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Development and implementation of forensic anthropology in Swedish forensic practice

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Abstract:
This paper presents the ongoing development of forensic anthropology in Sweden. We discuss the background of the discipline, its application, as well as its current and potential development in Swedish forensic practice. Collaboration with osteoarchaeologists in skeletal forensic cases has a long tradition in Sweden. Analyses of skeletal remains are performed ad-hoc, in contrast to analyses of fleshed human remains. While several law enforcement employees are educated in forensic anthropology and /or osteoarchaeology , they are not employed in these fields, and regional variations are evident. Internationally, forensic anthropology has become an autonomous forensic discipline over the past decades, requiring skills beyond mere skeletal analysis. To keep on a par with international standards, it may be time to revisit the concept of forensic anthropology in Sweden. Despite the limited presence of supporting organisational structures and systems, forensic anthropological and hard-tissue-reliant physico-chemical analyses have proven valuable in Swedish forensic practice, especially in cases of personal identification, trauma analysis and search efforts. We argue that Sweden could benefit from making qualified forensic anthropology expertise available in all law enforcement regions, starting to implement and promote forensic anthropology in routine forensic casework and formalising the role of forensic anthropology practitioners.

Keywords:
forensic anthropology, forensic medicine, forensic chemistry, crime scene investigation, human osteology

INTRODUCTION

In Sweden, forensic anthropology is not currently formalised as a profession, nor is the way in which forensic anthropology expertise should be integrated with forensic and medico-legal investigations [1]. This is, in part, conditioned by the fact that forensic anthropology is not recognised as an independent discipline, but rather as a component of archaeological and/or medico-legal services. There is a general perception that forensic anthropological questions can be answered by medical doctors and/or osteoarchaeologists, even though the vast majority lack formal education and/or experience in the field. Osteology (biological anthropology and zooarchaeology) has a fairly long history in Sweden and has been integrated within Swedish archaeology education since the 1960s (meaning that osteologists are generally also archaeologists) [2, 3], however most archaeologists do not hold a diploma in osteology (as osteoarchaeologists do) and are thus not qualified to analyse skeletal remains. Many professional archaeologists are, however, experienced in skeletal recovery. Forensic medicine practitioners are often not experienced in recovery or examination of bare bones, even though human osteology (part of anatomy training) is included in their education. No formal academic training or programs in forensic anthropology exist in Sweden [1, 4].

The development of forensic anthropology often depends on a country's legal framework, the volume and typology of forensic casework and its forensic and educational traditions. Sweden is a country with a fairly small population (just above 10 million), has a low number of lethal violence cases (around 1 case per 100,000 inhabitants [5]), and experiences sporadic mass casualty events. Forensic anthropology is rarely part of routine forensic investigations in Sweden. In comparison, neighbouring Denmark — with a smaller population and similar homicide rate to Sweden — offers forensic anthropology analyses at the three forensic medicine institutes, upon request by the Chief Forensic Pathologists [6].

In this paper, we will revisit the potential to develop forensic anthropology in Sweden and what the benefits may be. We present the background of forensic anthropology in practical work in Sweden, its current status and its application and development in forensic practice. While the authors recognise that forensic anthropology and forensic archaeology

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are interdependent in search efforts and recoveries that involve human remains [7-9], this paper will focus on forensic anthropology and specifically its application in the investigation of the dead.

SWEDISH LAW ENFORCEMENT ORGANISATION AND LEGAL FRAMEWORK IN RELATION TO HUMAN REMAINS INVESTIGATIONS

Today, the two main authorities involved in death investigations in Sweden are The Swedish Police Authority (sw. Polismyndigheten) — the largest government authority in Sweden, and the National Board of Forensic Medicine (NBFM; sw. Rättsmedicinalverket) – a national agency that, under the umbrella of the Ministry of Justice, is responsible for issuing reports in forensic medicine, psychiatry, toxicology and genetics to The Police Authority, prosecutor, and courts of law. The different divisions (six divisions for forensic medicine, two divisions for forensic psychiatry and a national laboratory for forensic genetics and toxicology) are based in six cities around the country [10, 11]. The geographical location of law enforcement and forensic medicine divisions is unevenly distributed. This is due to large variations in population density, which ranges from 367 inhabitants per km^2 in the Stockholm region to only 2.6 inhabitants per km^2 in the northernmost region of Norrbotten [12]. The Police Authority is organised into seven regional units that together include 95 local police forces distributed across the country [13] (Figure 1a). A similar geographical distribution can be seen for the NBFM (Figure 1b). Police and NBFM divisions in the south cover smaller geographic areas than those in the north (Figures 1a & 1b). Specifically, the NBFM forensic division in Umeå covers 225 000 km^2, an area representing more than half of Sweden's geographic territory with a population of only 0,9 million [11, 14].

NBFM was formed in 1991 when the previously autonomous forensic medicine departments that acted under the National Board of Health and Welfare were gathered under one governmental agency that was given overall administrative control over four forensic disciplines (medicine, genetics, psychiatry and chemistry) [11]. Similarly, the formerly autonomous regional police departments were merged into The Police Authority in 2015. Both strategic reorganisations were executed to facilitate the provision of more standardised and equal services nationwide, increase the efficiency and homogeneity in the casework and provide better communication between the departments throughout the country. Despite the long-term process of harmonisation in terms of operational procedures, differences in the way various local departments (both within The Police Authority and the NBFM) handle and approach the same type of cases still prevail.

Variances in the management of forensic anthropology cases exist due to differing traditions which date back to a time when departments and units were more autonomous, but also because of different geographical conditions. Forensic anthropological expertise is far from equally available across the country [1]. It is, to the best of our knowledge, limited to Stockholm within The Police Authority, and Linköping, Stockholm and Uppsala within the NBFM. The location of these competences is not the result of a strategy developed and implemented by law enforcement, but rather the result of certain law enforcement professionals possessing additional educational

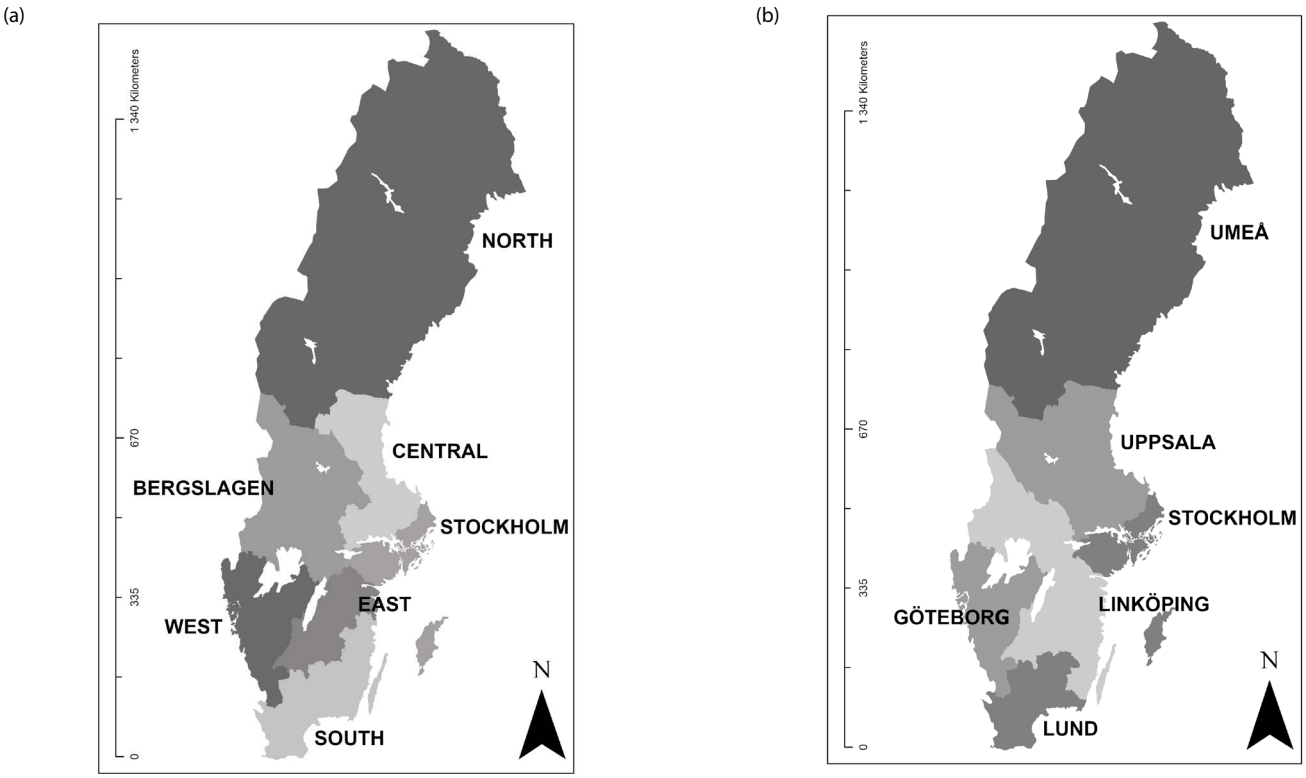


Figure 1. (a) The seven regional police units that are part of The Police Authority. (b) The six divisions of the National Board of Forensic Medicine (NBFM). Figures by Clara Alfsdotter, geodata retrieved from C Lantmäteriet (CC BY, data accessed 2022-01-05)

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backgrounds in forensic anthropology or osteoarchaeology. Since these skill sets are not recognised as their main profession, this makes forensic anthropological proficiency development harder to sustain [1]. For forensic archaeology, a big step forward was the creation of a full-time position in forensic archaeology in 2018 within the Swedish National Forensic Centre (NFC, Sw. Nationellt forensiskt centrum)[1], which is part of The Police Authority. Further information about the past development of forensic archaeology in Sweden can be found in a recent paper that addresses the development, current state, and potential future of forensic archaeology and anthropology in relation to human remains investigations [1].

The best way to depict the situation and different problems encountered in the implementation of forensic anthropology in practice is to present it in relation to the management of skeletal remains at the recovery scene and in the autopsy room.

The recovery scene — The Police Authority

When skeletal remains are found, the police decide whether the scene should be secured, criminal scene investigators contacted, and findings subject to a forensic medical examination. The way in which the police proceed in these cases is not based on existing legal frameworks or internal guidelines, but rather on routine. While the law and current provisions clearly regulate what steps should be taken by the police and forensic medicine specialists in the management of recently deceased persons and in clinical forensic practice, this is not the case with skeletal remains. Variations in the handling of skeletal cases are greater [1], as has also been noted in other countries [15, 16]. In many cases, the examination of skeletal remains does not involve forensic medicine specialists but is undertaken via the police. This can, for example, be achieved through the utilisation of osteological consultancy services, either within the police or externally at universities, museums, and archaeological companies. One of the reasons for this, as pointed out by crime scene investigators, is the varying osteological competence at NBFM departments [1]. Another likely factor is that osteoarchaeologists are available throughout the country and can rapidly answer questions about species identification (human or non-human), which is often the first question posed when skeletal remains are found. While some police regions (e.g. Stockholm) can count on crime scene investigators with a background in osteology and examination of modern human remains (among those the author PM), this is not the case in other regions. As crime scene investigators are responsible for deciding which expert(s) to consult in casework involving skeletal, buried or fragmentary remains, it often comes down to the personal contacts and acquaintances of the investigators in charge [1].

Collaboration with external consultants specialised in forensic anthropology or human osteology has a long and fluctuating history in Sweden. In the 1970´s the osteologist and zoologist Gejvall [17, 18] and forensic odontologist Johanson [19] were approached by the Swedish police and requested to perform identifications. Gejvall was also involved in osteological training at the Police Academy [3]. Since then, osteological education for the police has, to the best of our knowledge, been lacking. However, it is now once again on the agenda (see Forensic anthropology development within The Police Authority). More recently, the police and the NBFM have utilised both local osteoarchaeologists for consultations, as well as specialists from both Denmark and Finland. However, issues with the ad-hoc involvement of external osteoarchaeologists in the initial assessment of a potential forensic finding still persist. Specifically: 1) while osteoarchaeologists are knowledgeable in skeletal analysis, many are not familiar with forensic procedures or modern skeletal material, 2) there is no national qualification framework underpinning the forensic anthropological competences of the persons contacted, 3) analyses performed ad-hoc are not subject to standard operating procedures or quality control, 4) there is no formal register of cases where competence in skeletal anatomy/osteoarchaeology is requested, thereby hindering the possibility for statistical analysis that would demonstrate how often such skills are required during police investigations [1]. Having said this, skeletal remains sent to the NBFM are subject to similar limitations, illustrated by an absence of skeletal case statistics, standard operating procedures and a requirement for forensic anthropology accreditation.

The grey area for investigation of skeletal remains extends to the recovery phase. There are no defined guidelines within the police on how, and by whom, recovery should be conducted in scenarios of skeletal / disarticulated / scattered /commingled/ burned/ buried and fragmentary remains. For example, standard operating procedures for fire scenes address only the recovery of fleshed remains without defining what should be done in cases of skeletal finds or fragmentary remains [1, 20]. Fire investigations where the presence of human remains are expected represent an example of recoveries that can benefit from the inclusion of professionals with archaeological, skeletal anatomical and taphonomic competences [21, 22]. An unofficial handbook from AFFA (the Forensic Archaeology Working Group based in Stockholm), authored in the 1990's, addresses the topic of clandestine burials. Knowledge and implementation of this guideline varies however [1].

The autopsy room — The National Board of Forensic Medicine (NBFM)

The way in which forensic medicine specialists are involved in first assessment of skeletal cases and their frequency varies greatly between divisions. Cases involving species identification, if maceration is not needed, are in most cases solved telematically, using photographs sent by mail or MMS; a practice that can be acceptable according to forensic anthropology working groups and technical advisory boards [23, 24]. This is done only if the quality of the picture is assessed as suitable for an adequate assessment. If the pictures are assessed as being of poor quality or the remains cannot be unequivocally determined as non-human, the remains are transported to the responsible medico-legal division and examined in person. In some cases, external consultants or genetic analyses are requested. The forensic significance of the remains in terms of distinguishing between modern and archaeological human remains is assessed with the aid of radiocarbon dating. This is often done regardless of the state of preservation of the remains and in cases where the contextual information and artefacts cannot

1 At time of publication, two additional full-time positions in forensic archaeology have been created (from 2022). The three forensic archaeologists at NFC are tasked with strategic development of forensic archaeology on a national level.

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exclude archaeological origin beyond any reasonable doubt. Radiocarbon dating is an internationally accepted, validated and highly reliable method that, in the Swedish medico-legal reality, is easily obtainable and cost-effective. It is thus preferred over other, less reliable methods. Radiocarbon and stable isotope analysis have been performed on teeth and bones of unidentified skeletal remains for more than a decade and a referral note for these analyses is available in the forensic medicine case management system. Whilst particular burial modes and contextual information, such as historical maps, can provide some insight in terms of past land use, special analysis of the remains in each case is warranted. In addition to facilitating the distinction between forensic and archaeological finds, radiocarbon analysis can be used to focus the search for missing persons by estimating year of birth with high accuracy. This is done using bomb-pulse radiocarbon analysis [25-30], a method enabled by the remnants of large-scale above-ground nuclear detonations [31, 32]. Examples can be seen in Table 2.

In cases involving modern human skeletal remains, forensic medical examinations are often requested to facilitate the identification of the deceased and assess the cause and manner of death. The police have the overarching responsibility for identifying deceased individuals who cannot be identified on the scene by the physician that pronounced the death [33] (for example in cases of decomposed remains, burned remains and extensively mutilated corpses). According to Swedish law, forensic medical examinations, if in the form of external inspections or autopsies, are to be performed by medical doctors [34]. The legal framework does not focus specifically on skeletal remains but since these represent the end-stage of human decomposition, it can be assumed that they also fall under the responsibility of medical doctors. This does not preclude the possibility of involving other specialists in the analyses, since forensic medical doctors can delegate their tasks and engage external consultants. The involvement of external osteoarchaeologists or forensic anthropologists is, however, sporadic. The NBFM does not have internal guidelines on how skeletal remains should be processed and/or when and how forensic anthropological expertise should be requested. However, the agency does have a formal internal document that lists staff with specialist skills who can be contacted if needed, including forensic anthropologists. Some NBFM divisions have, on a case-by-case basis, worked with external consultants. Today, this competence exists in-house as two forensic medicine doctors (the authors AG and AP) and one forensic medicine assistant (the author RT) have formal forensic anthropology qualifications from abroad. Their knowledge and experience are primarily used locally in their respective divisions, but is sometimes also requested by other colleagues. However, this is done mainly on the basis of personal contacts and is not clearly formalised, as these employees are not employed as forensic anthropologists. An area in which forensic anthropology has a more prominent position is Disaster Victim Identification (DVI). Since 2016 a representative of the field has been present in the NBFM national DVI group, ensuring that forensic anthropological aspects are taken into consideration in all stages of DVI work.

Table 1. Number of cases involving analyses of fully/partially skeletonised remains as well as bones and skeletal parts examined at the NBFM between January 2018 and December 2021. In this period 22543 autopsies and 654 analyses of other nature (cases not registered as autopsies) were conducted at the NBFM's six medico-legal divisions. These cases make up 1.12 % of all cases handled by the NBFM.

CASES NOT REGISTERED AS AUTOPSIES[1]			TOTAL
	Human/ non-human bone identification	Analysis of human bones (archaeological, cemetery cases and burned remains)	
	85[3]	40	125
AUTOPSY CASES[2]			
Skeletons and bones	Analysis of individual bone elements	Analysis of complete/almost complete skeletonised bodies	
	16	27	43
Burned human remains	Analysis of burned skeletal remains (without remaining soft tissue)	Analysis of charred body parts with multiple burned bone elements	
	24	19	43
Decomposed corpses with partial skeletonisation[4]	Analysis of remains with more than 50 % of the total body area skeletonised	Analysis of remains with less than 50 % of the total body area skeletonised	
	25	23	48
			259

[1] Cases not registered as autopsies include site investigation reports, analysis of skeletal remains with no forensic interest, some of the cases involving burned human remains, consultations, and physico-chemical analyses.
A total of 37 radiocarbon datings were performed in the same period (not included in the statistics).
[2] Autopsy cases refer to autopsies (22436) and external inspections of corpses (107). Analyses of skeletal remains are sometimes registered as autopsy and sometimes as external inspection (an improved filing system is currently being developed).
[3] Most of the telematically solved human/non-human bone identification cases are not registered, so the number of such cases handled at the NBFM is much higher than can be seen statistically.
[4] Desiccated and saponified corpses have not been included in the statistics, even though these types of cases could also be of interest to forensic anthropologists.

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The regional differences in the frequency of forensic anthropology consultations also apply to requests for other special examinations, such as isotope analyses. Despite the value of radiocarbon methods, the proclivity to request such analyses is variable among forensic medicine doctors in Sweden. Some requests come directly from The Police Authority even if the case has already been examined at a forensic medicine department. This indicates that a proportion of forensic medicine specialists may be unaware of the information that such analyses have the potential to provide.

CURRENT DEVELOPMENTS

Forensic anthropology development within The Police Authority

There has been a steady increase of cases involving skeletal remains that have been assigned to employees with osteoarchaeological backgrounds within The Police Authority in the last few years, from 10 cases in 2015 to about 100 cases in 2021. Most of the cases (approximately 75-80 %) relate to outdoor discoveries that were eventually identified as non-human bones. The reason for the drastic increase in cases is probably due to the simple fact that osteologically trained personnel have advocated for osteology and made themselves available to a greater extent than previously. These cases were probably not visible in the statistics when consultations were predominantly external. For example, Stockholm, which now relies on internal osteological competence, has a long tradition of consulting osteoarchaeologists (not least from Stockholm University). In addition, the availability of smartphones and resulting enhanced email access, has allowed remains to be commonly identified through digitally transmitted imagery. This procedure liberates police personnel, who previously would have guarded the recovery site until the remains could be identified, thus saving police resources. The increase in internal osteological consultations is not uniform since regional osteological competence within the police varies greatly [1]. In some regions, crime scene investigators still depend on external osteologists, thereby making a reliable statistical basis difficult to obtain. The above-mentioned case figures should thus be regarded as the minimum volume requiring osteological competence. The recognition of the potential benefits offered by the presence of archaeological and osteological skills in crime scene work is today visible within a number of civilian crime scene investigator (CSI) job descriptions, where archaeology and/or osteology are specifically identified as two desirable areas of qualification.

Another recent development within the Stockholm Police force is that AFFA (the Forensic Archaeology Working Group) has been revived at the Forensic section in Stockholm. AFFA was founded by crime scene investigators in the 1990's and has been intermittently active since then [1, 35]. Their aim is to serve as theoretical and practical support at outdoor crime scenes and related undertakings. The group is involved in developing best practice instructions for correct and ethical treatment of human remains in various contexts, as well as identification and recovery work at outdoor crime scenes. In the ongoing discussion on procedures, the collaboration between various police departments as well as with external authorities (such as the Swedish National Heritage Board and the County Administrative Board) are considered essential, in order to determine the best course of action in each case.

In the past two years, forensic archaeology and forensic anthropology have been included in the basic course for new Swedish crime scene investigators in the form of one-and a half-day's training. During this time students are introduced to forensic archaeology theory and methodology as well as receiving hands-on training in metal detecting and ground penetrating radar. The lectures also include forensic anthropology methodology, case reports and a small workshop with human and non-human remains. A collaboration has also been initiated with the NFC and NBFM in Linköping regarding tool impressions, with the aim of linking bjects - in this context knives and other sharp instruments - with injuries to bone and cartilage. Previously, such investigations were conducted without osteological competence at the NFC and consequently without skeletal trauma expertise [1].

Forensic anthropology development within the National Board of Forensic Medicine (NBFM)

It is generally assumed (not just in Sweden) that there are not enough cases in forensic medicine departments to justify a full-time forensic anthropologist [36]. This assumption may be open to challenge, given that there is no clear picture of how often and in which instances expertise in forensic anthropology analyses is requested. Today, thanks to an NBFM investigation that aimed to identify and compile all cases from the last four years that involve skeletal remains analysis, there is a clearer picture of the number of cases where forensic anthropology expertise could have been beneficial if employed. The results are shown in Table 1. The analysis showed that skeletal cases constitute 0.6 % of autopsy cases (134/22543, between 29 and 46 cases per year) and 19 % of cases other than autopsies (125/654, between 30–44 cases per year).

The project encountered several difficulties because of the lack of a consistent way to register these cases in the NBFM database and due to the fact that not all consultations, such as those solved telematically without a formal request from the police or internal requests for second opinions, are registered. Moreover, a significant number of cases involving initial assessment of skeletal findings do not reach the NBFM at all. Instead they are processed through external consultants such as osteoarchaeologists. It is clear that the areas where forensic anthropology expertise can be utilised are multiple and include postmortem cases of varying preservation as well as clinical cases [7, 36, 37], these neither listed in the statistics. Some of the forensic areas that may benefit from forensic anthropology expertise were recently identified and presented by three of the authors (AP, AG, RT) during the annual Swedish forensic medicine meeting in November 2021.These include, but are not limited to: (i) assisting in recoveries (especially when the forensic anthropologist is skilled in forensic archaeology), (ii) differentiation between human and non-human remains, (iii) differentiation of forensic vs. archaeological material with the help of radiocarbon analyses and the promotion of physico-chemical analyses in medico-legal examinations, (iv) assisting in estimation of the postmortem interval of decomposed remains, (v) personal identification, especially in light of the recently published Forensic Anthropology Society Europe (FASE) statement paper [38], (vi) trauma analysis (including consultations in routine autopsy cases and living individuals, including skills in maceration), (vii) assisting autopsies of burned remains and (viii) involvement in education/training programs for doctors and police, as well as collaborative projects and research. Practical examples that demonstrate the use of forensic anthropology expertise in the listed areas are presented in Table 2.

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Table 2. Examples of casework from the police and the NBFM where forensic anthropological competence has been successfully implemented.

RECOVERY	Support in the assessment of manner of death	Extensively burned human remains were found inside a burnt-out car. Despite the car owner's medical history including a history of explicit suicidal thoughts, murder had to be ruled out. The osteoarchaeological expertise of one of the criminal investigators allowed all the remains to be carefully recovered and the position of the body to be attested. The corpse was lying in a "correct" anatomical position on a reclined driver's seat. The blade of a knife was found on the front passenger seat. Despite these findings, the subsequent autopsy identified no sharp or blunt force injuries on the remains. The combined evidence (the position of the body on the reclined seat and the absence of trauma other than thermal destruction of the skeletal remains) led to the conclusion that this was indeed a case of suicide.
RADIOCARBON DATING	Using radiocarbon dating to attest age of birth	In 2018 the body of a severely decomposed newborn was found in a plastic bag on the ground, partly hidden by vegetation. A 24-year-old-woman was suspected, and later confirmed by DNA analysis, to be the mother. The woman claimed she had given birth when she was only 15 years old, that is in 2009. This was, however, questioned by the police due to the condition of the baby's corpse, which retained soft tissue. ^{14}C analysis on the baby's femur revealed radiocarbon levels matching 2008.3 (YYYY.M), thus supporting the mother's statement. The results implied that she was underage at the time of giving birth and thus significantly affected the legal outcome of the case.
	Narrowing down the search for a presumed identity	A severely decomposed body of a man was found in a Swedish harbour in 2020. Decomposition changes meant that no visual identification or estimation of the man's age was possible. Despite extensive police efforts, no clues to the identity of the deceased could be obtained. With no presumed identity, fingerprints and dental examinations were of no use. ^{14}C analysis was finally requested. The analysis of a tooth crown, with enamel laydown of 6.5 years (28), and a root indicated that the man was born 1988±1.2 years. This data gave the police a specific time frame within which to search for a match. The identification was concluded with a positive DNA match. The deceased´s date of birth was revealed to be 1987.
PMI INTERVAL and DECOMPOSITION	Knowledge on decomposition sequence helps the search for missing individuals	A recent study of outdoor human decomposition in Sweden (39) elucidated the general decomposition sequence of people in Swedish outdoor settings. These findings have been used in several cases where police or teams involved in the search for missing people needed information related to corpse conditions, i.e. what to look for and where (disarticulation state, scavenging etc). In one ongoing case, the police, looking for a man who was believed to have died in a lake 8 years prior, employed forensic taphonomic data to guide their search efforts. Specifically, they utilised intelligence on such behavioural aspects as floating and sinking, as well as the potential state of the remains.
IDENTIFICATION	Identification through skeletal morphology	After a brick building burned down an elderly man was missing. 106 grams of severely burnt and fragmented skeletal remains, mostly fragments of lumbar and thoracic vertebrae were recovered. The fragments showed severe degenerative changes (osteophytes and spondylosis). The morphology of the fragments was compared with the missing person's medical records and the 3D reconstruction of a recently performed CT scan. The antemortem data matched the characteristics of the recovered vertebral parts. This, together with circumstantial data, was judged by the police to be sufficient to establish a credible and conclusive identification.
	Identification through surgical implant	In a burnt down building, skeletal remains and a hip prosthesis were recovered from the fire debris. During the examination 406 g of severely burned, mainly calcined human skeletal fragments were identified. No teeth were present. No DNA with the potential for identification could be extracted. The anthropological analysis revealed degenerative changes in the spine such as bridging and osteophytes, as well as eburnation on large joint surfaces. The pelvis showed signs of right hip replacement surgery. After cleaning the metal hip prosthesis, a serial number became visible. A review of the missing house owner's radiological reports revealed that he had undergone a hip replacement as well as replacement of both knee joints. He also had degenerative changes in his thoracic and lumbar vertebrae. The medical records confirmed that the recovered prosthesis belonged to the missing man, who had undergone hip replacement surgery 15 years prior. The police determined that his identity could be established based on these findings.
	Identification through antemortem trauma and surgical interventions	Almost completely skeletonised body parts of an adult man were found in a forest. When the examination commenced no dental records were available, however medical records that documented a history of complex right femoral fractures were obtained. Anthropological and radiological analyses of the femur confirmed that the bone had been subject to surgical interventions comprising insertion of an intramedullary nail on two occasions. These findings matched the information extracted from the medical records. Even though the deceased's identity was subsequently established via dental records, the history of fractures would probably have been deemed sufficient for identification purposes without dental records.
TRAUMA ANALYSIS	Identification of the tool used to produce injuries	Between 2015-2021, one of the authors (PM) was consulted in approximately 20 cases nationwide involving blunt and sharp force trauma analysis in collaboration with crime scene investigators and forensic medicine practitioners. A significant portion of the cases involved dismemberment injuries (that have seen a steady increase in Sweden in the last 60 years (54, 55) with at least 10 cases in the last three years (P. Molnar, unpublished report)). The analyses include assessment of saw type, direction of saw stroke and dexterity. In one of these cases, injuries caused by multiple instruments were identified.
	Pseudo-trauma vs. perimortem trauma	A severely decomposed body was recovered from a lake. The body was, in part, skeletonised and both the skull and the tibia showed defects that could be erroneously interpreted as having been caused by a sharp instrument. A detailed examination of the damaged surfaces, including a stereomicroscopic inspection, was performed. With the background knowledge of the potential taphonomic alterations occurring in water environments, the forensic anthropologist concluded that the defects were the result of the movement of the body in water and thus postmortem alterations rather than traumatic injuries.

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TRAUMA ANALYSIS	Maceration to reveal skeletal injuries	Maceration is needed in many forensic autopsy cases, including dismemberment cases, to allow a better visualisation of injuries. Performed macerations have allowed the discovery of injuries that were not noted previously, which enabled an in-depth forensic anthropological trauma analysis. Consequently, estimations of the weapon used, the minimum number of traumatic events and the force of impact could be assessed.
	Fractures vs. skeletal morphological variability in child abuse	Forensic anthropology analyses have aided investigations of suspected child abuse, in both the living and the dead. Infant and toddler fractures can be caused by physical abuse and certain fracture types, such as those of the rib as well as so called classical metaphyseal lesions (CML), have been regarded as highly specific to abuse (56). For debates on the subject see (57-59). Identifying possible differential diagnoses are crucial in such investigations. Forensic anthropologists educated in developmental and juvenile osteology are familiar with, for instance, developmental osteological mimickers of fractures. This competence can facilitate the addition of potentially crucial information in trauma assessments.

At present, the group of employees with forensic anthropological educational backgrounds, together with the Centre for method development (CMU) at the NBFM are working together to set up a system that will lead to more consistent registration of cases involving skeletal remains and a more formal system for forensic anthropology consultations. In addition, a more homogenous way to handle and analyse skeletal remains is being sought by publishing a list of recommendations for forensic anthropology analyses. As a result of interest from several forensic pathologists to learn more about the rudiments and principles of forensic anthropology, the idea of organising courses in forensic anthropology for residents in forensic medicine has emerged. A discussion and a final decision has yet to take place on this matter.

Collaborations

Several individuals are working to develop and advocate for forensic anthropology, both within law enforcement and academia. A national professional network in forensic archaeology and anthropology (ForArk), currently chaired by one of the authors (CA), was formed in 2017 by Anna McWilliams. The aim of ForArk is to promote cooperation and exchange of knowledge between different practitioners within the field of forensic archaeology and anthropology. ForArk acts as a point of contact for organisations such as The Police Authority, the NFC and the NBFM, as well as for academic institutions, private companies and independent consultancies. ForArk members come from fields including crime scene investigation, cold case investigation, forensic medicine, archaeology (including maritime and digital archaeology), osteology, geology, entomology, law and sociology to name but a few. Annual meetings are held where members present and discuss current developments and issues. As a result, ForArk members have experienced substantially increased communication with fellow professionals in possession of special expertise in this field. Many of these individuals previously did not meet, since routine casework at the police and NBFM typically involves local professionals.

In terms of research, Sweden based researchers are engaging in forensic-anthropological and forensic-taphonomic research [1, 4, 28, 39-52]. This is in addition to a long tradition of osteoarchaeological research, including forensic-anthropology-relevant skeletal research into, for example, traumatic injuries versus taphonomic skeletal alterations [53]. Furthermore, several police regions have recently consulted scholarly lectures in forensic anthropology, taphonomy, and archaeology.

CONCLUDING DISCUSSION

For half a century, Swedish law enforcement has, with varying continuity, collaborated with osteologists in Sweden. Since this tradition started, forensic anthropology has developed internationally into a highly sophisticated field that currently encompasses a wider skill set and research scope than that found at the genesis of the discipline [15]. While a solid education and experience in skeletal anatomy is still crucial for practitioners of forensic anthropology [7, 60], additional skills are needed for substantial forensic anthropological work, including knowledge of human decomposition and postmortem interval, forensic taphonomic signatures related to peri- and postmortem treatment and deposition (see [1] for a discussion relating to Sweden), recovery methods and theories, personal identity methods, basic knowledge in forensic imaging, extended knowledge of skeletal trauma, chain of custody, court system knowledge, forensic ethics and the role of the forensic anthropologist in relation to other forensic experts [8, 21, 61-68]. Forensic anthropology can contribute to investigations of large-scale human rights violations (e.g. genocides, terrorism and armed conflicts), DVI, forensic search and recovery (including fire investigations), examination practice and clinical forensic medicine [7, 21, 67-72]. The utilisation of properly trained forensic anthropology professionals can advance, among other things, analyses of chains of events, estimation of minimum number of individuals, biological profile and identification, trauma, taphonomy and fire alteration [7, 21, 67, 69, 71, 72]. Forensic anthropologists have been argued to be the most appropriate professionals in outdoor crime scenes and in all cases of extensively altered or commingled human remains [7]. Forensic medicine doctors and forensic anthropologists are not interchangeable, but are two professionals whose skill sets complement one another [63]. In several countries, the development has gone from ad-hoc forensic anthropology consultations to the establishment of forensic anthropology within forensic institutions and non-governmental organizations [69]. We suggest that such a development would also benefit Swedish forensic practice.

In order to keep on a par and up to date with international standards of forensic anthropology, and to increase credibility of the legal outcome in cases that are in need of forensic anthropological competence, we suggest that now is a good time to formalise forensic anthropology as an independent profession in Sweden. A national infrastructure including guidelines for proficiency testing, education, and quality control, are crucial steps in professionalising forensic anthropology [1].

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A continuity of employed forensic anthropologists would allow the development of experience and professional roles, increase collaborations and facilitate an overview of needs and potential development avenues in a manner that the current ad-hoc system does not allow. To guarantee a uniform level of minimum best practice, quality assurance is crucial. The current ad-hoc-system means that anyone can be consulted in skeletal cases. This dynamic, combined with the varying educational backgrounds of professionals working with skeletal analysis in Sweden, as well as the sporadic requests to partake in forensic analyses, dictates that the goal of minimum best practice is some way distant from the current state of affairs [1]. Certification of forensic-anthropological practitioners is therefore identified as an important step to increase quality assurance and to facilitate the work of the police that need to assign cases to practitioners [1]. Certification could, for example, be achieved through the European organisation FASE – that offers an international certification exam [68]. Furthermore, a system that could guarantee an enhanced level of quality control would comprise two specialists working on or reviewing the same case before a report is issued, as is currently the case for all other medico-legal reports.

We argue that Sweden is in an advantageous position to create a national infrastructure for forensic anthropology, as both The Police Authority and the NBFM (responsible for different parts of human remains investigations) are today state agencies that can facilitate a national infrastructure for forensic anthropology. The NBFM would be an ideal hub for forensic anthropology practitioners (either in the form of internal employees or external consultants that are tied to one NBFM department), instead of the police involving professionals from diverse organisations (NBFM, the Police, universities, archaeological companies/museums) on a case-by-case basis without clear forensic anthropology work assignments. For holistic investigations of burned, commingled, buried or decomposed human remains, practitioners in forensic anthropology with additional skills in archaeology – or in collaboration with a forensic archaeologist – should also be called to attend complex potential crime or catastrophe scenes to increase data and evidence collection. We argue that Sweden should make qualified forensic anthropology expertise available in all law enforcement regions, start to implement forensic anthropology in routine forensic casework and formalise the role of forensic anthropology practitioners.

**The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official position of their organisations.*

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