

The Reference Collection—Is it Dead? The Role of the Physical Reference Collection in the Digital Age

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(Received 31 October 2012; Revised 13 June 2013; Accepted 9 July 2013)



ABSTRACT: With the recent launch of online resources resulting from the AHRC Archaeological Fish Resource project in the United Kingdom (UK) and the increasing number of other online and offline digital reference materials available, it is perhaps timely to consider the relative importance of digital versus physical reference resources. There are several questions concerning location and ease of access. The physical collection may not be easy to get to, perhaps housed in another country. Digital resources should in theory be more accessible, but are they? The size and scope of both can be limited: physically, by problems of acquisition and storage; and digitally, by format and selection. The digital resource can never supply certain information, e.g., DNA and isotopes. The storage and dissemination of these and other data are, however, exactly what online access can provide. With pressure on existing fish stocks and on museum space for collections, we need to work out ways to integrate our collections, both with other physical collections and with rapidly developing and changing digital resources. This paper explores these issues and incorporates the results of an online survey concerning the current availability and use of physical and digital resources.

KEYWORDS: OSTEOLOGICAL COLLECTIONS, INTERNET RESOURCES, LEARNING RESOURCES, REFERENCE WORKS, DIGITAL IMAGES, FISH BONE

RESUMEN: El reciente lanzamiento de recursos en la red derivados del proyecto AHRC (Archaeological Fish Resource) en el Reino Unido, así como el progresivamente mayor número de materiales disponibles en la red y fuera de ella, hacen necesario considerar en estos momentos la importancia relativa de los recursos de referencia digitales frente a los tradicionales. Existen varias cuestiones en este punto que afectan a la facilidad de acceso y localización. La colección física de referencia puede no ser fácil de acceder, o encontrarse incluso albergada en otro país. Los recursos digitales deberían, en teoría, ser más accesibles, pero la cuestión es: ¿lo son? El tamaño y propósito de ambos tipos de recursos pueden ser limitados. A nivel físico, por problemas de adquisición y almacenaje y, a nivel digital, por el tipo de formato y la selección de lo incorporado en las colecciones. Los recursos digitales nunca pueden proporcionar determinados tipos de información, caso del ADN o de los isótopos. El almacenaje y diseminación de este tipo de datos y otros similares es lo que los recursos en la red pueden precisamente facilitar. Debido a las presiones sobre los actuales stocks de peces, así como del espacio disponible en los museos para colecciones, necesitamos alcanzar modos para integrar nuestras colecciones, tanto con otras equivalentes como con los rápidamente cambiantes recursos digi-

tales. Este trabajo explora estas cuestiones al tiempo que incorpora los resultados de un muestreo en la red referido a la disponibilidad y uso de los recursos materiales y digitales.

PALABRAS CLAVE: COLECCIONES OSTEOLÓGICAS, RECURSOS EN INTERNET, RECURSOS DE APRENDIZAJE, TRABAJOS DE REFERENCIA, IMÁGENES DIGITALES, HUESOS DE PECES

INTRODUCTION

In order to identify archaeological fish remains, it is necessary to have comparative materials. Reference collections of disarticulated fish specimens were uncommon in museums and universities until recent decades. Spirit and other collections were usually not originally collected for use by archaeozoologists. Many of the disarticulated collections now available are due to the diligent acquisition by archaeozoologists faced with the task of identifying remains from sites but with little available reference material. These collections have often grown haphazardly in response to a specific need. Some may be in private hands and not always available for general use.

With the now usually standard practice of sieving, fish bones may be frequently recovered in archaeological assemblages. But (British) universities rarely offer specific training in this field and may have very limited reference collections and few staff competent in this area. It was with this in mind that the AHRC-funded Archaeological Fish Resource project was conceived to include practical workshops and the production of an online photographic reference collection, hosted by Nottingham University, UK, and covering the species most frequently found in European assemblages.

Following the launch of this online resource, an internet-based feedback survey was undertaken and widely disseminated to ascertain general availability, breadth, and other aspects of both the new digital resources and traditional reference collections. The survey was widely announced over many months, including the ZOOARCH and ICAZ Fish Remains Working Group (FRWG) lists among others, to give as many interested parties as possible a chance to participate and offer their opinions. The survey was entirely voluntary with no obligatory questions, partly because some of the questions might not be perceived as relevant to particular individuals. Although several questions

had a British/European bias, most can be more generally applied.

Of the 128 responses, twice as many females as males participated, and, as expected, most were between 25 and 54 years of age. It is possible that these demographics may not be entirely representative as there are undoubtedly more people involved in the study of archaeological fish bones than those who took the survey.

The number of countries in which people are based who work on archaeological fish remains is an impressive 36. Admittedly, many of these individuals are based in the UK, the rest of Europe, and the USA, but the breadth ranges from South America to Australasia with a sprinkling of people from across the world. The number of countries and areas in which they do their actual research is even broader and ranges from those people concentrating on one area within a single country to those whose work covers the globe. Many people have more than one geographical region of interest, sometimes apparently unrelated, e.g., Egypt and UK. Again there is a concentration of work in the USA, UK, and Europe. The positions held by the respondents are varied and not highly biased in favour of one group or another, but over 20% are independent researchers, something that becomes relevant in a number of the other questions and comments returned.

COLLECTION SIZES AND ACCESSIBILITY

A high proportion of respondents have their own collection, and many people have access to a university collection at or near their main workplace. Access to national and specialist collections is more varied but often at some distance (Table 1).

The size of different types of reference collections of disarticulated fish skeletons is very variable, from under 30 species to over 1000 (Table 2).

	Your own	Field Unit	University	Regional & specialist	National	Total responses
at or less than 5km from main workplace	43.2%	5.3%	25.0%	12.1%	14.4%	132
	57	7	33	16	19	
under 30 km	16.2%	8.1%	45.9%	13.5%	16.2%	37
	6	3	17	5	6	
31 –60 km	15.8%	10.5%	36.8%	21.1%	15.8%	19
	3	2	7	4	3	
61 –100 km	15.4%	11.5%	19.2%	30.8%	23.1%	26
	4	3	5	8	6	
over 100 km from main workplace	5.0%	6.7%	15.0%	28.3%	45.0%	60
	3	4	9	17	27	

TABLE 1

The availability of collections and distance from workplace.

	Your own	Field Unit	University	Regional & specialist	National	Total responses
under 30 fish species	50.8%	12.3%	24.6%	9.2%	3.1%	65
	33	8	16	6	2	
30 –100 species	22.7%	9.1%	40.9%	16.7%	10.6%	66
	15	6	27	11	7	
100 –500	32.6%	4.7%	25.6%	16.3%	20.9%	43
	14	2	11	7	9	
500 –1000	8.3%	0.0%	12.5%	37.5%	41.7%	24
	2	0	3	9	10	
over 1000 species	3.4%	0.0%	10.3%	20.7%	65.5%	29
	1	0	3	6	19	

TABLE 2

The size of reference collections by number of species.

The number of specimens of each species represented within the collections was not investigated. If working on a limited fauna from a specific area, then a small reference collection is perfectly acceptable. But most people work with assemblages that could contain a large number of fish species, a problem that is usually less acute for mammals and to some extent birds.

Over half of the respondents said their own collection contains less than 30 species, and only three private collections have more than 500. A *Archaeofauna* 22 (2013): 75-82

surprisingly large number of university collections also have few species, a worrying situation that we should endeavor to rectify, and this highlights one reason for the current demand for assistance in alternative ways. Even some of the national collections may not be as substantial as we would like, either because they are relatively new or have collections that were built with a different purpose in mind. Even with the best facilities in the world, it is highly unlikely that any physical collection will have all the possible specimens you might

need. In theory, a digital collection may fulfill this need. Nevertheless, it is quite likely that there is always going to be something missing, and the larger the resource, usually the more difficult it becomes to search for an individual specimen.

Access to physical collections may not be easy, restricted either by distance or by operating hours (and highly unlikely to be open late at night when your report is due!). There may also be user fees—something that several independent and commercial workers indicated could mean leaving some specimens unidentified, because it is not always possible to justify the extra costs to a project for only a handful of bones. Inexperienced researchers may have to wait for supervision, and all workers will need time to familiarize themselves with a collection. Special, rare or fragile, specimens may also have restrictions on their use. Most curators, whether of public or private collections, will be reluctant to let novice users loose among these precious specimens.

People working away from their home base may find that reference collections of local taxa are not available or difficult to access, and export of the material is not always allowed. Similarly, when working on material from other parts of the world, even major collections may not have all the relevant taxa.

Sometimes it becomes necessary to visit reference collections outside your base country. A total of 23 respondents reported that they do this at least once a year, whereas another 35 have visited such collections but less frequently. This inevitably

adds extra time and cost to any project, and reluctance to visit other collections may result in some important taxa being left unidentified.

Digital resources should be more readily accessible, but this assumes free, or very cheap, and fast internet broadband and suitable equipment. Usually this is not a problem but sometimes it is, especially in some parts of the world. Having resources in the «Cloud» can be frustratingly slow or even inaccessible. Even in Britain, broadband can be slow and expensive.

Quite a few people are already finding that access to digital resources is useful, either in the form of internet-based materials or hard-copy that has been digitized. Others have compiled photographs of their own and other specimens (Tables 3-5). All of these can be very useful when working away from relevant collections or in conjunction with your main working collection.

Several hard-copy reference works, mostly out of print, have been made available in digitized formats, such as in pdf, and these are now reaching a wide audience. Some have been uploaded to the web and others exchanged by personal contact. The survey has thrown in other less well-known resources, and internet sites are useful to disseminate their existence, even if they are not yet readily available (such as through copyright issues). The main reference works and websites found to be useful are listed in Appendix A and B and also on the author's website (<http://www.shd-arch-zoo.co.uk/fishresources.html>).

	frequently	occasionally	rarely	not yet	Total responses
The Archaeological Fishbone Resource http://fishbone.nottingham.ac.uk/	9.7%	32.3%	19.4%	38.7%	93
	9	30	18	36	
University of Sydney Fish-bone images http://fish.library.usyd.edu.au/	3.5%	11.6%	12.8%	72.1%	86
	3	10	11	62	
NABONE comparative fish osteology http://nabohome.org/products/manuals/fishbone/	5.7%	20.5%	19.3%	54.5%	88
	5	18	17	48	
Other	9.1%	12.1%	9.1%	69.7%	33
	3	4	3	23	

TABLE 3

Responses to question: Have you used any of these online resources?

	websites, eg the Archaeological Fishbone Resource	digitised atlas, pdf etc	other, eg your own photos of bones	Total responses
together with your main reference collection	30.30% 40	42.40% 56	27.30% 36	132
when away from reference collections	30.50% 29	34.70% 33	34.70% 33	95
as occasional reference only	55.30% 21	26.30% 10	18.40% 7	38
as a teaching aid	37.80% 17	33.30% 15	28.90% 13	45
rarely / never use	29.20% 7	29.20% 7	41.70% 10	24

TABLE 4

Responses to question: If and when do you use digital resources?

	Very useful	Moderately useful	Neutral	Not useful	Total responses
for undergraduate archaeology students	50.70% 34	31.30% 21	13.40% 9	4.50% 3	67
for postgraduates	50.00% 34	32.40% 22	16.20% 11	1.50% 1	68
for archaeozoologists not specialising in fish	53.50% 38	29.60% 21	16.90% 12	0.00% 0	71
for archaeozoological fish specialists (beginners)	67.60% 46	20.60% 14	11.80% 8	0.00% 0	68
for archaeozoological fish specialists (experienced)	34.30% 24	34.30% 24	25.70% 18	5.70% 4	70
for fish specialists (non- archaeology)	25.80% 17	39.40% 26	34.80% 23	0.00% 0	66

TABLE 5

Responses to question: How useful do you think the Archaeological Fishbone Resource is? (<http://fishbone.nottingham.ac.uk/>).

CURATION AND STORAGE

The costs of curation and problems of storage must also be considered. Most of us have pressures on storage space, and, no doubt, many are constantly being asked to justify the space used for storage and access, not to mention the cost of the various cabinets and containers. I cannot stress enough the importance of ongoing curation. Those Archaeofauna 22 (2013): 75-82

outside the profession often do not understand that continuing maintenance of collections is required. If the collection is handled a lot, e.g., by the very students and researchers for which it is intended, there will be degradation, and labels, containers, and at least some specimens will need replacing even with «one careful owner». You might think that these concerns apply only to physical collections, but it is equally important to consider them

for digital resources, which leads to the next subject: security of the collections.

By their very nature, the physical fish remains are fragile, as indicated above, but the collection overall is also subject to all types of threats, such as fire, flood, earthquakes, etc. Of course, one would always hope that no harm will come to a collection, but even national collections cannot be protected against everything. Digital collections have the benefit that multiple copies could be stored in different locations, but there are other dangers. As has already been experienced by several of us, rapid changes in software and equipment have meant that some programs and media can no longer be accessed by the latest platform. Storage media degrades, and data have already been lost. Locations on the internet can change without much warning, and sometimes the resource is no longer maintained at all.

There are concerns over veracity and orphan specimens. These problems apply to both types of resources but are perhaps more important concerning the value of the physical collection (from which the digital ones will be derived). In short, it is extremely important that as much data about the provenance and identity of the specimens are preserved and kept with the specimens. When collections are used, moved, or mothballed, this information can get lost and thus reduce the usefulness of specimens. For online resources too, there must be quality assurance checks, or the resource will not be considered reliable. In any case, it is good practice for users to state what resources they have used for identification, both physical and online.

PROS AND CONS: PHYSICAL VERSUS DIGITAL RESOURCES

The digital resource is very good for quick (hopefully) access to large images of specimens for training and for basic identification purposes, especially for those species that are rare, e.g., sturgeon, or small, e.g., gobies, in most collections. It does, however, have significant drawbacks. Currently, these resources usually show only one or a few specimens and a limited number of species. The views offered are frequently limited, and, unless produced in collaboration with an experienced archaeozoologist, may not show the most important characters for identification. Survey respondents offering suggestions for improvement to the Archaeological Fish Resource frequently

expressed an interest in more than one specimen, more elements, more views, and more species. Digital images should also have a scale for estimation of bone size and details concerning the original specimen. When using a physical collection, you often have a range of sizes to compare, the subtle differences between individuals can also be seen, and it is very easy to turn and orient a specimen, though this is becoming more readily available in digital resources. Although not restricted to digital resources, there is always the temptation to go with the first matching picture. The specimen selected for imaging may also gain the status of a «type specimen» and natural variants are then recorded as abnormal. New researchers do not yet have the depth of experience to recognize this type of variation or to question whether a large bone in one's hand is a likely match to an image of one from a species normally not exceeding a few centimeters in size. Fragmentary materials, so common with archaeological remains, are particularly difficult to compare without side-by-side access to actual materials of similar size. All researchers should also be aware of the likely species for the area of study and of the gaps in both types of collections, while being conscious of the possibility of changes in distributions and of imported species. For physical research, such as DNA and isotope studies and the gathering of metrical data, the digital resource is useless, although online access to the resulting datasets can and will be extremely useful.

There is a halfway house. Online resources can be used as a supplement to the skeletal reference collection and as an aid when a physical specimen or collection is not available. When working away from one's home base, it is now possible to take digitized versions of reference works, notes and sketches, and images of specimens made with scanners and digital cameras. Likewise, specimens that cannot be identified on site but are not permitted to be removed can now be much more easily photographed and checked later or opinions sought from colleagues online.

CONCLUSIONS

The best option for reference comparisons is still access to a large collection of physical specimens, disarticulated, well-prepared, and laid out. For some workers and some material, however, this is not possible. Those working in commercial

units (in the UK at least) rarely have more than a handful of comparative fish specimens, probably prepared by themselves. These individuals as well as independent researchers and international researchers may have difficulty in gaining access to other collections due to travel costs and charges levied. The archaeozoological community should be prepared to waive user fees or provide subsidies or other ways of support and collaboration.

One may take the Atlantic sturgeon as an example of problems in finding specific material. Few people may have access to a complete, disarticulated specimen of this species, and even regional and national collections may only have a partial specimen, a pickled one, or an old, partly articulated one that is difficult and unpleasant to work with. This situation may be repeated in the future for other species, including those that were once considered common. For example, it is now very difficult to obtain an Atlantic cod of any size. Making good quality digital images available from as many specimens as possible, ideally with size and other details recorded, will protect the rarer specimens we have from handling damage and make them more generally available.

In order to make the best use of all resources, we should be prepared to explore ways of integrating our collections, both with other physical collections and with digital resources. They should also be accessible to researchers beyond the archaeozoological community.

In conclusion, the physical reference collection is very much «alive» and is expected to be needed long into the future. Nevertheless, the new digital resources also should be embraced and improved.

ACKNOWLEDGEMENTS

Many thanks go to Leif Jonsson for his useful comments on the text and to all those who took part in the survey.

APPENDIX A

Selection of online reference collection resources (checked as active 27 Oct 2012)

ARCHAEOLOGICAL FISH RESOURCE PROJECT:
<http://www.nottingham.ac.uk/archaeology/research/bioarchaeology/zooarchaeology/fish.aspx>

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BISHOP MUSEUM FISH REMAINS, a tool for identifying Hawaiian fish remains: <http://hbs.bishopmuseum.org/frc/>

BUSEKIST, J. 2004: Bone Base Baltic Sea, a computer supported identification system for fish bones. Version 1.0 for MS-Windows CD-ROM iso image. University of Rostock, Germany: <http://www.bioarchiv.de>

FROESE, R. & PAULY, D. (editors) 2012: FishBase. World Wide Web electronic publication. www.fishbase.org, version (10/2012). (NB for scientific information on fish species).

NABONE comparative fish osteology (Gadidae): <http://nabohome.org/products/manuals/fishbone/>

OSTEO: FRESHWATER FISH OSTEOLOGICAL DATABASE: <http://www.wahre-staerke.com/osteo/>

OSTEOBASE: WEB INTERACTIVE EXPLORATION FOR OSTEOLOGY: <http://www.mnhn.fr/osteo/osteobase/>

UNIVERSITY OF SYDNEY FISH-BONE IMAGES: <http://fish.library.usyd.edu.au/>

VIRGINIA BUTLER WEBSITE (N. American Pacific): <http://web.pdx.edu/~virginia/photocollection.htm>

APPENDIX B

Selection of osteology reference works

CANNON, D.Y. 1987: *Marine Fish Osteology. A Manual for Archaeologists*. Publication Number 18. Simon Fraser University, Burnaby, British Columbia.

CARAS, J.M. 1992: *Osteología Comparada de los Lábridos Ibéricos*. Tesis Doctoral. Universidad Autónoma de Madrid, Madrid.

DESSE, J.; DESSE-BERSET, N. & ROCHETEAU, M. 1987: Contribution à l'ostéométrie de la Perche *Perca fluviatilis* (Linné, 1758). *Fiches d'ostéologie animale pour l'archéologie*. Série A: Poissons, No. 1. CNRS, APCDA, Juan-les-Pins.

DESSE, J.; DESSE-BERSET, N. & ROCHETEAU, M. 1987: Contribution à l'ostéométrie du Mulet *Liza (Liza) ramada* (Risso, 1826) (= *Mugil capito* Cuvier, 1829). *Fiches d'ostéologie animale pour l'archéologie*. Série A: Poissons, No. 2. CNRS, APCDA, Juan-les-Pins.

DESSE, J.; DESSE-BERSET, N. & ROCHETEAU, M. 1990: Ostéométrie de la Lote d'eau douce *Lota lota* (Linné, 1766). *Fiches d'ostéologie animale pour l'archéologie*. Série A: Poissons, No. 6. CNRS, APCDA, Juan-les-Pins.

DESSE, J.; DESSE-BERSET, N. & ROCHETEAU, M. 1996: Ostéométrie et archéologie de la Daurade royale *Sparus aurata* (Linné, 1758). *Fiches d'ostéologie anima-*

- le pour l'archéologie. Série A: Poissons, No. 9. CNRS, APCDA, Juan-les-Pins.*
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- FALABELLA, F.; MELÉNDEZ, R. & VARGAS, M.L. 1995: *Claves osteológicas para peces de Chile central. Un enfoque arqueológico.* Artegrama Ltda., Santiago de Chile.
- GAYET, M. & VAN NEER, W. 1990: Caractères diagnostiques des épines de quelques silures africains. *Journal of African Zoology* 104: 241-252.
- GRAVENDEEL, R.; VAN NEER, W. & BRINKHUIZEN, D. 2002: An identification key for dermal denticles of Rajidae from the North Sea. *International Journal of Osteoarchaeology* 12: 420-441.
- GROUARD, S. 2001: Subsistance, systèmes techniques et gestion territoriale en milieu insulaire antillais pré-colombien. Thèse Doctorat Ethnologie et Préhistoire, Université de Paris X - Nanterre. (Bone drawings of 100 species of fish from the Caribbean).
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- LEACH, F. 1997: *A Guide to the Identification of Fish Remains from New Zealand Archaeological Sites.* New Zealand Journal of Archaeology Special Publication, Wellington.
- LEBEDEV, V.D. 1960: *Quaternary Freshwater Ichthyofauna of the European USSR.* Moscow.
- LEPIKSAAR, J. 1994: *Introduction to Osteology of Fishes for Paleozoologists.* 3rd edition. Göteborg.
- LIBOIS, R.M.; HALLET-LIBOIS, C. & ROSOUX, R. 1987: éléments pour l'identification des restes crâniens des poissons dulçaquicoles de Belgique et du nord de la France: 1 - Anguilliformes, Gastérostéiformes, Cyprinodontiformes et Perciformes. *Fiches d'ostéologie animale pour l'archéologie. Série A: Poissons, No. 3.* CNRS, APCDA, Juan-les-Pins.
- LIBOIS, R.M. & HALLET-LIBOIS, C. 1988: éléments pour l'identification des restes crâniens des poissons dulçaquicoles de Belgique et du nord de la France: 2 - Cypriniformes. *Fiches d'ostéologie animale pour l'archéologie. Série A: Poissons, No. 4.* CNRS, APCDA, Juan-les-Pins.
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- RADU, V. 2005: Atlas for the identification of bony fish bones from archaeological sites. *Studii de Preistorie, Supplementum* 1: 9-77. Asociația Româna de Arheologie, Bucharest.
- RODRIGUEZ SANTANA, C.G. & ARNAY DE LA ROSA, R.M. 1999: Contribution à l'ostéométrie du poisson-perroquet *Sparisoma (Euscarus) cretense* (Linné, 1758). *Fiches d'ostéologie animale pour l'archéologie. Série A: Poissons, No. 10.* CNRS, APCDA, Juan-les-Pins.
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- ROSELLÓ IZQUIERDO, E. 1989: *Arqueoictiofaunas ibéricas. Aproximación metodológica y bio-cultural.* Publicaciones de la Universidad Autónoma de Madrid, Madrid.
- ROSELLÓ IZQUIERDO, E. & SANCHO, G. 1994: Osteometry of the Chinchard *Trachurus trachurus* (Linné, 1758). *Fiches d'ostéologie animale pour l'archéologie. Série A: Poissons, No. 8.* CNRS, APCDA, Juan-les-Pins.
- STERNBERG, M. 1992: Ostéométrie du Loup *Dicentrarchus labrax* (Linné, 1758). *Fiches d'ostéologie animale pour l'archéologie. Série A: Poissons, No. 7.* CNRS, APCDA, Juan-les-Pins.
- VAN NEER, W. 1989: Contribution à l'ostéométrie de la Perche du Nil *Lates niloticus*. *Fiches d'ostéologie animale pour l'archéologie. Série A: Poissons, No. 5.* CNRS, APCDA, Juan-les-Pins.
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