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KAROL – AN INTERDISCIPLINARY RESEARCH PROJECT ON THE SKULL COLLECTION RETURNED FROM THE KAROLINSKA INSTITUTE IN SWEDEN TO FINLAND

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INTRODUCTION

In August 2024, 82 human skulls were returned to Finland from Sweden, where they had been kept in the anatomical collections of the Karolinska Institute since the 19th century. The remains were returned to Pälkäne, because approximately half of them (42 individuals) had originally been collected from the old church of Pälkäne (Fig. 1) during Gustaf Retzius's fieldwork in 1873 (Retzius 1878; Ruohonen 2021). Local stakeholders had expressed a strong wish for the prompt reburial of the remains, and this was scheduled only two weeks after the return of the remains. As a result, all documentation and sampling of the material had to be carried out within a narrow timeframe. Members of

our team performed the documentation and sampling of the skulls at the new church of Pälkäne (Fig. 2).

The documentation process included osteological examination, the production of 3D models of the intact skulls and CT scans of four mummified individuals at Tampere University Hospital. From all returned skulls, samples for ancient DNA (aDNA) and protein analyses, radiocarbon dating, and stable isotope studies were collected. In addition, a few small soil and seed samples from the ear canals were retrieved, as well as entomological material preserved on the crania. Together, the varied sample types provide a foundation for research of the assemblage.

Our research project is scheduled to continue at least through 2027, and it is currently funded by the Kone Foundation and the Pirkanmaa Regional Fund of the Finnish Cultural Foundation. Further support has also come from the Kuopio Museum for the analysis of soil samples from North Savo (Kirkinen 2025), and from the Museum Centre Vapriikki for fieldwork, CT scans of mummified individuals, and textile analyses of the silk bonnets preserved on two of the Pälkäne skulls (Kirjavainen, in press). The headgear was not reburied but instead catalogued in the collections of the Historical Museums of Tampere, which include nationally significant textiles and have specialized textile conservation facilities (Honkasalo 2013: 9).

THE HUMAN REMAINS

In addition to the 42 individuals from Pälkäne, the assemblage also included other skulls collected during Retzius's expedition in 1873. These skulls originate from Pielavesi (7 individuals), Rautalampi (3 individuals), and Eno (2 individuals), and one additional skull was later sent to Retzius from Pielavesi by Rudolf

Figure 1. The old church of Pälkäne was abandoned in the 1830s after the completion of the new church. The stone church dates to the late 15th - early 16th century CE, but earlier wooden churches preceded it on the same site. The oldest excavated burials from the site date to the 13th century CE. Individuals of higher social status were buried inside the church, and 19th-century accounts report that after Retzius's visit, several graves within the building stood open and some of the deceased were missing their heads (Koukkula 1972: 566). Photo: U. Nordfors.

Jack (Ruohonen 2021; Åhrén et al. 2024). These remains were later transferred from Pälkäne to their respective home parishes for reburial.

Approximately one-third of the skulls (26 individuals) originated from the anatomical collections of the University of Helsinki from where they had been donated to Sweden during the 19th century. Many of these skulls bear traces of autopsy, and most of them belonged to prisoners of the Sveaborg (Viapori) fortress. Four of these individuals, originating from Ulvila, Pori, Kiuruvesi, and Helsinki, are known by name (Åhrén et al. 2024). The assemblage also includes individuals whose geographical origins are known but whose identities remain uncertain. This group includes a man convicted of homicide from Häme, as well as individuals from Saarijärvi, Paltamo, Turku, Halikko, and broadly Karelia.

Our project also received an additional named individual from Rovaniemi. This skull had originally been donated from the Sveaborg prison to the anatomical collections of the University of Helsinki, where it had remained for more than a century without ever being transferred to Sweden. In the early 2000s, the skull had been sent to the Sámi Museum Siida as part of the repatriation of Sámi ancestral remains. It was later determined that the individual did not belong to the Sámi population, and the skull was redirected to Rovaniemi for burial. There, the living relatives of the individual expressed a wish for further analyses, which could be carried out in our project.

AIMS OF THE RESEARCH PROJECT

Determining the appropriate burial places for individuals whose origins remain unknown

The decision issued by the Finnish Ministry of Education and Culture (VN/36221/2023-OKM-1) stipulates that the human remains returned from the Karolinska Institute must be

Figure 2. In 2024, we worked in a field laboratory set up in the new church of Pälkäne, where we documented the skulls and collected samples prior to the reburial. Protective suits were worn throughout the process, even though the material had been handled for more than a century. With this choice, we sought to avoid introducing additional contamination from ourselves. Photo: S. Säilynoja, Museum Centre Vapriikki.

reburied. However, the assemblage includes 17 individuals whose geographical origins remain unknown. Establishing the most probable home region of these individuals is essential for ensuring their legal rights and equal treatment, so that they can be reburied in a location that aligns with their historical and cultural context. To achieve this, we combine scientific analyses with historical research, which together provide a robust framework for assessing provenance.

Ancient DNA analyses, particularly approaches that leverage DNA segments identical by descent (IBD), play a central role in this task. IBD analysis examines long segments of DNA that two or more individuals share through recent common ancestry (Ringbauer et al. 2017). Historically, Finns have usually found their partners and remained in the region where they were born, which appears as localized patterns of IBD sharing: on average, individuals originating from the same region share more IBD segments with each other than with individuals from other regions (Kerminen et al. 2017; Martin et al. 2018). By comparing each unidentified individual's genome to a large dataset of present-day genomes from Finland, we can assess the geographic distribution of their shared IBD segments within the country. The spatial clustering of these segments often gives the most precise estimate of an individual's genetic origins (see Nordfors et al. 2025). Our project is conducted at the University of Turku within the Centre of Excellence for Human Diversity through Contacts (HuDi-Con), which provides us access to the extensive genomic dataset of present-day Finns maintained by the Finnish Institute for Health and Welfare (THL).

However, genetic ancestry does not automatically reveal where an individual resided during their lifetime. Therefore, isotopic analysis, particularly the study of strontium isotope ratios($^{87}Sr/^{86}Sr$), complements the DNA data by providing an independent perspective on geographic background. Strontium isotope ratios reflect regional geological variation and are incorporated into human tissues through food and drinking water (Bentley 2006; Lahtinen et al. 2020). Because teeth mineralise at different stages from early childhood to early adulthood, strontium values from multiple teeth can reveal residential mobility and changes in place of residence during formative life phases. Our sampling strategy therefore includes several dental elements, allowing for a comprehensive reconstruction of individual life histories. This approach helps determine whether the deceased were born and raised in the same locality and identifies the geological region from which they most likely originated.

Historical sources are also used in determining the likely origins of the unidentified individuals. Although the Karolinska Institute's archival records were largely destroyed in a 19th-century fire (Åhren et al. 2024), a surviving shelf inventory lists several Finnish localities from which skulls had been obtained. Additional place names are listed in Retzius's *Finska kranier* publication (Retzius 1878). By comparing the results of genetic and isotopic analyses with the localities mentioned in these historical documents, we can narrow down the range of plausible places of origin and better assess the likelihood of particular geographical associations.

The diverse life histories of individuals

Our aim is to reconstruct multidimensional life histories for all 83 individuals by combining evidence from various biological, historical, and archaeological sources. For an anatomical collection such as this, highlighting the human histories behind the remains is important, given that the original collectors operated within their contemporary scientific norms that afforded limited attention to the life histories or social identities of the individuals involved. New approaches allow the material to be reintegrated into its historical contexts and the individuals to be understood once again as lived members of their communities and societies.

We perform radiocarbon dating (Uusitalo et al. 2022) of individuals recovered from the various burial grounds around Finland as well as from the church of Pälkäne. These analyses provide chronological information about both the periods during which the sites were in use and the lifespans of the individuals themselves. At Pälkäne, radiocarbon dating is particularly crucial, as the church served as a burial place from the 13th to the 19th century (Nordfors et al. 2025) and remains recovered from the same site

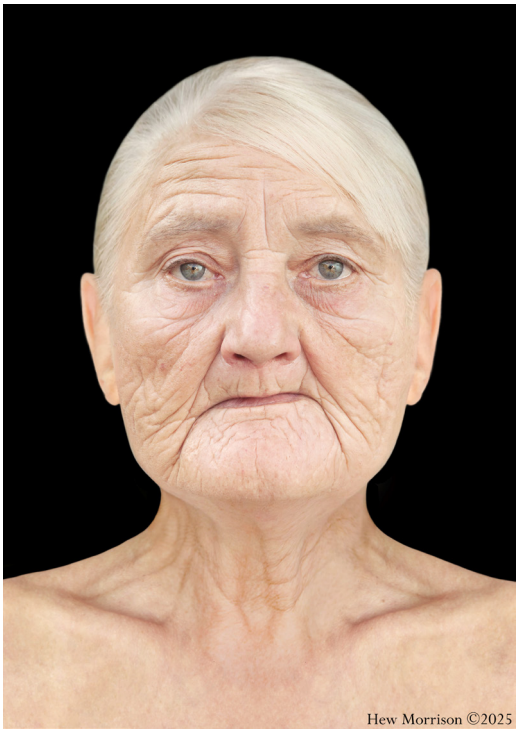

Figure 3. A facial reconstruction of an elderly female V168. The reconstruction work is done by a forensic artist, and it forms part of our broader effort to reconstruct the life histories of these individuals. Picture: H. Morrison.

may therefore originate from markedly different centuries. However, because several individuals likely date to the historical period - during which the atmospheric radiocarbon content has greatly varied - their radiocarbon results may produce broad ranges spanning through the past few centuries. To obtain greater precision, we analyze multiple tissue types, such as teeth and different cranial bones, from the same individual to leverage their different years of formation.

Various other methods allow us to investigate the lifestyle, health, and disease of these individuals. Osteological analysis provides information on health conditions and behaviours even when only the skull is preserved. Teeth and bones may show for example signs of nutritional deficiencies in childhood or adulthood, infections, or healed trauma, and dental wear can indicate certain habits, for example, pipe smoking (e.g., Scott 2018).

Using DNA and proteomic methods, we also investigate pathogens and oral microbiome, whose species provide indicators of general health (Warinner et al. 2015; Hendy 2021). The presence of bacteria, viruses, and protozoa offers evidence of living conditions, interpersonal contacts (infectious diseases), environment, and hygiene. Parasites transmitted via animals or between humans further illuminate hygiene practices and the role of domestic animals in daily life (Søe et al. 2018; Tams et al. 2018). We also examine whether individuals carried chromosomal aneuploidies, such as Down syndrome (Rohrlach et al. 2024), Finnish Disease Heritage mutations (Norio 2003), or other known disease-associated variants. Ancient DNA also reveals inherited phenotypic traits such as hair and eye colour, which can be incorporated into facial reconstructions that we produce for public engagement (Fig. 3).

Stable isotope analysis of carbon and nitrogen contributes information on the diets (Makarewicz & Sealy 2015) and can also reveal breastfeeding histories by indicating the age at which individuals transitioned from breast milk to solid foods (Jay 2009). Dietary reconstruction is further refined through palaeoproteomics, as dental calculus can preserve proteins from milk, fish, and meat (Warinner et al. 2022).

Historical records form a key component of our contextual work. Parish registers provide information on the life courses of named individuals and their families, while court records at district, appellate, and senate levels contain details about the imprisonment and deaths of those held at Sveaborg. The burial sites excavated by Retzius in 1873 are reviewed using published accounts, the expedition diary found in 2022, and supplementary oral histories and local folklore. Together, these sources allow us to situate each find within its broader historical and archaeological setting, both as community members in life and as burial sites in a landscape. (See Fig.4 for a visual representation of KAROL's multidisciplinary workflow.)

New knowledge on historical communities and populations

A total of 42 skulls in the assemblage originate from Pälkäne, where we have previously analysed DNA data from 21 individuals recovered from archaeological excavations.

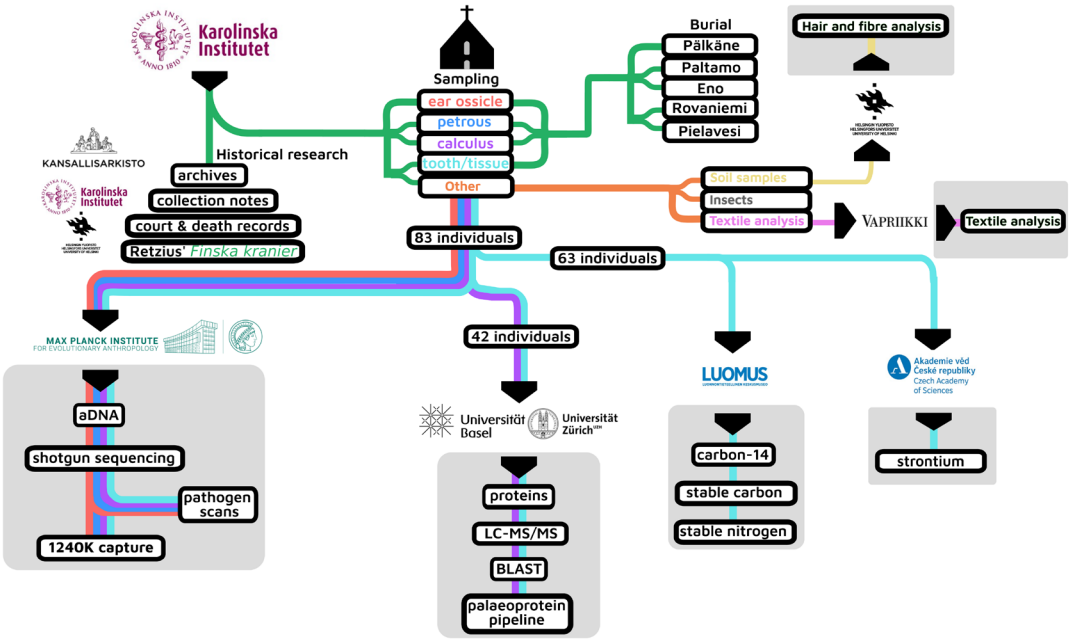

Figure 4. Tubemap diagram of the KAROL project's multidisciplinary workflow. The movement of skulls, ear ossicles, petrous bones, calculus samples, and tooth/other tissue is indicated by green, orange, blue, purple, and cyan tubes, respectively. The institutions where laboratory work is conducted are indicated by their respective logos.

Together, these 63 individuals constitute one of the largest bioarchaeological datasets from the same locality currently available from Finland. This assemblage allows us to assess the size of the Pälkäne population, patterns of kinship and mobility, and the community's connections to surrounding regions. In addition to the Pälkäne individuals, the collection includes people with known places of origin from Pielavesi, Rautalampi, Kiuruvesi, Paltamo, and Eno (15 individuals in total). These are especially important because central and eastern Finland have been underrepresented in Finnish ancient DNA research. Their inclusion enables more detailed investigation of the long-recognised east–west genetic, linguistic, and cultural divide in Finland (Salmela et al. 2008; Kerminen et al. 2017). This divide is also reflected in the distribution of common disease-associated genetic variants: for instance, the higher incidence of coronary artery disease in Eastern Finland is at least partially driven by genetic factors (Kerminen et al. 2019). Moreover, many rare disorders belonging to the Finnish Disease Heritage (FDH) (Norio 2003) have geographically restricted distributions in eastern Finland, shaped by post-medieval migration and demographic bottlenecks.

Taken together, the dataset offers an exceptional cross-section of Finland's population in the historical period, including individuals from varied social and geographic backgrounds. Prisoners, for example, represent a very different social milieu from the Pälkäne parishioners buried within the church, enabling concrete comparisons of differences in everyday conditions and lived experiences. The material also opens perspectives onto broader historical phenomena, including 19th-century prison life and potential regional differences in dietary practices.

A concrete connection to the present and descendants

The return of the collection has prompted many people to wonder whether the skulls might include their distant relatives. It is likely that many of these individuals have living direct descendants or more distant kin today. Although genetic relatedness cannot always be verified beyond six generations using DNA alone (Salmela 2025),

surviving genetic connections may nevertheless provide a valuable resource for those engaged in genetic genealogy. For many, exploring such connections carries emotional significance, as it links them to past generations, places of origin, and broader familial networks.

In accordance with standard practice in ancient DNA research, the genomic data generated by the project will generally be made publicly available alongside the scientific publications, which in principle enables comparison with raw data generated by commercial genetic testing services. In practice, however, such comparisons require technical expertise. Commercial platforms also often utilise published ancient DNA data in their services, but they lack methodological transparency and often offer only vague and sometimes misleading interpretations of genetic relationships between ancient and living individuals. Furthermore, these international services rarely, if ever, take into account population-specific factors, such as the high background relatedness of the Finnish population. Owing to the high level of public interest, our project will seek to develop an accessible tool that allows users of commercial DNA tests to compare their data with that of the individuals we have analysed, providing scientifically informed insights into their own genetic roots.

Ethical considerations

A central priority of the project is to ensure that all individuals in the assemblage are treated with dignity and respect. This commitment raises a number of complex ethical questions that have no straightforward answers: where should the boundary of privacy be drawn for people who can no longer speak for themselves; how can we avoid exploiting the human histories represented by the remains; and to what extent do we have the right to act as interpreters of these individuals' lives (see, e.g., Tarlow 2006; 2012; Henderson & Cardoso 2018; Squires et al. 2022)? Our material also includes individuals who are known by name, as well as prisoners, so we must exercise careful judgement before releasing data and results (see Tarlow 2023).

Also, questions surrounding facial reconstruction (see e.g., Johnson 2016, Møllegaard 2025) require considerations, and we continually assess whether producing reconstructions, especially of prisoners, can be justified ethically. Within the project, we also consider the ethical implications of preserving 3D models of the skulls. Questions arise regarding where such digital representations should be archived, who should have access to them, and for what purposes they may be used (see Smith & Hirst 2019; Bohling 2025).

An additional ethical consideration concerns the possibility that some skulls may not originate from Finland. The histories of old anatomical collections may be fragmentary, and misattributions are not uncommon (Harmon 2018; Carmack et al. 2024). Should any individual prove to be non-Finnish, we would reassess our responsibilities accordingly, including questions of appropriate consultation and potential return.

We place particular emphasis on transparency and responsibility throughout the research process. The progress of the project and the reasoning behind our decisions are communicated openly on the project's Facebook page (https://www.facebook.com/profile.php?id=61570485848880) and in public lectures. We also collaborate closely with Museum Centre Vapriikki and several regional museums, which may incorporate our findings into their exhibition work. Ultimately, our aim is to advance scientific knowledge while ensuring that our work honors the deceased and contributes to a respectful and meaningful engagement with the past.

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