# ARCHAEOLOGY AND CONSERVATION ALONG THE SILK ROAD

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böhlau



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# Archaeology and Conservation along the Silk Road

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# Preface – University of Applied Arts Vienna

Initiated and supported by the Eurasia Pacific Uninet (EPU), the Second International Conference on "Archaeology and Conservation along the Silk Road" was held on May 20–22, 2016 in Nanjing, China.

The first conference of this series in May 2014 was organised by the Northwest University in Xi'an; Prof. Liangren Zhang acted as coordinating partner for the Institute of Conservation of the University of Applied Arts Vienna. Soon after the conference Prof. Zhang was appointed to Nanjing University, and subsequently the project moved with him to the megacity in Southern China. In order to facilitate cooperation, Nanjing University became a member of the EPU network in 2015.

With this event it was possible not only to link as many EPU members as possible – university institutes, specializing in archaeology and conservation-restoration, in Austria, China, Mongolia and Central Asia, but also to call in other experts whose research focuses on the Silk Road(s). The University of Applied Arts Vienna was responsible for gathering researchers, especially those from Austrian universities and specialist institutions as speakers at the conference, to deliver a broad spectrum of Silk Road topics. The Institute of Conservation also invited professors and researchers from Dresden, Potsdam, Berlin, Rome and Berne to Nanjing to report on their current projects and dissertations. Prof. Zhang organised the attendance of Chinese colleagues as well as experts from Iran and Russia, where he is currently involved in field projects.

52 participants from China, Austria, Germany, Switzerland, Iran, Russia, Italy and the U.K. as well as the U.S.A. gathered at the 2016 conference. In over 40 lectures a variety of topics were presented, including research into the migration of nomads, the spread of a variety of grains as a basis for human and animal diets, but also bio-archaeological research into the spread of diseases and epidemics between East and West. The reports featuring conservation sciences in artistic technology (the production of glass, tiles and bronze casting), as well as painting techniques were especially fascinating for the conservators, though problems of preservation and conservation of the different sites along the Silk Road were of no lesser interest. The University of Applied Arts Vienna was represented by a lecture on the training of conservators in Austria and a presentation of a pertinent diploma thesis on Ephesos.

Thanks to the financial support from the EPU, 7 Austrian experts from EPU Member Institutions could participate in the conference. The lectures of the Austrian group made distinct contributions to affirming Austria's excellent international reputation in the field of archaeology and conservation and its innovations. The conference also provided invaluable opportunities for exchanging experiences and networking.


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This publication, a compilation of the conference lectures, represents a substantial step towards the expansion of cooperation between Nanjing University and University of Applied Arts Vienna and in a broader context between China and Austria.

I would like to gratefully acknowledge all the colleagues who made their presentations available for the publication. In particular, I would like to thank my colleague Tanushree Gupta who has undertaken the editing of the conference papers. Martina Haselberger deserves my thanks for her collaboration in the organisation of the conference. I am grateful to Sabine Ladstätter, Director of the Austrian Archaeological Institute (ÖAI), for her assistance in putting together the conference programme and for sharing her expert contacts. I thank my colleague and friend Liangren Zhang for his splendid collaboration over the course of many years. I look forward to our next joint Silk Road conference, which will be held in Iran in 2018!

Gabriela Krist
Vienna, April 2018


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# Preface – Nanjing University

Coined by Ferdinand von Richthofen, the term Silk Road has become a handy concept for scholars who attempt to deal with the trans-continental cultural movements between Europe and Asia. Although much has been achieved in the field of history, archaeology and art history, a lot of potential of this concept remains to be explored. The One Belt - "The Silk Road Economic Belt" and One Road - "the 21st-century Maritime Silk Road" initiatives advocated by the Chinese government since 2013, albeit ignoring the historical complexity, appears to be a well-thought-out exploit of the historical Silk Road to address the contemporary political and economic challenges. The initiatives, in return, have instigated Chinese research institutions, which have long shied away from the foreign land, to start research work in Silk Road countries. In this milieu, Nanjing University has initiated an archaeological field project in Russia and Iran respectively since 2015.

In the same mode, the Eurasia Pacific Uninet (EPU) was found to unite universities of Austria, East Asia, Central Asia, South Asia and the Pacific Region. With a total of 146 member institutions, the network has been fostering joint research centres, inter-institutional research projects, conferences, as well as faculty and student exchange. The timely marriage of the initiative of the former president Brigitte Winklehner and the rising interests of Chinese scholars towards archaeology of foreign countries gave birth to the first "Archaeology and Conservation along the Silk Road" International Conference at Xi'an in May 2014, which was organised by Northwest University and University of Applied Arts Vienna. The success of this conference inspired us, now representing Nanjing University and University of Applied Arts Vienna respectively, to organise the second conference in the series at Nanjing in May 2016.

The second international conference "Archaeology and Conservation along the Silk Road" was planned in such a way that it played out the spirit of the Silk Road in the academic world. On the one hand, the Silk Road has been a popular theme of conferences over the world, yet scholars from many countries, such as Russia and Iran, are under-represented. Seven scholars from Russia and five from Iran presented the steppe Silk Road and the Iranian part of the Silk Road, both of which have often been forgotten in the international conference. On the other hand, archaeologists and conservators, because of the unfortunate separation of the two disciplines, have been sitting in different conferences without communicating with each other. This conference instead brought them together in the hope of providing them with an opportunity to exchange questions and approaches. Although designed as a small conference, 52 scholars from ten countries, including China, Russia, Germany, Austria, and Iran, joined, presenting a variety of subjects.


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For various reasons, the majority of the papers delivered in the conference are not available for publishing. Those included in this volume are 13 articles, which nevertheless speak well for the disciplinary and geographic scopes of this conference. In the field of cross-regional phenomenon, Michaela Binder from the Austrian Institute of Archaeology, employing modern DNA and isotopic analyses, explores into the population migration and plague dissemination in the antiquity of Eurasia. Martin Steskal from the same institution finds the DNA components from Europe, Asia, and Africa among the population of the cemetery at the Roman city of Ephesus in Turkey, which depicts a mixed population in this city. Andreas Heiss from the University of Vienna provides a detailed account of the species and sources of the charcoal found at Ephesus. Peter Jia from University of Sydney, based on starch analysis, narrates the dissemination of wheat from the western Tianshan Mountains into Xinjiang, and further into the other regions of China. Hossein Tofighian from the Iranian Centre for Archaeological Research surveys the torpedo jars, which denote active maritime trade across the Persian Gulf and the Indian Ocean in the Parthian and Sasanian periods. Alexey Tishkin from the Altai State University demonstrates the excavation materials from the Yaloman-II cemetery, which denotes the intimate cultural connection with Han China, regardless the great distance. Kira Samosiuk from the State Hermitage Museum exposes the little-known field drawing and photographs of the Berezovskiy brothers at the "Tajik" Grottoes in the Kucha Oasis in the late 19th century.

As stated above, conservation is another major theme of this conference, and it is well represented in this volume. Birgit Schmidt from the Federal Institute for Materials Research and Testing analyses the fresco fragments cut by German explorers from the Semsim Grottoes in the early 20th century, and attempts to reconstruct the original context of the fresco. Ellen Egel from Berlin State Museum studies the composition and conservation materials of the fresco fragments cut away also by German explorers, and discovers the different sources of pigments. Zhou Shuanglin from Peking University examines the material, production techniques, and conservation problems of the gold-coated silverwares from a Tubo-period cemetery in Dulan County, Qinghai Province. Steffen Laue from the Potsdam University of Applied Sciences describes his conservation work on the mausoleum Ishrat-Khana in Samarkand, where he discovers some unique local techniques, such as "Gansch" plastering and "Kundal" gilded relief. Marisa Laurenzi Tabasso from University of Rome and honorary professor at University of Applied Arts Vienna has been conserving the rock structures of Persepolis and finds white or gray coating on them. Barbara Rankl from the University of Applied Arts Vienna presents a conservation program of the stone sarcophagus discovered at the cemetery of Ephesus.


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The organisation of this conference and the publication of this volume cannot be possible without support from various institutions and individuals. In a time of shrinking funding and tightening schedule, we owe our gratitude to all the colleagues who were willing to sacrifice funding and time to attend this conference; to the volunteers who ensured the successful delivery of the event; to Nanjing University for providing funding; to the EPU for paying the travel expenses of the European participants; to Martina Haselberger from University of Applied Arts Vienna for her assistance in the organisation of the conference; to Sabine Ladstätter for her assistance in assembling the conference program and for sharing her expert contacts. The publishing of papers of such diverse disciplines and academic traditions presents a tremendous challenge to the editors. We would like to gratefully acknowledge all the colleagues who made their presentations available for the publication. We would like to thank Tanushree Gupta from University of Applied Arts Vienna for editing the papers of this volume.

Liangren Zhang
Nanjing, July 2017


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# Plagues and Peoples[1] – a Bioarchaeological Perspective on Trade Routes

MICHAELA BINDER

ABSTRACT: Movement and transport along transcontinental trade routes can influence populations and settlements along its course in a wide range of ways. It is inherently connected with mobility and migration of individuals or groups which aside from goods can also carry new diseases. These processes can have considerable impact on cultural, social, political and biological developments along the routes. They, therefore, represent key elements of studies seeking to elucidate the history and dynamics of trade routes. Through the integration of modern scientific methods such as stable isotope and ancient DNA (aDNA)-analysis, skeletal human remains from archaeological sites represent an important source of information that can help shedding light on the origin of people(s) and population affinities but also the presence of diseases. This paper will discuss the possibilities of modern bioarchaeological research in contributing to the comprehensive study of ancient trade routes. It will introduce the methods available to study mobility, migration, mortality and morbidity in past human populations and set them within the research context of the wider Silk Road region and trade routes in general.

KEYWORDS: Bioarchaeology, Palaeopathology, Biomolecular Archaeology, Migration

## INTRODUCTION

The purpose of transcontinental trade routes is movement, an activity that can involve different things that move or are moved – the movement of goods, people, ideas, religions, and concepts, but also of pathogenous agents. This can have a significant impact on the communities settling along their courses, whether in the form of population structure, ethnic or cultural identity, material wealth or health. Investigating these processes in history can be based on a wide range of sources including historic records, material culture or architecture. This contribution will discuss how the scientific study of human remains from archaeological sites, aided by novel biomolecular methods can be used to inform historic and archaeological research into how trade, travel, migration

1 Title in reference to McNeill 1998


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and warfare along the routes of the Silk Road impacted health, living conditions as well as population structure of the groups settling along their course.

## HUMAN REMAINS AS A SOURCE OF INFORMATION ABOUT LIFE IN THE PAST

Human remains represent one of our most direct sources of information about life in past human populations because the skeleton stores considerable information about the identity of a person such as biological sex, age-at-death, health and disease, diet, place of origin, activity but also genetic relationships.[2] With new scientific techniques, such as stable isotope analysis or aDNA-analysis, skeletons and mummies from archaeological sites allow for increasingly detailed insights into many aspects of the life of past human populations such as living conditions, subsistence strategies but also determining the focus of this contribution: the presence of diseases, origin and relationships of and between populations in the past. Archaeological research in the Silk Road region can draw upon a remarkably rich record of human remains, including large collections of skeletons but also due to very dry environmental conditions, groups of well-preserved mummies (Fig. 1). Nevertheless, human remains are still vastly under-used as a resource to study how movement along the Silk Road impacted the life of the populations settling within its realm of influence. This is partially also due to the fact that bioarchaeology as a subject is not very well established and the necessary laboratory facilities are not available in the main countries of the silk road. Thus, research mainly has to rely on collaborations with institutions in Europe or the US. Using selected examples of current bioarchaeological research on human remains from the silk road region,

Figure 1 "The Beauty of Xiaohe". Photo: Matt Rourke / AP / picturedesk.com.

2 E.g. Larsen 2015


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this contribution aims to showcase the vast potential held by human remains as a source of information on life of past human populations, focussing on two major themes of Silk Road research – the movement of people(s) as well as the movement of plagues.

## MOVEMENT OF PEOPLE(S)

Throughout the time period of its existence, the silk roads enabled and attracted movement of people both on an individual level in form of traders, pilgrims, scholars or other kinds of travellers but also on a larger scale in form of nomadic tribes or conquering armies such as the Xiongnu or the Mongols.[3] All these people(s) would have significantly influenced the population structure of the regions which they crossed and where they ultimately settled. The impact of these migrations and movements is still well visible in the genetic make-up of many areas along the Silk Road.[4] However, in many areas still very little is known about the origins and history of settlement dynamics that led to the modern population structure. Human remains from archaeological sites could be used to shed light on these questions.

## TRACING MIGRATION AND POPULATION HISTORY IN THE BIOARCHAEOLOGICAL RECORD

The human skeleton contains a record of both genetic and geological information that allows for inferences about long- and short-term relationships but also the geographical origin of an individual. It, therefore, provides a valuable source of data to study kinship, population history, mobility and migration in the past. The bioarchaeological tool kit offers a sophisticated set of traditional and biomolecular methods that allow for increasingly detailed and high-resolution insights into these processes.

The relationship between individuals and populations represent one of the most traditional research themes in the field of studying human remains from archaeological sites. Inspired by the then thriving field of evolutionary biology, scientists already started in the 19th century to use metric analysis of the shape of the skull and to a lesser degree also bones of the post-cranial skeleton to infer individual and population affinities.[5] In addition, so-called non-metric traits, non-pathological anatomic variants of morphological features in the skeleton and teeth were soon recognized as a marker of the biological relationship between individuals and groups and integrated into the methodological canon of physical anthropology. Both approaches are based on the premise that the mor-

3 E.g. Romgard 2008; Hansen 2012
4 E.g. Comas et al. 1998
5 Pietrusewsky 2008


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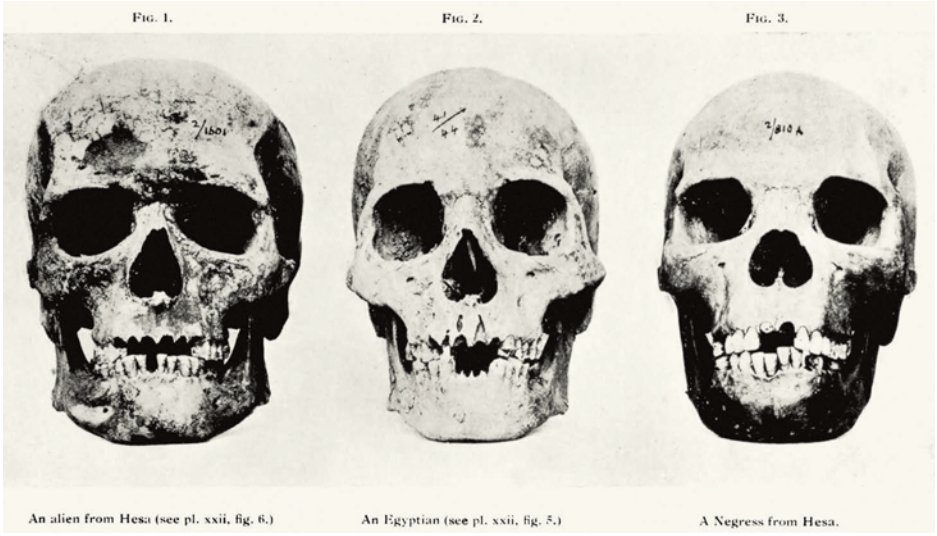


Figure 2 Different skull shapes supposedly identifying different population affinities. Image: M. Binder, reproduced after Smith & Jones 1910, Pl. XXV.

phology and shape of the skull, teeth or long bones reflect the genetic background of an individual (Fig. 2). Similar appearances, therefore, indicate relatedness while differences between individuals and diachronic changes occurring within a population are explained through the presence of non-local individuals.

However, the scientific value and validity of inferences about population history based on morphological and morphometric studies have been increasingly called into question in recent decades.[6] This is largely due to the recognition that despite a general heritability, both metric and non-metric traits can also be influenced by non-genetic parameters such as environmental factors or muscular activity during mastication.[7] In addition to these extrinsic factors, genetic processes like gene drift, alterations in the genetic pool of a population caused by random mutation rather than external genetic input can lead to significant changes in skeletal morphology of an individual. Consequently, due to a large variety of underlying factors causing many of the morphological traits traditionally used in population history studies, their heritability remains imprecisely understood.[8]

Therefore, despite significant improvements in the methodologies applied in quantitative studies of population history over the past decades, both what regards acquisition of data as well as statistical processing, moving from simple uni- and bi-variate statistics and

6 Ibid.
7 Carson 2006
8 Hughes and Townsend 2013


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indices to complex multi-variate analyses, the results of these studies, now referred to as biodistance studies, remain problematic due to the complex background of many of the observed parameters.[9]

In recent years, the introduction of new biomolecular methods has opened new pathways in the study of the population history of past human populations based on human remains. The most widely used new method is the analysis of stable strontium isotopes from bone and teeth.[10] The ratio of the strontium isotopes, $Sr^{87}/Sr^{86}$,varies between different types of underlying bedrock. These values are reflected in the Sr-content in water and, through ingestion by animals and people, consecutively also incorporated into bone and teeth.[11] In theory, this principle allows for the detection of the geographic region of origin of a person. However, several caveats limit the value of the results. In the human skeleton, Sr-isotopes are found in the mineral portion of bone and teeth. In teeth, they are only incorporated during childhood when the tooth enamel is forming and, therefore, only reflect the place of residence of a person during childhood. Bone, on the other hand, undergoes constant remodelling and consequently only stores the isotope signatures of the past ten years prior to death, but, on the other hand, is considerably more prone to diagenetic contamination. The second major issue is related to the fact that many geographical regions around the world share a similar geological background and, therefore, produce very similar strontium signatures.[12] Moreover, geological zones are often relatively large, thus, providing rather unspecific results what regards the place of origin of a person. As a consequence, Sr-isotopes in skeletal human remains only allow for a distinction between local versus non-local individuals but cannot be used to identify the exact origin of a person. Nevertheless, they represent a useful tool to gain some insights into mobility and migration in past human populations.

New momentum in bioarchaeological studies addressing population history was gained with the introduction of scientific methods allowing for the detection and analysis of remnants of genetic information preserved in bones, teeth and soft tissue of archaeological human remains.[13] With our genes storing information about our ancestry ranging from immediate parents back in time to the phylogeny of our species, they allow for detailed insights into a wide range of parameters such as kinship, migratory patterns, and wider population history. The majority of studies investigating aDNA have used the DNA present in the mitochondria which are located in the cytoplasm and produce

9 Larsen 2015: 361
10 Katzenberg 2008; Brown and Brown 2011
11 Bentley 2006
12 Katzenberg 2008
13 Stone 2008; Brandt et al. 2013


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energy for the cells.[14] Mitochondrial DNA (mtDNA) has several advantages. It is present in a high number of copies in each cell and is, therefore, more likely to survive over time than nuclear DNA. Moreover, due to the fact that mtDNA is only inherited from the mother, has a higher rate of mutation, and does not recombine, it is particularly useful for analyses of population genetics even though it only allows for inferences about the female line of ancestry. With increasingly sophisticated analytical techniques, researchers have started also to turn more attention to the study of DNA from the nucleus of the cell which is far more difficult to detect because it is only present in one copy per cell. It holds a large number of different loci yielding information about relationships between populations and individuals, but of course also sex, phenotype or alleles leading to diseases. Nuclear DNA is inherited from both parents, recombination in each generation results in a mosaic of DNA from all ancestors.

Survival of DNA in archaeological human remains is variable and highly dependent on environmental conditions.[15] While cooler temperatures, low humidity and neutral to alkaline soils act favorably for the preservation of the biomolecules carrying genetic information; heat, water and high acidity, all lead to their rapid degradation. In addition, DNA is prone to contamination by modern materials even though modern techniques such as next-generation sequencing allow for better differentiation between original and intrusive material.

## Movement of people(s) in the Silk Road region

Through millennia of travel, trade, and migration, the entire Silk Road region experienced a highly complex population history.[16] Despite a vast amount of written and archaeological sources of considerable time depth, many questions are still remaining. Theories and models of migration and settlement dynamics have so far largely been based on written sources, material culture or linguistics despite it is now generally recognised that there are a large number of problems inherent to these parameters potentially leading to erroneous inferences about population history. Despite some exceptions,[17] human remains representing direct evidence so far remain a vastly under-used resource in Silk Road archaeology. In the following, I will discuss a number of studies highlighting the potential of bioarchaeological research to shed light on many important aspects of movement of people(s) along the Silk Roads.

14 Stone 2008
15 Ibid.
16 E.g. Comas et al. 1998
17 E.g. Kuzmina 1998; Kuzmina and Mair 2007


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One notable example is a set of studies carried out on the mummified remains of the Tarim Basin.[18] Dating to the 3rd and 2nd millennia BC, these have become widely known for their morphological resemblance to European populations despite their origin deep in the Central Asian plains.[19] Based on the archaeological and anthropological evidence including funerary ritual, aspects of material culture and craniometric studies, two main theories had been brought forward to explain the European feature of the Tarim basin inhabitants.[20] One hypothesis suggests that the earliest settlers of this part of Asia were nomadic herders from the steppes of Russia and Kazakhstan, while the other suggests that people came first from the oases of Baktria, or modern Uzbekistan, Afghanistan, and Turkmenistan. In order to clarify the genetic heritage and ancestry, skeletal and mummified human remains from several sites in the region were subjected to aDNA-analysis,[21] most recently Li and co-workers[22] studied the cemetery of Xiaohe. The results of this new study revealed multiple lineages of mtDNA, indicating a complex settlement history of the Tarim Basin. In the earliest layers, the main component was a lineage originating in Siberia as well as a contribution from Western European populations. This confirmed to the original steppe hypothesis with close genetic ties to the Russian/ Kazakh plains. Only during the later period, a small signal of a Southern Asian lineage was detected, indicating a small amount of gene influx from the oases of Bactria as well.

Another area of research exemplifying how archaeological human remains can be used to elucidate the population history of the Silk Road region are burials related to Xiongnu, the confederation of nomadic tribes which ruled over large parts of Central and Northern Asia between the 3rd century BC and the late 1st century AD.[23] In posing a major opponent to the Han Chinese involved in frequent raids and battles, the impact of Xiongnu is reflected in a large number of written documents of the Chinese. Nevertheless, their origin and relationships to other peoples in Europe and Asia remained unclear until recently. Studies using both traditional, morphological approaches[24]and aDNA-analysis[25] on skeletal human remains revealed a heterogenous mixture of genetic affiliations including North-East Asian tribes but also with influences of Siberian, Turkic and Indo-European tribes. In addition, these analyses were used to address questions of

18 E.g. Cui et al. 2009; Li et al. 2010; Li et al. 2015
19 E.g. Mallory and Mair 2000
20 Mair 2005; Hemphill and Mallory 2004; Barber 1998; Han 1998; Kuzmina 1998
21 Cui et al. 2009; Li et al. 2010
22 Li et al. 2015
23 Higham 2004: 390–392
24 Non-metric traits: Ricaut et al. 2010
25 Keyser-Tracqui, Crubézy, and Ludes 2003; Keyser-Tracqui et al. 2006; Kim et al. 2010


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kinship patterns and social organisation within Xiongnu cemeteries.[26] The results suggest burial of family groups within close vicinity of each other.

## MOVEMENT OF PLAGUES

Travellers along the Silk Road not only carried goods or knowledge but in many cases they were also accompanied by pathogens which people or animals were infected with and, thus, led to the spread of a wide variety of infectious diseases between Asia and Europe. The effect of the movement of pathogenous agents could be devastating particularly because of the fact that they were carried to populations which had never been exposed to them before and, therefore, lacked any immunity to fight the disease.[27] This is based on the evolutionary principle that if a population is exposed to a pathogen over many generations, the immune system develops resistance and the population gets less vulnerable to the disease. If in contrast, an individual or population is exposed to an unfamiliar pathogen, they are much more likely to contract the disease or succumb from it.

Based on historic records, the transmission and spread of several diseases are famously connected to movement along the Silk Roads, first and foremost the plague but also measles, smallpox, anthrax, and leprosy.[28] According to these documents, some of them had a devastating impact on populations on both ends of the Silk Road and consequently on major historic developments.

However, historic records are not necessarily the most trustworthy sources, particularly what regards the diagnosis of diseases because, of course, the diseases as we know them today were only named and defined during the late 19th or early 20th century. Even though medical descriptions of Chinese or Roman physicians are often very detailed and thorough, they often do not allow for exact identification of a disease. Consequently, many factors about the origin, evolution, identity and spread of many plagues remain unknown.

26 Keyser-Tracqui, Crubézy, and Ludes 2003

27 McNeill 1998: 192

28 Monot et al. 2009; Schmid et al. 2015; Simonson et al. 2009


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## TRACING DISEASES IN THE BIOARCHAEOLOGICAL RECORD

Similar to the place of origin and genetic heritage, skeletal or mummified human remains can also preserve information about the diseases a person once suffered from. Again, several different methods are available to specialists working in the field of palaeopathology, the study of diseases in the past. The most common method relies on the fact that many pathological conditions can also leave an imprint in the skeleton.[29] Depending on the underlying disease there are generally four different forms of how bone can respond to a disease:

– new bone formation (by far the most common form): infectious diseases, nutritional deficiencies, neoplastic diseases, vascular diseases, trauma (Fig. 3)
– bone destruction: infectious diseases, neoplastic diseases
– abnormal formation of shape: nutritional/metabolic diseases, developmental disorders
– abnormality in size: developmental disorders

Figure 3 New bone formation on the shin bone. Photo: M. Binder/OEAI-OEAW.

Unfortunately, studying diseases based on morphological changes in skeletal and mummified human remains is very complex and is faced with a number of problems inherent to methodology and physiology.[30] The skeleton is generally very slow to react to a disease process and, therefore, only long-standing, chronic processes will lead to bone changes.[31] The development of a bone response further pre-supposes a certain degree of strength and resilience of the diseased individual. Otherwise, it will die before any signs in the skeleton develop. Moreover, the skeleton has only very limited ways to respond

29 Ortner 2003; Ortner 2011
30 Ortner 2011
31 Ortner 2003: 110


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