

A quantitative history of Japanese archaeology and natural science

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ABSTRACT

This study examines the relationship between Japanese archaeology and natural science through a quantitative analysis of the two most authoritative archaeological journals and two other relevant journals in Japan. First, although previous studies have emphasized the impact of the Department of Anthropology at the University of Tokyo on the scientific aspects of Japanese archaeology, results of the present study suggest that its impact has been more limited than previously assumed. Second, while previous studies claimed that research funding by the Japanese government from the latter half of the 1970s was an important factor in developing the scientific aspects of Japanese archaeology, the present study shows a result inconsistent with the claim. Finally, although I admit that the previous studies have properly captured some aspects of the relationship between Japanese archaeology and science, I conclude that we should look at the broader array of contributors to the relationship between Japanese archaeology and natural science.

KEYWORDS: history of archaeology, Japanese archaeology, philosophy of archaeology, interdisciplinarity, archaeology and science

1. Introduction

Modern archaeology is interdisciplinary. It typically focuses on archaeological remains through natural and/or social scientific methods. Chemistry, for example, is virtually indispensable for the analysis of archaeological remains and ethnographic studies can often be useful. Thus, to describe the history of archaeology, we need to understand the process by which such interdisciplinary relationships were formed, i.e., how different kinds of approaches were introduced and employed in archaeology. Processualism, which had been advanced primarily by Lewis R. Binford (e.g., Binford 1962, 1965), offers one good example. Processualism is a kind of scientific approach to archaeology focusing on law-like explanations and scientific methodology. Many of historical descriptions of American archaeology have actually referred to it and the controversies around it (O'Brien *et al.* 2005; Patterson 1995; Trigger 2006; Wiley & Sabloff 1993).

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In the history of Japanese archaeology, processualism has also been an important topic, although not as a main promoter of such interdisciplinarity. As Anzai (1990) argued, reactions to processualism have been actually mixed: Fujimoto (1976) had examined processualism in detail as early as in 1976, and has been consistently interested in it (e.g., Fujimoto 1985). Akoshima studied and earned his Ph.D. under the supervision of Binford, and published articles positively describing processualism in the 1980s (e.g., Akoshima 1983, 1988). On the other hand, other scholars have long ignored processualism although many Japanese archaeologists likely knew of processualism before the 1970s. As an example, Tanaka mentioned processualism negatively as early as in 1966 in a brief newspaper article (Tanaka 1966) although as far as I am aware, additional academic articles referring to processualism, other than Fujimoto (1976), did not appear before the 1980s. Moreover, by 1985, some have even begun to mention it critically (e.g., Goto 1984; Yokoyama 1985). Thus, as Barnes & Okita (1999) pointed out, interdisciplinarity in Japanese archaeology has been encouraged not through the introduction of processualism but by other means.

Some previous studies have described the background behind the introduction of natural science into Japanese archaeology. First, Ikawa-Smith (1982, 2003) and Pearson (1992) have claimed that Japanese archaeology consists of two different traditions: archaeology as *science* and archaeology as *history*. They have emphasized the role of the Department of Anthropology at the University of Tokyo in strongly influencing on the tradition of archaeology as science. For instance, Ikawa-Smith (1982, p. 300) has argued that “[t]he successive heads of the department [of Anthropology] since 1925 have been scholars whose research interests were in biological anthropology...Its strong natural science orientation sets the tone for one of the important trends in Japanese archaeology.” She maintained this claim in 2003, arguing that “the Anthropology Department of Tokyo University was particularly notable for contributions to prehistoric research through applications of various methods and techniques of natural sciences” (Ikawa-Smith 2003, p. 681). Pearson (1992, pp. 119–120) has agreed with her claims, stating that “[o]ne tradition, the study of prehistoric archaeology as part of human natural history, stems from the Science Faculty of Tokyo University. It stresses scientific methods and technical analyses...Many contributors to the growing body of scientific analyses have been affiliated with the Anthropological Institute, Faculty of Science, of the University of Tokyo.”

One might be concerned with the definition of ‘natural’ science here. It is difficult to define natural or social sciences and any previous studies did not actually do so (Barnes & Okita 1999; Ikawa-Smith 2003, Pearson 1992). However, for the sake of argument, this paper regards studies using physical, chemical, and biological, and experimental and/or mathematical approaches as natural scientific research while social scientific studies

include ones using approaches employed in ethnography, cultural or social anthropology, and sociology (see also the next section for more specific criterion used in this study). Note that although we can easily find many crossover studies like sociological research using statistics, such cases do not affect the argument in this paper.

Second, Barnes & Okita (1999, p. 353) argue that social change led by Japanese government from the latter half of the 1970s greatly influenced the relationship between archaeology and natural science, rather than attributing this development to the role of any particular university: “many Japanese scholars...turned to scientific technology for their version of a more rigorous approach to archaeology. This trend was supported by the Japanese government, which had long neglected humanities research funding” (Barnes & Okita 1999, p. 352). Indeed, the Ministry of Education, Science and Culture in Japan began conducting a special funding program for ancient cultural properties, ‘Research on Archaeological Sites and Ancient Cultural Properties by Natural Scientific Method’ from 1976 to 1978 and ‘Conservation Science, Humanities, and Natural Science on Ancient Cultural Properties’ from 1980 to 1982, from which two significant reports were published (Committee for Conservation of Ancient Cultural Properties 1980, 1984). Many agree that these two research funding programs were responsible for bringing together a large number of researchers from the humanities and natural sciences, and that Naotsune Watanabe (1919–1999), professor of the Department of Anthropology at the University of Tokyo, had made an important contribution to managing the research funding (e.g., Iguchi 2005; Ikawa-Smith 2003; Sahara 1981).

While these claims properly capture *some* aspects of the relationship between Japanese archaeology and science, it is probable that they have not looked at a number of other significant factors. For instance, even though the University of Tokyo has had a relatively strong impact on the relationship between archaeology and science, it seems reasonable to ask just how strong the impact has been and how much other universities have contributed to the scientific aspects of archaeology. And if research funding has supported this movement since 1976, what was the situation prior to 1976? Moreover, the previous studies have largely depended on qualitative analyses of notable figures in Japanese archaeology rather than pursuing a more quantitative investigation.

The present study aims to explore scientific aspects of Japanese archaeology that previous studies have overlooked in an effort to answer the above-mentioned questions. Especially, a quantitative approach—bibliometric method—is used to investigate these questions and test the qualitatively-based claims of previous studies. Important journals of Japanese archaeology are examined and the universities from which the authors of relevant articles graduated are analyzed over an extensive time period. Based on the analyses, I show a more diverse picture of the situation surrounding the development of the relationship between science and archaeology in Japan than previous studies have

shown.

The structure of the paper is as follows: Section 2 explains the materials and methods the present study uses; Section 3 summarizes the results of the study; Section 4 replies to possible objections.

2. Materials and methods

2.1 Materials

The present study focuses on papers published in two major archaeological journals in Japan, the *Journal of the Archaeological Society of Nippon* (*Kokogaku Zasshi* in Japanese, and hereafter abbreviated as the *Journal*) and the *Quarterly of Archaeological Studies* (*Kokogaku Kenkyu* in Japanese, and hereafter abbreviated as the *Quarterly*). The former was launched in 1910 and the latter in 1954 (but published as *Our Archaeology*, or *Watashitachi no Kokogaku* in Japanese, before 1959); the two publications are the most well-known and authoritative journals specializing in archaeology in Japan and reflect the mainstream of Japanese archaeology.

Two other relevant journals are also examined: *Journal of the Anthropological Society of Nippon* (*Jinruigaku Zasshi* in Japanese, and hereafter abbreviated as the *Anthropology*) and *Archaeology and Natural Science* (*Kokogaku to Shizen Kagaku* in Japanese, hereafter abbreviated as the *Arch. Nat.*). The *Anthropology* was originally launched by the Tokyo Anthropological Society and researchers from the University of Tokyo including Shogoro Tsuboi (1863–1913) and Ryuzo Torii (1870–1953). It is one of the main journals for biological anthropology or anatomy in Japan. The *Arch. Nat.* is an interdisciplinary journal started in 1968; as its journal title indicates, its aim and scope focus on interdisciplinary studies involving archaeology and science. These journals are examined in order to more fully assess the scientific process of Japanese archaeology and the role of the Department of Anthropology at the University of Tokyo (hereafter abbreviated as the DAUT).

I examine papers in the *Journal* published from 1950 to 1984, and in the *Quarterly* from 1960 to 1984. This is because (1) the situation before the World War II was strongly influenced by nationalism and thus writings and research during that period need to be analyzed from a different perspective (e.g., Fawcett 1995), (2) the *Quarterly* changed its journal title and became more academic after 1959, and (3) one of the main aims of this paper is to examine the claims in previous research, which refers mainly to the situation before the 1990s. Papers in the *Anthropology* from 1950 to 1984, and in the *Arch. Nat.* from 1968 (when the journal has been started) to 1984 were likewise included.

The *Journal* and the *Quarterly* contain original papers, research notes, reports and others items; the *Anthropology* contains original papers, brief reports, and

communications; the *Arch. Nat.* contains original papers, research notes, and perspectives as publication categories. For this study, I examine only original papers and research notes as they are the main categories in the four journals. The total number of the published original papers and research notes is 361 in the *Journal* from 1950 to 1984, 369 in the *Quarterly* from 1960 to 1984, 649 in the *Anthropology* from 1950 to 1984, and 146 in the *Arch. Nat.* from 1968 to 1984.

2.2 Methods

To examine the scientific aspects of Japanese archaeology, relevant articles using ‘scientific methods’ were identified for the *Journal* and the *Quarterly*. A set of specific criteria was applied to produce the list of appropriate papers. In order to be considered for inclusion in this study, the paper must do one of the following at least:

- (1) Use a physical method to explore the ages of material remains including radiocarbon age estimation (Age Estimation).
- (2) Focus on physical aspects of human skeletal remains (Biological Anthropology).
- (3) Analyze chemical properties of material remains (Chemical Analysis).
- (4) Explain how to conserve material remains effectively in terms of biology, chemistry, or physics (Conservation).
- (5) Apply experimental replication of material remains (Experiment).
- (6) Consider social change in terms of entropy (Information Science).
- (7) Explore botanical conditions in the past (Palaeobotany).
- (8) Examine past geological situations (Palaeogeology).
- (9) Analyze biological environments in the past (Palaeontology).
- (10) Use mathematical models to explore the ages of material remains (Population Estimation).
- (11) Analyze forms of material remains statistically (Statistics).

Using these criteria, a total of 51 articles were selected from the *Journal* and the *Quarterly*. Papers in the *Anthropology* were chosen according to the same criteria and ninety-two such papers were identified. It should be noted that although the *Anthropology* includes biological anthropology articles referring to modern humans and non-human animal skeletons, and a few papers describing the typology of stone tools or pottery, these papers were excluded from the study since the focus of the present study is on the relationship between archaeology and science. Finally, all of the papers in the *Arch. Nat.* (146 papers in all) were included since they are all relevant to the purpose of the present study.

Following selection of the relevant articles, the university from which the author graduated (author’s ‘graduated university’), citation relationship and affiliations, as well as historical changes in the number of the relevant papers, were examined. If the impact

of the DAUT on the scientific aspects of Japanese archaeology has actually been strong, we should expect to find a large number of papers written by researchers from and at the DAUT, as well as numerous papers by the DAUT researchers being cited in the four journals. In addition, if the research funding beginning in 1976 was an important factor in fostering the scientific aspects of Japanese archaeology, we should find a historical increase in relevant papers following the funding. Moreover, if the DAUT has had a strong impact on the scientific aspects of Japanese archaeology, it should be found that this historical increase was supported extensively by researchers from the DAUT.

3. Results

3.1 How influential was the DAUT?

3.1.1 The impact of the DAUT (1): Author's graduated university and department

How strong has been the impact of the DAUT on the scientific aspects of Japanese archaeology? To answer this question, authors of the relevant 51 papers in the *Journal* and the *Quarterly*, 92 papers in the *Anthropology*, and 146 papers in the *Arch. Nat.* were identified, and each author's graduated university (i.e., where the author's Ph.D. was earned or, if the author did not hold a Ph.D., where the author completed his/her studies) was determined. If the impact of the DAUT has been strong, we should expect to find more authors of these articles graduating from the DAUT rather than from other universities¹.

Table 1 shows the graduated universities and the number of the relevant papers published in the four journals. It suggests that researchers graduating from the University of Tokyo have had a strong impact in the four journals, accounting for 32.9% of all the examined papers.

Table 2 shows the specific graduated departments for the University of Tokyo authors. The result suggests that the impact of the DAUT (55.8% of the total) has been stronger than any of the other University of Tokyo departments.

However, despite appearances, the DAUT's impact on the general trend in the scientific aspects of Japanese archaeology has been only partial; researchers from other universities have also published numerous papers. Indeed, not only have researchers from Kyoto University worked as actively as the DAUT in this area, but almost all of the papers by researchers from the DAUT have been published in the *Anthropology*.

Table 3 summarizes the authors' graduated universities and departments for the

¹ When examining co-authored papers, I focused on the first author.

Table 1. Top-5 Graduated Universities of the researchers writing relevant papers

Graduated Universities	Number of Papers
U. Tokyo	95
Kyoto U.	73
Unknown	17
Tohoku U.	16
Osaka U.	12
Others	76
Total	289

*U: University

Table 2. Top-5 Graduated Departments of the researchers at the University of Tokyo writing relevant papers

Graduated Departments	Number of papers
<u>Anthropology</u>	53
Chemistry	20
Geology	9
Medicine	7
Archaeology	2
Others	4
Total	95

Table 3. Top-5 Graduated universities and departments of the researchers writing relevant papers in the Anthropology (departments names are not described if they are unclear)

Graduated University (Department)	1950-1954	1955-1960	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	Total
<u>U. Tokyo (Anthropology)</u>	7	4	7	4	5	4	13	44
Keijo Imperial U. (Medicine)	3	3			1			7
U. Tokyo (Medicine)			1				6	7
Sapporo Medical U.					2		3	5
U. Tokyo (Geology)				2		2		4
Others	1	1	3	4	4	3	9	25
Total	11	8	11	10	12	9	31	92

relevant 92 papers in the *Anthropology*. As indicated, 44 out of the 53 (83%) papers published the DAUT graduates in the four journals have been published in the *Anthropology*, strongly suggesting that the large number of publications by the DAUT graduates is explained by their dominance in that particular journal, which was launched by researchers from the University of Tokyo.

We can contrast this with the analysis of other journals. Table 4 shows the authors' graduated universities and departments for articles in the *Journal* and the *Quarterly*. Unlike in the *Anthropology*, the contributions to these journals by authors who graduated from the DAUT are not especially outstanding when compared to those from other universities and departments. These results suggest that, with respect to the scientific aspects of Japanese archaeology in general, the DAUT has not had as much impact as previously thought

This interpretation is further supported by the analysis of the *Arch. Nat.*, which

Table 4. Top-10 Graduated universities and departments of the researchers writing relevant papers in the *Journal* and the *Quarterly* (departments names are not described if they are unclear)

Graduating U. (Dept)	1950–1954	1955–1959	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	Total
Tohoku U. (Archaeology)					1		3	4
Kyushu U. (Archaeology)					2		1	3
Kyoto U. (Agriculture)					1	2		3
Kyoto U. (Geology)						1	2	3
Tohoku U. (Geology)				1	1			2
Tohoku U. (Geography)						2		2
U. Tokyo (Geology)	1						1	2
U. Tokyo (Archaeology)			1				1	2
Kyoto U. (Archaeology)				1	1			2
U. Tokyo (Anthropology)					2			2
Others	1		2	1	7	8	7	26
Total	2		3	3	15	13	15	51

Table 5. Top-10 Graduated universities and departments of the researchers writing relevant papers in the *Arch. Nat.* (departments names are not described if they are unclear)

Graduated U (Departments)	1968–1969	1970–1974	1975–1979	1980–1984	Total
Kyoto U. (Geology)	3	10	4	3	20
U. Tokyo (Chemistry)	3	7	4	4	18
Kyoto U. (Chemistry)		3	3	4	10
Unknown		2	5	3	10
Kyoto U. (Archaeology)	2	3	4		9
Kyoto U. (Engineering)	1	3	3		7
U. Tokyo (Anthropology)	1	1	4	1	7
Kyoto U. (Physics)	1	3	2	1	7
Kyoto U. (Agriculture)		1	3	2	6
Osaka Electro Communication U.		2	3		5
Others	2	13	11	21	47
Total	13	48	46	39	146

*Comm: Communication

accounts for 50.5% of all the examined publications (as compared to the *Anthropology*'s 31.8%). Table 5 shows the authors' graduated universities and departments for the relevant papers in the *Arch. Nat.*

Here, the contributions of the DAUT graduates account for only 4.8% of the publications, while scholars from the Geology department of Kyoto University account for 13.7%.

These results show that the apparent dominance by the DAUT graduates was, for the most part, limited to the *Anthropology*, which suggest that we should look at more diverse contributions to understand the historical development of the scientific aspects of Japanese archaeology.

3.1.2 The impact of the University of Tokyo (2): Citation relationship

What, then, was the influence of the papers by the DAUT graduates on the works of other scholars? This section analyzes citation relationships among relevant papers and examines the number of papers in the four journals that cite scientific papers written by researchers graduating from the DAUT. In the following, I examine 51 scientific papers in the *Journal* and the *Quarterly*, and 146 papers in the *Arch. Nat.* Papers in the *Anthropology* were excluded since nearly all the papers therein cited papers by researchers from the DAUT.

The results are summarized in Table 6. If the impact of the DAUT has been strong with respect to the scientific aspect of Japanese archaeology, we should expect to find that

Table 6. Citation relationship

	1950–1954	1955–1959	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	Total
<i>Journal</i>								
a.			1			1	1	3
b.	2		2		4	5	4	17
<i>Quarterly</i>								
a.				1	4		1	6
b.			1	3	11	8	11	34
<i>Arch. Nat.</i>								
a.					5	6	4	15
b.				13	48	46	39	146
Total								
a.			1	1	9	7	6	24
b.	2		2	16	63	59	54	197
a/b in total	0.00%	0.00%	50.00%	6.25%	14.29%	11.86%	11.11%	12.18%

*a: The number of the papers citing scientific papers written by researchers graduating from the DAUT. b: The number of the papers using 'scientific methods'

the relevant papers extensively cite papers written by the researchers graduating from the DAUT. As shown, the results do not indicate high citation rates for papers by researchers graduating from the DAUT (12.18% among all examined papers). Thus, once again, the evidence suggests that the academic impact of the work of the DAUT researchers has not been strong enough to claim that the DAUT has been the single promoter of the scientific aspects of Japanese archaeology.

3.1.3 The impact of the University of Tokyo (3): Affiliations and the number of the papers

One might argue that it is not the graduated universities or departments that should be examined, but rather the affiliation of the authors at the time their papers were published. If the impact of the DAUT was strong, we should expect to find a large number of papers published by researchers belonging to the DAUT at the time of publication.

Tables 7–9 show the relationship between the affiliations of the authors and the number of papers published in the *Journal* and the *Quarterly*, the *Arch. Nat.*, and the *Anthropology*, respectively. Again, the DAUT scholars are the top contributors to the *Anthropology*. However, the expectation of the DAUT dominance is not confirmed when one considers the other journals. As indicated, Tokyo National Institute and Nara National Institute for Cultural Properties, Nara University of Education, and some departments of Kyoto University have published more papers than the DAUT. Even

Table 7. Top-10 Affiliations and the number of the papers in the Journal and the Quarterly (departments names are not described if they are unclear)

Affiliations	1950–1954	1955–1959	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	Total
Tokyo Nat. Institute of CP					4	1	1	6
Nara Nat. Institute of CP				1	2			3
Unknown					1	1	1	3
Kanazawa U. (Geology)				1	1			2
Kanazawa U. (Archaeology)			1				1	2
U. Tokyo (Geology)	1					1		2
U. Tokyo (Anthropology)					2			2
Okayama U. (Archaeology)					2			2
Hiroshima U. (Integrated Arts and Sciences)						2		2
Tohoku U. (Archaeology)							2	2
Others	1		2	1	3	8	10	25
Total	2		3	3	15	13	15	51

*Nat: National, CP: Cultural Properties

Table 8. Top-10 Affiliations and the number of the papers in the Arch. Nat. (departments names are not described if they are unclear)

Affiliations	1968–1969	1970–1974	1975–1979	1980–1984	Total
Nara U. Education (CP)	1	8	6	5	20
Kyoto U. (Reactor Institute)	1	5	5	1	12
Nara Nat Institute of CP	1	7	3		11
Nagoya U. (Chemistry)	1	1	3	2	7
U. Tokyo (Anthropology)	1	1	4		6
Tokyo Nat. Institute		2	2	1	5
Miyazaki U. (Agriculture)			3	2	5
Kyoto U. (Liberal Arts)		2	2		4
U. Tokyo (Others)			2	2	4
Kanazawa U. (Chemistry)	1	2			3
Others	7	20	16	26	69
Total	13	48	46	39	146

in the *Anthropology*, we find substantial contributions from other universities such as Sapporo Medical University.

Thus, analyses based on the relationship between the affiliations of the authors and the number of relevant papers also suggest that more diverse contributions could be found in the historical development of the relationship between Japanese archaeology and natural

Table 9. Top-10 Affiliations and the number of the papers in the *Anthropology* (departments names are not described if they are unclear)

Affiliations	1950–1954	1955–1960	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	Total
U. Tokyo (Anthropology)	7	3	1	2	4	2	6	25
Sapporo Medical U.			3		2		5	10
U. Tokyo (Medicine)							6	6
Kagoshima U. (Agriculture)			1	1			2	4
Nat Museum Nature & Science				1		2	1	4
Hiroshima Medical U.	3							3
Niigata U. (Medicine)			1		2			3
Kyoto U. (Anthropology)					1		1	2
Kyoto U. (Primate Research Center)							1	1
Hyogo College of Medicine						2	1	3
Others	1	5	5	6	3	3	8	31
Total	11	8	11	10	12	9	31	92

science.

3.1.4 Summary and discussions

To sum up, the number of papers written by researchers from and at the DAUT does not exceed the number of papers from other universities except in the *Anthropology*. Furthermore, the number of citations of papers by the researchers from the DAUT is rather limited. Putting these results together, we can conclude that the DAUT impact on the scientific aspects of Japanese archaeology *in general* has been limited and that we should look at broader contributions to understand the historical development of scientific aspects in Japanese archaeology.

In fact, the introduction of the scientific method to Japanese archaeology was the result of a variety of trends. Table 10 summarizes the top-10 universities and departments publishing papers in the *Journal*, the *Quarterly*, and the *Arch. Nat.* It shows that researchers graduating from the Departments of Geology, Archaeology, Chemistry, Physics, and Agriculture at Kyoto University and the Department of Chemistry at the University of Tokyo have published more papers in the three journals than researchers from the DAUT in the journals.

Indeed, we can find many historical instances of collaboration between scientists and archaeologists from the above departments. First, as Kobayashi (1976) showed, since the time of Chikashige Masumi (1870–1941, the Department of Chemistry) and Kosaku Hamada (1881–1938, the Department of Archaeology), the Department of Chemistry at

Table 10. Top-10 Graduated departments and affiliations of the researchers writing relevant papers in the *Journal*, the *Quarterly*, and the *Arch. Nat*

Graduating U. (Dept)	1950–1954	1955–1959	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	Total
Kyoto U. (Geology)				3	10	5	5	23
U. Tokyo (Chemistry)				3	8	4	5	20
Kyoto U. (Archaeology)				3	4	4		11
Kyoto U. (Chemistry)					3	3	5	11
Kyoto U. (Physics)				1	4	2	3	10
Unknown					2	5	3	10
Kyoto U. (Agriculture)					2	5	2	9
U. Tokyo (Anthropology)				1	3	4	1	9
Kyoto U. (Engineering)				1	3	3		7
Osaka Electro Comm U.					2	3		5
Affiliations	1950–1954	1955–1959	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	Total
Nara U. Education (CP)				1	8	6	6	21
Others				1	4	3	9	17
Nara Nat Institute of CP				2	9	3		14
Kyoto U. (Reactor Institute)				1	5	5	1	12
Tokyo Nat Institute of CP					6	3	2	11
U. Tokyo (Anthropology)				1	3	4		8
Nagoya U. (Chemistry)				1	1	3	2	7
Miyazaki U. (Agriculture)						4	2	6
Tohoku U. (Archaeology)					1		4	5
Kanazawa U. (Geology)				2	1		1	4

Kyoto University has collaborated with the Department of Archaeology. They had been interested in analyzing chemical components of archaeological remains for their dating, especially the copper used in old coins.

Second, the Department of Geology at Kyoto University has focused on

Palaeomagnetism since the time of Motonori Matsuyama (1884–1958). Jinichiro Hatsuda (1906–2001, the Department of Geology), a student of Motonori Matsuyama, was also interested in paleomagnetism, and worked together with Kyoichi Arimitsu (1907–2011, the Department of Archaeology) and others in a co-project, “Dating of pottery by thermoluminescence” in 1965 (Nishimura & Nishida 2011; Yabuuchi 1968). This dating method depends on the physical properties of heated archaeological remains: When archaeological remains have been heated to a certain temperature, the remains retain the earth’s magnetic field at the time of heating. Thus if we know the historical pattern of palaeomagnetism, we can infer when the remains were heated (e.g., Butler 1991).

Third, the Department of Chemistry at the University of Tokyo has long been interested in a chemical approach to the conservation of ancient cultural properties. Yuji Shibata (1882–1980), Kenjiro Kimura (1896–1988), and their students, including Kazuo Yamasaki (1911–2010) and Yoshimichi Emoto (1925–1992), actively contributed to this area, and finally founded a society specializing in conservation science in 1951 (e.g., Editorial committee for 100-year history of the University of Tokyo 1990; Yamasaki 1987).

Fourth, Table 10 also indicates that researchers at Nara University of Education, the Tokyo National Institute, and the Nara National Institute for Cultural Properties, and the Kyoto University Reactor Research Institute have published more papers than the Department of Anthropology at the University of Tokyo. These universities and departments have attracted researchers specializing in the scientific approach to archaeological sites and remains (especially from the Departments of Geology and Chemistry at Kyoto University and the Department of Chemistry at the University of Tokyo). Researchers at the Kyoto University Reactor Research Institute belonging to the above-mentioned tradition of collaboration between the Departments of Chemistry and Archaeology at Kyoto University have also conducted chemical or physical analysis of material remains (e.g., Shigematsu 1970).

Taken together, both the results of the present study and the above historical observations suggest that previous studies have not looked at the diverse way in which the relationship between science and archaeology developed in Japan.

3.2 Was the funding responsible for an increase in relevant papers?

To determine whether research funding by the Japanese government begun in 1976 was an important contributing factor to the development of the scientific aspects of Japanese archaeology, historical changes in the number of relevant papers and their ratio to the total number of the papers published in the *Journal* and the *Quarterly* were examined. Papers in the *Anthropology* were excluded since nearly all the papers examined from the journal were related to biological anthropology and the increased research funding

Table 11. Historical changes of the number of the papers related to natural science in the two archaeological journals

	1950–1954	1955–1959	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984
Total in the <i>Journal</i>	54	44	43	57	48	53	62
Total in the <i>Quarterly</i>	—	—	55	73	84	74	83
Natural science in the <i>Journal</i>	2	0	2	0	4	5	4
Natural science in the <i>Quarterly</i>	—	—	1	3	11	8	11
Natural science in total	2	0	3	3	15	13	15
Ratio in the total	3.70%	0.00%	3.06%	2.31%	11.36%	10.24%	10.34%
Ratio in the <i>Journal</i>	3.70%	0.00%	4.65%	0.00%	8.33%	9.43%	6.45%
Ratio in the <i>Quarterly</i>	—	—	1.82%	4.11%	13.10%	10.81%	13.25%

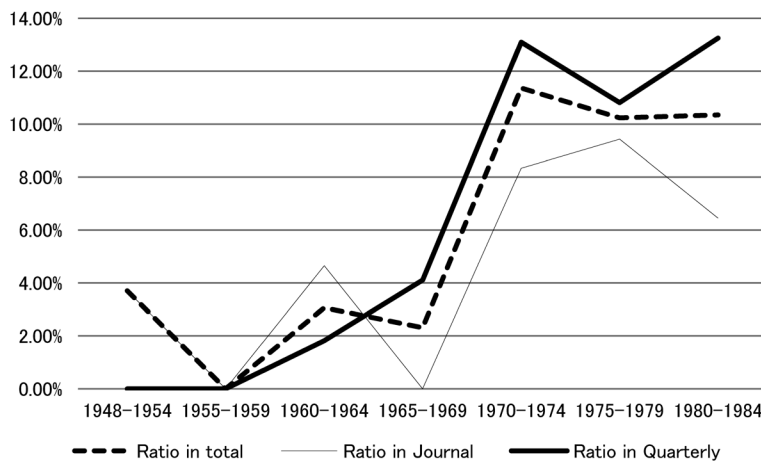


Figure 1. Historical changes of the number of the papers related to natural science in the two archaeological journals

(‘Research on Archaeological Sites and Ancient Cultural Properties by Natural Scientific Method’ from 1976 to 1978 and ‘Conservation Science, Humanities, and Natural Science on Ancient Cultural Properties’ from 1980 to 1982) did not include topics related to biological anthropology (Committee for Conservation of Ancient Cultural Properties 1980, 1984).

The results are summarized in Table 11 and Figure 1. If the research funding by the Japanese government that began in 1976 was important to the development of the scientific aspects of Japanese archaeology, we should expect to find an increase in the number of scientific papers in the *Journal* and the *Quarterly* after 1976.

As shown, however, the number of the papers did not increase from the latter half of the 1970s to the 1980s; rather, we find a much greater increase from the 1960s to the

first half of the 1970s, preceding the initiation of government funding. In addition, the number of papers in the *Arch. Nat.* did not materially change: There were 48 papers in 1970–1974, 46 in 1975–1979, and 39 in 1980–1984. These results suggest that research funding did not directly influence the scientific aspects of Japanese archaeology.

Note that, as Table 4 suggests, papers by researchers from the DAUT had a weaker influence on the historical increase from the 1970s. This result further supports the present study's finding that we could find more diverse contributions to the historical development in scientific aspects of Japanese archaeology than previous studies have claimed.

4. Discussion

The above sections have examined the prevailing views on the history of interdisciplinarity in Japanese archaeology, especially with respect to the introduction of the scientific method to archaeology, and pointed out the limited influence of the DAUT on the process. Some possible objections to these conclusions can now be addressed.

First, one might argue that the present study fails to look at ethnoarchaeology, an approach led mainly by Hitoshi Watanabe in Japan (e.g., Watanabe 1968, 1972). I agree that Watanabe has had an important influence on the trend of archaeology as a kind of science, and that he had graduated from the DAUT. For instance, as Ikawa-Smith (2003) suggests, Takeru Akawaza has been strongly influenced by Watanabe (Akazawa 1969, 1983). However, note that ethnoarchaeological perspective is mainly related to *social* science rather than to *natural* science. Since the present study focuses on the natural scientific aspect of Japanese archaeology, ethnoarchaeology and *Material Culture* (*Busshitsu Bunka* in Japanese), a related Japanese journal, have been excluded.

Second, one might point out the possibility that the effect of the research funding begun in 1976 can be found in later periods, after 1985. Though this possibility is undeniable and requires further examination, it does not undermine the claim of the present study that the steep increase in the number of archaeological research that employed scientific method before 1976 was not due to the funding.

Third, the question of why we find a greater increase in the number of the relevant papers from the 1960s to the first half of the 1970s in the two archaeological journals still needs to be answered. As shown in Tables 4, 7, and 12, which summarize the historical change of the themes in the *Journal* and the *Quarterly*, there appears not to be a single reason for the change. Rather, it seems that various universities, departments, and topics came together during this period. One of the reasons why the special research funding from 1976 to 1978 and 1980 to 1982 was possible may have been due to such historical convergence.

Table 12. Historical changes of themes in relevant papers except before 1960

Themes	1960–1964	1965–1969	1970–1974	1975–1979	1980–1984	Total
Palaeogeology			3	4	3	10
Palaeobotany		2	4	1		7
Chemical Analysis			1	2	4	7
Experiment				3	3	6
Biological Anthropology		1	3		1	5
Statistics	1		1	1	2	5
Conservation			2	1		3
Age Estimation	1		1		1	3
Population Estimation				1		1
Information Science					1	1
Palaeontology	1					1
Total	3	3	15	13	15	49

Fourth, it might be argued that since archaeological activities cannot be boiled down to published papers, we should examine more diverse aspects of such activities. I agree with the objection. However, for the sake of space, I could not examine all of the aspects in the paper. For instance, we could examine scientific aspects of Japanese archaeology by focusing on published site reports. Actually, I have searched site reports published from 1950 to 1984 in the database of the Nara National Cultural Properties Research Institute, and found 2408 published reports during the periods. Next, as a pilot study, I have randomly picked up 50 reports and analyzed them, and the result shows that no reports include any scientific analyses. Although it is probable we can find some reports including scientific analyses if we examine all of the 2408 reports, their analyses warrant future research.

Finally, my arguments do not intend to claim that previous studies should be rejected. Rather, they have properly evaluated the DAUT's contributions to scientific aspects of Japanese archaeology, especially contributions to biological-anthropology analyses of archaeological remains. I have argued that to fully understand the historical development of interdisciplinarity of Japanese archaeology, we should look at more diverse contributions.

5. Conclusion

The present study examined the relationship between Japanese archaeology and science from 1950 to 1984, and assessed previous claims regarding the development of the relationship. The results indicate a more varied picture than previous studies have

assumed. The DAUT has had a relatively strong impact on the scientific aspects of Japanese archaeology, but its impact has been limited largely to biological anthropology. We should not ignore the important and varied contributions of other universities and departments. Moreover, it remains unclear as to how much the research funding from 1976 to 1978, and from 1980 to 1982 has affected the scientific aspects of Japanese archaeology.

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