human osteoarchaeology in the UK 2001–2007: a bibliometric perspective. *International Journal of Osteoarchaeology*, 20 (2), 192–204. doi:10.1002/oa.1021

Nalimov, V.V. and Mulchenko, B.M., 1971. *Measurement of science: study of the development of science as an information process*. Washington, DC: Foregin Technology Division.

Norris, M., Oppenheim, C., and Rowland, F., 2008. The citation advantage of open-access articles. *Journal of the American Society for Information Science and Technology*, 59 (12), 1963–1972. doi:10.1002/asi.20898

O'Brien, M.J., Lyman, R.L., and Leonard, R.D., 1998. Basic incompatibilities between evolutionary and behavioral archaeology. *American Antiquity*, 63 (3), 485. doi:10.2307/2694632

Palomar, T., García-Heras, M., and Villegas, M.A., 2009, Archaeological and historical glasses: A bibliometric study. *BOLETIN DE LA SOCIEDAD ESPAÑOLA DE ARTICULO Cerámica Y Vidrio*, 48 (4), 187–194.

Penfield, T., *et al*., 2014. Assessment, evaluations, and definitions of research impact: A review. *Research Evaluation*, 23 (1), 21–32. doi:10.1093/reseval/rvt021

Polanyi, M., 1958. *Personal knowledge*. The University of Chicago Press. Available from: http://www.press.uchicago.edu/ucp/books/book/chicago/P/bo3628989.html

Price, D.S., 1961. *Science since Babylon*. New Haven, CT: Yale University Press.

Price, D.S., 1963. *Little science, big science*. New York, NY: Columbia University Press.

Pritchard, A., 1969. Statistical bibliography or bibliometrics. *Journal of Documentation*, 25 (4). Available from: http://www.academia.edu/598618/Statistical_bibliography_or_bibliometrics

Ravichandra, R.I.K., 1983. *Quantitative methods for library and information science*. New Delhi: Wiley Eastern.

Rubin, R., 2010. *Foundations of Library and Information Science, Third Edition*. Third Edition edition. New York: Neal-Schuman Publishers.

Shennan, S., 2004. Analytical archaeology. *In*: J. Bintliff, eds. *A companion to archaeology*. Malden: Willey-Blackwell, 3–20.

Solomon, D.J., Laakso, M., and Björk, B.-C., 2013. A longitudinal comparison of citation rates and growth among open access journals. *Journal of Informetrics*, 7 (3), 642–650. doi:10.1016/j.joi.2013.03.008

Trigger, B.G., 1998. Archaeology and epistemology: dialoguing across the Darwinian chasm. *American Journal of Archaeology*, 102 (1), 1. doi:10.2307/506135

Trigger, B.G., 2006. *A history of archaeological thought*. 2nd ed. Cambridge: Cambridge University Press.

Trigger, B.G., 2008. "Alternative archaeologies" in historical perspective. *In*: J. Habu, C. Fawcett, and J.M. Matsunaga, eds.. *Evaluating multiple narratives*. New York, NY: Springer, 187–195. Available from: http://link.springer.com/chapter/10.1007/978-0-387-71825-5_12

Weale, A.R., Bailey, M., and Lear, P.A., 2004. The level of non-citation of articles within a journal as a measure of quality: a comparison to the impact factor. *BMC Medical Research Methodology*, 4 (1), 14. doi:10.1186/1471-2288-4-14

Webmoor, T., 2007. What about "one more turn after the social" in archaeological reasoning? Taking things seriously. *World Archaeology*, 39 (4), 563–578. doi:10.1080/00438240701679619

Weisberg, M. and Muldoon, R., 2009. Epistemic landscapes and the division of cognitive labor. *Philosophy of Science*, 76 (2), 225–252. doi:10.1086/644786

Whewell, W., 1840. *The philosophy of the inductive sciences: founded upon their history*. Vol. in two volumes, London: John W. Parker.

Whitley, P.J., 2001. *The archaeology of ancient Greece*. Cambridge: Cambridge University Press.

Windelband, W., 1921. *An introduction to philosophy*. London: Unwin.

Windelband, W., 1998. History and natural science. *Theory & Psychology*, 8 (1), 5–22. (Original work delivered 1894.). doi:10.1177/0959354398081001