Frozen Samples
8 DNA from Arctic Human Burials

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1. Introduction

The climate of Arctic and Alpine areas should facilitate the recovery of DNA from human and animal remains. A priori, one would expect postmortem processes as well as subsequent microbial decomposition to be affected favorably by the low temperatures and the low humidity characteristic of these areas. In this chapter we will discuss this assumption and describe some finds of frozen remains.

Immediate postmortem change is essentially a process of competition between decay and desiccation; external factors such as temperature and humidity largely determine the outcome of this contest (Aufderheide 1981). Freezing, alone or in combination with sublimation (freeze-drying), is potentially ideal for the conservation of soft tissue; but in reality the situation is often complicated by the exposure of the tissue to repeated freeze-thaw cycles (Micozzi 1986). Brain tissue has been found to be preserved by the formation of adipocere (cf. Hauswirth et al. Chapter 7). This process was first thought to be favored by an aqueous environment and the presence of alkali, but is now thought to occur by postmortem hydrolysis of body fats and has been observed under relatively dry conditions (Micozzi 1991). Freezing, freeze-drying, and adipocere formation are examples of processes that should facilitate studies of ancient DNA (aDNA) in Arctic and Alpine areas. One should note, however, that virtually nothing is known about the fate of the endogenous DNA during these processes.

A quite different factor that affects the prospects of DNA studies is the actual availability of finds. In the Arctic, finds are sporadic and the recovery of ancient material is often hampered by practical problems. The many different kinds of finds range from surface samples consisting of single bones to well-preserved mummified bodies found in rock caves and to even better conserved bodies captured in permanently frozen layers. The following survey includes some of the more spectacular finds from Arctic and Alpine areas. The idea is to exemplify the types of finds available to DNA studies rather than to provide an exhaustive list.
Outside permafrosted layers, surface finds of ancient human remains are few and generally disturbed by exposure to harsh weather conditions and animals. Most finds consist of a single bone or highly disturbed skeletal remains. At the other extreme, a few complete, naturally mummified bodies have been found in protected rock shelters or stone graves where local conditions of low temperature and low humidity have desiccated the bodies and stopped the postmortem as well as microbial decomposition processes. In some cases, soft tissues are preserved to such extent that pathological examination of the body is possible. Finds of naturally mummified Eskimos have been reviewed by Hart Hansen (1989). Most of these mummies are probably only a few hundred years old.

Artificial mummification is not known from the eastern Arctic, but has been practiced by the inhabitants of the west coast of Alaska and the Aleutian Islands. A few mummies from this region have been subjected to investigations (Zimmerman et al. 1971, 1981). Artificial mummies as well as naturally mummified humans are known to have also been found in the Andes, and a few of them have been subjected to DNA analysis (Pääbo 1986; Rogan and Salvo 1990, cf. also Chapter 12).

Permanently frozen bodies can be recovered from burials in permafrosted layers and from glaciers. Burials found so far in permafrosted layers are mainly Christian and located at settlements and camps such as those founded by the Norse in Greenland and by whalers in many places in the circumpolar region. Skeletal remains from a 17th/18th century Dutch whaler station on Spitsbergen have been subjected to DNA studies (Hummel and Herrmann 1991). At least on one occasion a well-preserved body in a burial has been reported from an Arctic expedition (Horne 1980). There has also been a report of an accidental burial in permafrosted layers: in 1970, an extremely well-preserved 1,600-year-old female Eskimo body was found at a beach on St. Lawrence Island, washed out of the bankside. It had probably been trapped by a landslide or an earthquake (Zimmerman and Smith 1975). Soft tissue preservation due to freezing has been observed in Scythian burials from Middle Eastern permafrosted zones (Artamonov 1965) and from the Altai Mountains of Siberia (Rudenko 1970). Animal remains have also been found in permafrosted layers. Most spectacular is the finding of several frozen, 40,000-year-old woolly mammoths (Mammuthus primigenius) in the Siberian tundra. These mammoths are well preserved, and specific proteins (albumin, Prager et al. 1980) and DNA sequences (the work of R. Higuchi, cf. Cherfas 1991) have been studied.

From time to time, human bodies are uncovered from permanent ice. A group of people known as "the frozen family" was killed in their winter house by overriding sea ice in Barrow, Alaska, around A.D. 1500. This Eskimo family was found in 1982 and has been subjected to interdisciplinary studies (Newell 1984). In 1991, the frozen corpse of a man appeared in a glacier in the Ötztaler Alpen mountains. The body of the man, nicknamed Ötze, has been radiocarbon dated to the Late Neolithic, between 4,600 and 4,800 years