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Technical note

Technical Note: The Forensic Anthropology Society of Europe (FASE) Map of Identified Osteological Collections

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ABSTRACT

Identified (documented) osteological collections represent an important resource in the development of forensic anthropology standards and methods as well as a precious tool for learning and training of practitioners. Even though the number of papers presenting identified collections worldwide increases, many of the collections have still not been divulged to the scientific community in sufficient detail to ascertain their exact number. The Forensic Anthropology Society of Europe (FASE) therefore developed a tool that goes beyond sporadic publications: the FASE Map of Identified Osteological Collections, which is freely accessible and continuously updated and revised. The online map is available at http://forensicanthropology.eu/osteological-collections/. The map of skeletal collections was created in 2017 and currently displays information on 153 identified osteological collections (43 of them categorized as contemporary) located in 41 different countries. This article offers a short analysis of the type, geographical location and content of the collections included in the map. The aim of this article and the map as such is to provide a useful resource to facilitate research planning and teaching in forensic anthropology and related disciplines.

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1. Introduction

Forensic anthropology has developed on the foundations of biological anthropology at the beginning of the 20th century as a discipline that applies anthropological, anatomical, and archeological principles and methods in a medico-legal context, most

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Fig. 1. A screenshot of the Forensic Anthropology Society of Europe (FASE) Map of Identified Osteological Collections (1a) (http://forensicanthropology.eu/osteological-collections) with a zoomed view (1b) of one part of Europe and the information tab appearing on the left when clicking on a chosen collection.

often for personal identification and trauma analysis [1]. An indispensable tool for method development, education, training, and validation is the use of identified (documented) osteological collections [2]. Historically, skeletal collections have been amassed around the world and served as the basis in method development currently applied in forensic anthropology to reconstruct a biological profile for unidentified human remains [3,4]. However, not all collections, nor all of the methods that have been derived from them are suitable for forensic use. Some of the methods that are being universally applied by forensic anthropologists have been developed from regionally diverse, non-contemporary, and in part even non-identified skeletal samples, which limits their application to contemporary remains and remains that are temporally and spatially different from the methods' reference sample. Working in a context where method

reliability is imperative and rigorous standards are necessary [5], forensic anthropologists should be aware of such limitations and strive to overcome them by examining the performance of existing methods in contemporary regional or multi-regional samples to identify the approaches that need to be corrected for secular changes and populations differences, and those that perform well, either for a particular region or even independently of the sample used (e.g., DSP2 [6], Klales method [7]).

The collections most suited for validating and adapting anthropological methods to regionally specific present-day forensic scenarios are contemporary (modern) documented collections consisting of individuals with a fully or partially known biological profile. However, even non-contemporary collections may play an important role in both biological and forensic anthropology research as they contribute to the understanding of human variation, including, but not limited to temporal continuity, ecogeographical patterns, or microevolutionary impacts [3,8]. Moreover, many of the older collections include samples with well-documented (either by medical records or autopsy reports) traumatic, pathological, and taphonomical changes. Given that forensic anthropologists may be required to provide expertise in bone alterations, these specialized collections can serve as an excellent source for trauma/pathology research and training. Even if such alterations are not completely dependent on the chronology of the sample, it should be kept in mind that bone patterns of trauma and pathology may have changed in the past decades due to differences in types of weapons and ammunition, or developments in therapy for different diseases. This again point out the importance of creating contemporary collections, physical or virtual, specialized in specimens featuring trauma or pathology.

Despite the essential role that both contemporary and non-contemporary identified collections play in anthropological practice, there have been a limited number of attempts to offer a comprehensive list of all the existing collections. While the number of articles presenting identified, particularly contemporary, osteological collections are continuously growing [8–29], many others have been mentioned with little detail in publications such as congress abstracts or in documents accessible only to a limited audience, mostly students and researchers from the curating institution [13]). The latest attempts to list existing identified collections were made in 2020 by Franklin and Blau [30] who listed 72 collections of skeletons with documented demographic data and in 2018 by Henderson and Cardoso [31] who published a reference book that offers a comprehensive review on the history, legal framework, ethics, and demographics of the collections in the UK, Portugal, South Africa, USA and Canada. Another paper by Santos et al. [3] listed 54 identified collections in Argentina, Canada, Colombia, Europe, Japan, Mexico, the Philippines, South Africa, Thailand and the USA. However, tracing and listing identified collections is not something that can be limited to sporadic publications since it requires constant revisions, either by introducing new collections or updating existing ones, witnessed also by published updates on collections which illustrate how the number of material can double in a very short time [32,33].

The importance of offering an up-to-date list of existing identified skeletal collections has been recognized by the Forensic Anthropology Society of Europe (FASE) and as a result a free online map of the world's identified skeletal collections was established in 2017. The map is available on the FASE official webpage http://forensicanthropology.eu/osteological-collections/[34] and offers a comprehensive, constantly updated overview of the existing identified skeletal collections (Fig. 1) that can serve as a valuable research tool for students, researchers, and practitioners alike. The creation of the map is in agreement with one of FASE's main goals to support research and training in forensic anthropology and to raise awareness about useful resources for the scientific community. This paper aims to introduce the FASE map to a wider audience and to summarize the content of identified osteological collections in terms of location, sample size, demographic distribution, and other available information.

1.1. The FASE Map of Identified Osteological Collections

By "identified" collections we mean assemblages of skeletal material, whether of single bone elements (e.g. skulls), complete skeletons, or anatomical specimens with documented/known biological profile features (i.e., sex, age, ancestry, stature). The map distinguishes contemporary collections (collections exclusively or partially composed of individuals born after 1920), non-contemporary collections (exclusively composed of individuals born before 1920), and collections of uncertain temporal status (composed of individuals with unknown/not specified year of birth, often mixed assemblies of material pertaining to different epochs). While contemporary and non-contemporary collections are represented by remains that have at least two of the biological features known and often complemented by other demographic data (e.g. place of birth, cause of death, occupation), collections of uncertain temporal status lack date-of-birth information, but it may be that other biological features are documented (e.g. ancestry, sex). The map lists the collections´ names together with their geographical and institutional locations (Fig. 1a), as well as a summary containing more detailed information on the collections and sample itself (i.e. founding year, type of material, source of skeletal remains, composition) (Fig. 1b).

The data on which the inclusion in the map is based and those reported in the accompanying summary are either self-reported (based on a questionnaire sent by FASE to its members or information from curators of the collections) or ascertained from publicly available information sources, including webpages and scientific publications, which may not provide complete information. The map is regularly updated with new collections and related bibliographic sources, and, when needed, corrected by dedicated FASE osteological map administrators as new information emerges.

Table 1 presents the distribution of collections by continent and country (as of September 2021). To date, the map counts 153 collections from 41 different countries, of which 43 are categorized as contemporary, 55 non-contemporary, and 55 as collections of uncertain temporal status.

The majority of the identified collections are located in Europe (55%) and North America (23%). However, only a small fraction (17% in Europe and 17% in North America) of the collections are contemporary. This is probably because after the initial boom in assembling human skeletal material for scientific interest in human variability, there was a stagnation period until the end of the 20th century. At the start of the 21st century the creation of skeletal collections regained popularity for forensic purposes as a response to the increased implementation of anthropological approaches in forensic investigations and legal practice [1].

The distribution of the collections on the world map is uneven. Generally, some countries house a wealth of identified collections (contemporary and non-contemporary), while others have only a few or none at all. It is interesting to note that countries in Latin America, Africa, and Asia, possibly due to the nature of their forensic casework, have reported assembling of a number of contemporary osteological collections in the last decade. In these countries, the contemporary collections actually outnumber the non-contemporary ones. In contrast, some countries in Europe, which dominate in the number of non-contemporary collections, have no known contemporary assemblages. Even though many countries allow the use of human material for research and education purposes, the lack of contemporary collections may reflect the enactment of international acts regulating removal, storage and use of human tissue (e.g. Human Tissue Act, EU Tissue Directive) or local laws, insufficient financial means, infrastructure, or interest. Another

Table 1
Summary of the collections in the FASE Identified Collections Map (the complete list of collections is included in the Supplementary Table 1).

Country	Number of collections	Contemporary collections	Non contemporary collections	Collections of uncertain temporal status
TOTAL	153	43	55	55
EUROPE				
Austria	2		2	
Belarus	1			1
Belgium	5	1	4	
Bulgaria	1			1
Croatia	1		1	
Czech Republic	3	1	2	
France	4		2	2
Germany	12		7	5
Greece	2	2		
Hungary	2		2	
Italy	9	1	7	1
Lithuania	1	1		
North Macedonia	1			1
The Netherlands	2			2
Norway	1			1
Portugal	8	5	3	
Romania	1	1		
Russia	2		1	1
Scotland	5		2	3
Serbia	1			1
Spain	5	2	3	
Sweden	3			3
Switzerland	4		4	
Turkey	1			1
United Kingdom	6		1	5
Ukraine	1			1
	84	14	41	29
NORTH AMERICA				
Canada	2		1	1
United States of America	33	6	11	16
	35	6	12	17
CENTRAL AMERICA				
Mexico	3	2	1	
	3	2	1	
SOUTH AMERICA				
Argentina	2	2		
Brazil	9	8		1
Chile	1	1		
Colombia	2	2		
	14	13		1
AFRICA				
South Africa	5	4		1
	5	4		1
ASIA				
China	1			1
Hong Kong	1			1
India	2		1	1
Japan	2			2
Philippines	1	1		
Thailand	2	2		
	9	3	1	5
AUSTRALIA	3	1		2

possibility may be that the information about such collections is not (yet) in the public domain and thus is not available for this article and the FASE Map.

Detailed information is available for the majority of the listed collections, but for about quarter of the collections, the data are either not retrievable or incomplete. The analysis of the available information shows that most of the identified collections are housed at universities (61%), which store almost three-quarters of the contemporary collections, followed by museums (32%, in some cases linked to universities), and forensic institutes (8%).

The way the collections have been assembled varies over time. The collections dating back to the 19th and 20th century (mostly collections of uncertain temporal status) may include body donations from hospitals, autopsies, or material gathered during explorative voyages around the world that resulted in non-homogeneous assemblages. Contemporary collections are usually accrued for forensic purposes and are the product of collaborations between universities and local cemetery administrations (collecting unclaimed remains), or result from body donation programs. As the sources of the remains differ, the quantity and quality of information available for the collected remains vary as well. Body donation programs generally record a wealth of information with targeted questionnaires. For cemetery-sourced collections more or less extensive information may be retrieved from tombstones, and – when available – from inhumation and exhumation registers, death certificates, or autopsy reports. The cemetery-sourced collections can present limitations regarding data collection, which can range from profiling errors (i.e., the sex of an individual based on the gendered name present on the tombstone) to incomplete or inaccurate data (i.e. missing or incorrect entries in the registries).

In addition to basic biological data, such as age and sex, some collections are composed of material with known traumatological

(often derived from autopsies; 8%) or pathological (based on medical records; 13%) information. Other collections offer access to ante-mortem photographs or medical imaging of the deceased (4%) (e.g., Chiang Mai in Thailand, IEPCF or Piracicaba Collection in Brazil).

The sample sizes of the collections range from just 10 identified individuals to 137,000 individuals (i.e. skeletal collection St. Petersburg in Russia). However, collections with the greatest number of individuals are also those of uncertain temporal status, without clear distinction between archeological and potentially contemporary assemblages, including the size of the contemporary portion.

While the majority of the collections is comprised of complete or almost complete skeletons of adult individuals, a quarter of them is entirely or partially composed of single bone elements (of these 90% are skull collections), anatomical specimens, or non-specified skeletal material. Contemporary identified collections, mainly those sourced from cemeteries, are characterized by an over-representation of elderly individuals, which may provide an unbalanced source when universal age estimation methods are developed. On the other hand, these collections can provide valuable information on the effects of age on the skeletal system and the variation in age-related markers or development of new ones. A common denominator for most of the collections is the under-representation of non-adult, neonatal, and fetal remains. Around 13% (20 in total) of the collections report the presence of non-adult skeletal material, of which six are entirely composed of non-adult skeletal material (Granada Osteological Collection with 230 individuals ranging from 0 to 8 years of older [6], John Hopkins Human Fetal Skull Collection in Cleveland with 112 disarticulated fetal skulls, Scheuer Juvenile Skeletal Collection in Dundee with 150 juvenile archeological and contemporary skeletons, Trotter collection in St. Louis, USA with 133 fetal skeletons, Strasbourg Skeletal collection composed of 162 skulls ranging from 0 to 12 years of older, and Portal Collection housed at the Musée de L´Homme in Paris with 140 fetal skeletons.

It is important to be aware that due to the inherent variation in the demographic structure of many collections, they may not meet the criteria for an ideal reference sample [35] nor can they be considered to be an adequate representation of the living population from which they were derived. However, depending on the research question, each collection, independently of size and structure, may be of value for method development, research into human variability, trauma, pathological changes, or be used for teaching and training purposes.

The FASE map is currently limited to physical skeletal collections, but there are plans to include another section on virtual identified collections in the near future since it is expected that the importance of digital repositories will increase with further expansion of teleworking and online teaching and training. Virtual skeletal repositories, assemblages of three-dimensional skeletal models derived from CT-scans, or other digital imaging of human remains sourced from existing physical skeletal collections or living individuals [36–41] comprise a valuable resource of contemporary data. The number of forensically relevant studies conducted on 3D osteological models is continuously growing [41], but more research is needed to assess the reliability and practical application of these models in forensic anthropology [42].

2. Conclusion

The FASE map of identified skeletal collections has so far gathered information on 153 identified osteological collections worldwide, including 43 contemporary documented collections. This number is much greater than previously published information. For example, Ferreira et al. [15] listed ten European identified osteological collections in 2014, Go et al. [16] counted 12 cemetery-sourced identified collections globally in 2016, Ubelaker [4] mentioned 38 collections worldwide in 2014, Santos [3] reported 54 identified collections globally in 2019 while in 2020 Franklin and Blau [30] included 72 collections in their list of skeletal collections with documented demographic data. The discrepancies observed in these numbers evidence suboptimal data sharing among practitioners and researchers in different countries, or even within the same country [13], which FASE aims to overcome with its freely available online map. Based on the presented information, users can select collections most suited for their research or training intentions. FASE strives to continuously update the FASE map and correct if any, erroneous data and information, but it is up to the researchers and practitioners to use the information correctly, to recognize the limitations, and to acknowledge the information sources properly. Any comments or suggestions are welcome and can be emailed to fase.newsletter@gmail.com.

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Conflict of Interest

None reported.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.forsciint.2021.110995.

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