

Articoli/Articles

**PALEOPATHOLOGY OF THE COPPER AGE MUMMY  
FROM THE VAL SENALES GLACIER**

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**SUMMARY**

*The unique conditions of preservation of the Copper age mummy found in the Val Senales glacier permit to analyze the general state of health of a man of the late European prehistory. Investigations conducted within the organizational framework of an International Research Project revealed the presence of a series of alterations, that, in a broad sense, can be considered of paleopathological interest. These can be classified as: 1) post mortem lesions, including scalp erosion, alopecia, soft tissue loss in the right gluteal region, right coxo-femoral disarticulation, right sacro-iliac dislocation; 2) lesions that occurred intra vitam, including tattooings, dental wear, trichorrexia nodosa, nail hypoplasia, moderate osteoarthritis of the lumbar vertebral column and of the coxo-femoral joints, tibio-tarsal osteosclerosis. The paleopathological analysis of this unique mummy sheds vivid light on the mutual interactions between disease, environment, and culture, that shaped human life in a distant past.*

Parole chiave/key words: Mummy - Copper Age - Paleopathology - Tattooings

## Introduction

The antiseptic, dry and cold environmental conditions of high altitudes facilitate the natural mummification of corpses. Long term preservation may then be achieved if the mummified body is sealed under ice.

This notwithstanding, findings of ancient human mummies in mountain glaciers are extremely rare. Natural mummies of Inca sacrificial victims have been found in the Pichu-Pichu, Aconcagua and el Toro mountains of the Andes, and ancient Eskimo mummies have been recovered in Greenland<sup>1, 2</sup>. However, even though Alpine passes were certainly and repeatedly crossed by early Europeans, no ancient mummified human remains had been discovered in Europe up to 1991, when the sensational finding of a human mummy was reported from the



Fig. 1. - The Val Senales mummy emerging from melting ice. The photograph was taken during recovery.

locality designated Hauslabjoch or Val Senales, in the Italian Eastern Alps, near the Austrian-Italian border. The finding was probably made possible by the extensive retreat of Alpine glaciers occurring in the last few years.

Erika and Helmut Simon, a married couple from Nuremberg, were the authors of the discovery, which occurred at the altitude of 3200 m, in the Similaun glacier, on September 19, 1991. The mummy was officially recovered on September 23 by Prof. Dr. Rainer Henn, from the Department of Forensic Medicine of the University of Innsbruck, Austria (Fig. 1).

The mummified body was associated with several objects of high archeological interest<sup>3</sup>: a long bow, recovered in three pieces, a leather quiver with arrow shafts, some of which equipped with flintstone heads, a bronze ax mounted on a wooden handle, a flint dagger, also mounted with a wooden handle, remains of several leather artifacts, including a girdle bag, leather straps, remains of deer and goat skins, and other elements of garment. The artifact assemblage was typical of the Copper Age<sup>3</sup>. From the point of view of the history of Medicine, it is noteworthy that the collection of objects associated with the mummy included two fruit body fragments of the polypore fungus *Piptoporus betulinus* (birch polypore, *Basidiomycetes*)<sup>3</sup>. These fragments were punched and threaded on a leather strip (Fig. 2). There is no evidence of a use of such fungal fruits as tinder, but it is well known that they produce substances that have an antibiotic effect. Thus, this curious finding may represent a unique document of early medical-spiritual activity.

Radiocarbon dating of the Val Senales mummy was carried out at the Radiocarbon Laboratory of Zurich (Switzerland), using the 14 C-AMS technique. The test yielded an age of 5,300 years BP<sup>4</sup>.

## Characteristics of the Val Senales mummy

The mummy pertains to an adult male, measuring approximately 158-161 cm in height<sup>5</sup>. Based on complete X-ray

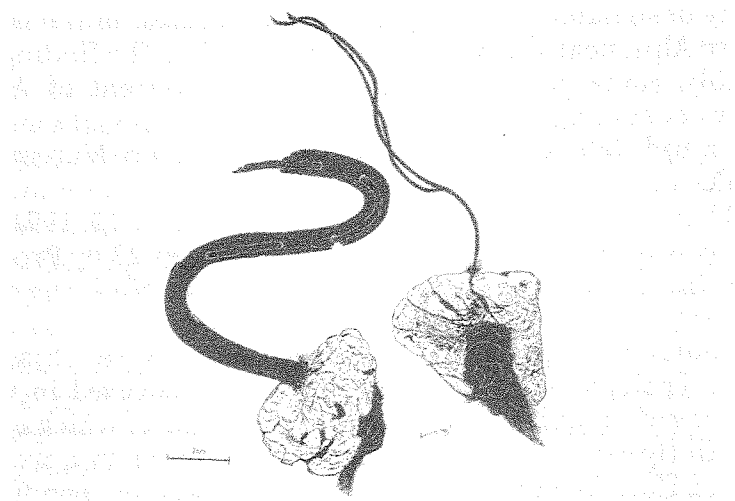


Fig. 2. - Portions of body fruits of *Piptoporus betulinus* threaded on a leather strip, recovered near the mummy.

analysis and computer tomography scans, the skeletal age at death can be estimated between 25 and 40 years. From the anthropological point of view, several morphological characteristics, and particularly the mesocranic index of the skull (Broca's index = 75.8), allow comparisons with anthropological samples of the late Neolithic or Early Bronze Age from Northern Italy, France, and Austria (Seine-Oise-Marne Culture, Horgen Culture, Ligurian Neolithic, Remedello Culture, etc.)<sup>3, 5</sup>. The relatively short stature of the *Ice Man* falls well into the range of statures of Neolithic populations of the Eastern Alpine region.

Normally, relatively recent corpses found in Alpine glaciers are preserved as adipoceres. Thus, their soft parts are transformed into a ceruminous mass. In contrast, notwithstanding the astonishing age, the Val Senales mummy is actually composed of mummified soft tissues, because the body had been dehydrated, and preserved by exposure to intensely cold and

dry air, prior to burial under snow and ice. Therefore, in view of its conditions of preservation, this mummy allows unique opportunities to examine the general state of health and the culturally-induced alterations of a late Prehistoric European man.

In fact, the investigations which have been thus far conducted, within the organizational framework of an International Research Project promoted by the Austrian and Italian Governments, revealed the presence of a series of alterations, that, in a broad sense, can be considered of paleopathological interest. Here, we will attempt to bring about a synthesis of the main findings, which will be presented according to the system involved. A special reference will also be made to the tattooings, that can be viewed as important culturally induced alterations, as well as traces of an early medical-spiritual activity.

#### Paleopathology of the skin and appendages

Microbiological investigations, conducted on the body surface three days after transportation to the Anatomy Department of the University of Innsbruck, revealed a moderate growth of sporiferous Gram- bacteria (*Sarzina* sp.), but no signs of thread or yeast fungi capable of reproduction<sup>6</sup>. Unfortunately, however, these investigations have a limited value, since they were carried out after partial surface disinfection. With regard to arthropod-induced pathology, it is relevant to note that there is no evidence of skin mites (*Sarcoptes* sp.), nor of other ectoparasites. Likewise, the human hair recovered near the mummy results free of lice. The body was not infested with maggots or flies, which is evidence that death occurred in a relatively cold season of the year, under environmental conditions unfavourable to the reproduction of carrion flies<sup>7</sup>.

The mummy (Fig. 3) appears to be completely deprived of scalp hair (alopecia), and scalp tissue is missing from a roughly roundish area, measuring a maximum of about 4 cm in diameter,

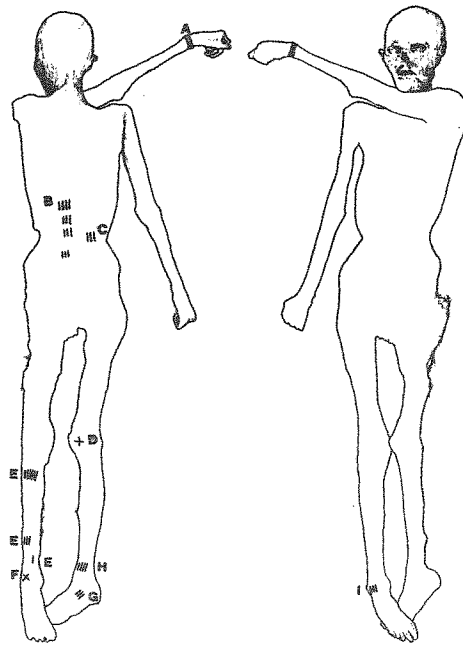


Fig. 3. - Posterior and anterior schematic representations of the Val Senales mummy. Letters refer to tattooings and skin signs.

located on the median skull line, along the sagittal suture, between the vertex and the parieto-occipital suture<sup>8</sup>. The available evidence clearly indicates that this loss of tissue occurred after death: there is no macroscopic sign of perilesional inflammation or hemorrhage, and the contours of the lesion appear irregular and finely indented. Moreover, the radiographic and tomographic examination of the skull does not reveal periosteal reaction<sup>9</sup>. Scalp lesions of this type are relatively frequent in human mummies that were exposed to the open air environment for a length of time. For example, a female mummy recently found in a Peruvian glacier, under environmental conditions of preservation roughly comparable to those of the mummy from Val Senales, reveals a vast area of scalp erosion<sup>1</sup>. The loss of scalp tissue could be related to environmental factors, such as temperature excursions resulting in a

differential volumetric variation of the skull and of the scalp, and/or to the action of scavengers, such as birds, particularly corvids, and small mammals. With regard to alopecia, this phenomenon is commonly observed in human mummies of different origin and antiquity. In some Ancient Egyptian cases, Sandison showed that the absence of scalp hair was related to depilatory practices, or, in some cases, to *bona fide* hippocratic baldness<sup>10</sup>. However, in the vast majority of the cases, alopecia occurred *post mortem*. In the case of the mummy from Val Senales this interpretation is strongly supported by the finding of tufts of human hair with high content of melanin in the area where the body was exposed<sup>11</sup>.

The abundant hair remains recovered from the site of the discovery also originated from deer (*Cervus* sp.), goat (*Capra* sp.), and brown bear (*Ursus arctos*), as determined after careful taxonomic studies based on morphological, chemical, and ultrastructural data<sup>3</sup>. Other mammalian species may also be represented. The human hair, samples of which were still attached to fragments of human skin, were dark brown-black, wavy, and measured up to 9 cm in length (Fig. 4). Most hair was

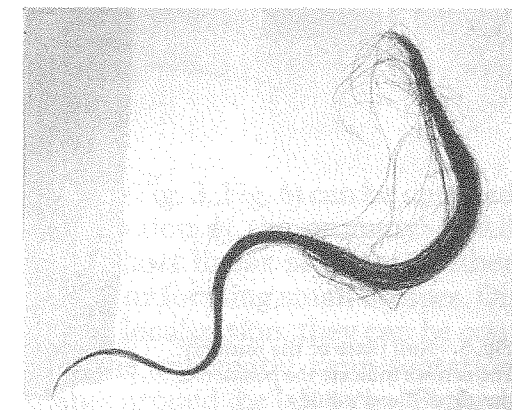


Fig. 4. - Hair tuft belonging to the mummy.

obviously of scalp derivation. Several scalp hair shafts demonstrated the characteristic abnormalities of *trichorrexis nodosa*, both at the initial stage, characterized by local swelling in areas where keratin fibers are partially ruptured, and at the end stage, with irregularly ruptured exposed surfaces<sup>11</sup>. This hair abnormality might have been related to the practice of manipulating and twisting curls of hair. Thus, the presence of *trichorrexis nodosa* could shed some light on the behavior of the Val Senales man.

The mummy had lost the nails of its fingers and toes, which is not uncommon in ancient mummies. However, further archaeological investigations of the site of the finding, carried out in August 1992 by the *Soprintendenza Archeologica di Bolzano*, allowed the recovery of a nail plate (Fig. 5). The morphology and metric measures of this nail plate fall within the fields of variability for the nails of the thumb, forefinger, index finger,

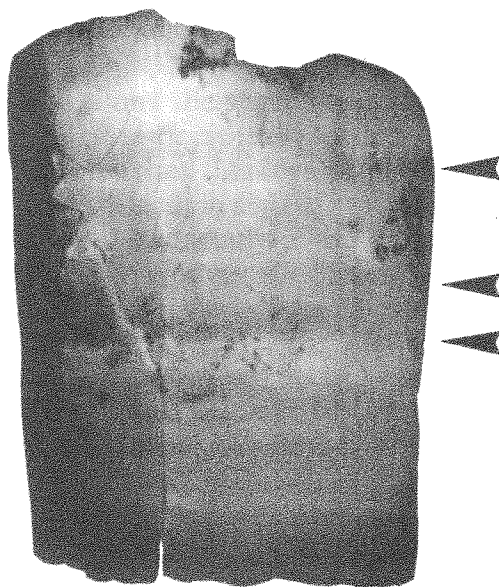


Fig. 5. - Nail plate of the mummy. The arrows indicate the position of the three Beau's lines.

and ring finger of a modern European male having a height between 155 cm and 165 cm<sup>12</sup>. The Val Senales nail plate is important from the paleopathological point of view because it shows three lines of ungueal hypoplasia (*Beau's lines*), most probably indicating three episodes of severe systemic stress, that respectively occurred approximately 4, 3, and 2 months before death (Fig. 5)<sup>12</sup>. These episodes might have been related to infectious diseases, starvation, zinc deficiency, massive hemorrhage, or to other stress-inducing factors. The timing of the events can be deduced from the distance between the proximal margin of the ungueal matrix and the margin of each of the three Beau's lines, taking into account that the average growth rate of hand nail plates is approximately 3 mm per month. In addition to Beau's lines, the gross and microscopic examination of the nail surface shows the presence of microtraces, that may have been caused by traumas due to work activities<sup>12</sup>. These traumatic alterations consist in a loss of substance along the nail's free margin, which can be attributed to flaking (*onychorexis*), and in microgrooves, also of traumatic origin, on the dorsal surface. Amorphous, dark-brown incrustations are distributed along the distal edge of the ventral surface of the nail. Altogether, the aspect of the Val Senales nail plate parallels that of nail plates from modern workers, such as peasants, masons, etc., and indicates that this man made constant use of his nails as working tools<sup>12</sup>.

### Tattooings

Several tattooings and skin signs (Fig. 3, Fig. 6) can be detected upon external macroscopic inspection of the mummy<sup>8, 13</sup>. All are geometric and composed of short linear segments, either aggregated in parallel orientation, or forming small crosses. On the basis of their morphology and localization, they can be conveniently described following the schematic representation shown in Fig. 3A) two parallel lines around the left wrist; B) three



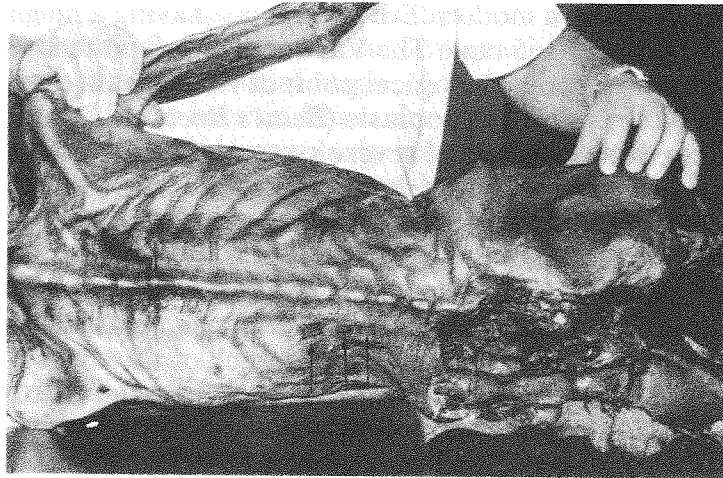


Fig. 6. - Dorsal view of the mummy. The arrows point to the left paravertebral tattoos. The vast loss of soft tissues at the level of the right gluteal region can be readily noticed.

groups, composed of three to four well-defined, parallel linear segments, each measuring about 5 cm in length and 3 mm in thickness, localized in the left paravertebral region, between the first and the third lumbar vertebra, 5 to 8 cm from the median line; C) a group, also composed of three parallel linear segments, to the right of the vertebral column, at the level of the fourth lumbar vertebra; D) a cruciform sign, composed of two intersecting lines, each measuring about 5 cm, localized on the internal aspect of the right knee; E) three groups of linear segments on the left calf of the leg; F) a cruciform sign on the left heel, on the skin overlying the tendo Achillis; G) a group of linear segments on the dorsal aspect of the right foot; H) a group of

linear segments on the right internal malleolar region; I) a similar group of linear segments on the right external malleolar region. The two parallel lines around the wrist should not be considered tattooings, but rather *post mortem* marks, probably caused by tight laces. It should also be considered that other signs might appear after careful examination of the skin with infrared light.

The typically bluish color indicates that all the tattooings were obtained after surface scarification or cauterization, followed by the immission of plant carbon powder in the deep dermis. It is noteworthy the localization in cutaneous regions overlying articulations, with the exception of the group on the left calf of the leg<sup>8, 13</sup>.

The Val Senales tattooings are of particular interest because of their uniqueness, since other primary evidence of this practice is not available for prehistoric Europe. Secondary evidence is found in Neolithic pottery figurines from Butnir (Bosnia), in a geographic and temporal horizon not far from that of the mummy from Val Senales<sup>14</sup>. In historic times, the practice of tattooing by primitive Eurasian tribes is attested by Classic writers. Herodotus, Xenophon, and Pomponius Mela report that tattooings were considered signals of high rank among the Scythians<sup>14</sup>. This is confirmed by the finding of the Scythian mummies of Pazyryk (Altai Mountains, Siberia), also preserved in permafrost and dated to about 400 BC<sup>15</sup>. In fact, these mummies demonstrate complex anthropomorphic and zoomorphic tattooings, clearly revealing their role of body decorations and signals of social status. Tattoos have also been observed on ancient mummies from North America and Greenland. The Quilakitsoq frozen Eskimo mummies from Greenland, dated to approximately 1500 AD, as well as the Alaskan Indian mummies from St. Lawrence island, dated to about 400 AD, have simple facial tattooings<sup>16, 17</sup>. Thus, examples of tattoos recorded on other ancient mummies are situated on highly visible parts of the body, and carry symbolic or communicative significance. In contrast, the Val Senales tattoos were certainly difficult to

see in life, on account of their location on body surfaces most probably covered by clothing during most of the year. Therefore, a function of social signal appears rather unconvincing, while a possible medical-spiritual role should be considered.

According to a recently advanced hypothesis, the Val Senales tattoos could represent evidence of attempts to treat articular pathologies. Surface skin cauterization was recently (and may still be) employed by nomadic Central Asian tribes to cure rheumatic diseases, in particular osteoarthritis, because, according to traditional tribal beliefs, fire may strengthen articulations, making them more resistant to disease<sup>17</sup>. In popular Tibetan medicine, medicinal herbs are burned in contact with the skin to treat articular pain. The treatment of arthritis with skin cauterization is also reported by Aulus Cornelius Celsus in the fourth book of the treatise *De Medicina*, (IV, 29) and it is mentioned in the *Corpus Hippocraticum*, in relation to its use by Scythian tribes. With respect to this literary evidence, it is relevant to note that the human mummy from burial number 2 of Pazyryk, also known as *Prince of the Scythians* for the richness of the funeral offerings and for the complexity of his tattooings, shows a series of small, dot-like tattoos, overlying the tibio-tarsal articulation, and the right and left lumbar paravertebral regions<sup>15, 17</sup>. The topographic correspondence of the dot-like Pazyryk tattooings with the linear tattooings of the Val Senales mummy may indeed support a connection of both with medicinal practices. In the case of the Val Senales mummy, this would also be consistent with the radiologic evidence of lumbar, coxo-femoral, knee joint and tibio-tarsal arthrosis. The tattoos on the calf of the leg could also be explained considering that, under conditions of functional stress, calf leg muscles may undergo painful spastic contracture<sup>17</sup>.

#### Dental wear

The *post mortem* retraction of the perioral soft tissues allows the direct inspection of the occlusal surfaces of the anterior teeth



Fig. 7. - Frontal view of the mummy. The marked retraction of the perioral soft tissues can be readily appreciated.

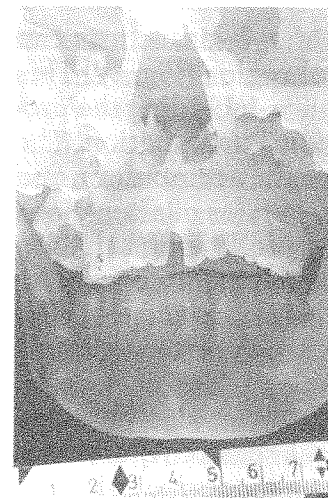


Fig. 8. - This view of the maxillary region, from a computer reconstruction of the cranium of the mummy, permits an evaluation of the degree of dental attrition.

of the upper dental arcade (Fig. 7). In contrast with the age, estimated on the basis of the radiographic study of the skeleton, these teeth demonstrate marked attrition induced wear (Fig. 8), indicated by the exposure of secondary dentine on the occlusal surfaces. Indeed, following the grading system proposed by Passarello<sup>18</sup>, the wear of the central and lateral incisors of the Val Senales mummy can be classified as third grade.

A wear of the anterior occlusal surfaces superior to that attributable to normal attrition during mastication was demonstrated in dentitions from several prehistoric populations<sup>19</sup>. Such alteration was correlated with the use of the anterior teeth in pulling and chewing strings or threads of leather, tendon, or plant fibers. It is therefore probable that the dental wear of the Val Senales man was also culturally-induced. This needs to be confirmed following a careful examination of the grade and gradient of dental attrition of the posterior maxillary dentition, and of the teeth of the inferior dental arcade, which were not accessible to direct inspection.

### Skeletal and soft tissue alterations

Upon external inspection, a vast area of soft tissue loss can be readily appreciated in the right gluteal region (Fig. 6)<sup>8</sup>. This lesion exposes the underlying bone structure, including the proximal end of the femur and the coxo-femoral articulation. The head of the femur appears dislocated from the acetabulum, and the round ligament appears ruptured. This series of alterations certainly occurred post mortem, possibly following attrition with stones or ice, immediately before or during recovery. Attrition also caused the loss of the penis, scrotal sacs and testicles.

Complete X-ray and CAT scanning analysis of the mummy reveals a series of skeletal changes (Fig. 9)<sup>20</sup>. The os sacrum demonstrates a vast loss of substance, that can also be noted on external inspection of the right gluteal region. Alterations of the lumbar vertebral column consist in a moderate calcifica-



Fig. 9. - Roentgenogram of the pelvic region, showing the dislocation of the right coxo-femoral and sacro-iliac articulations, and the moderate degree of articular osteosclerosis.

tion of the intervertebral discs, with formation of bone spurs on the anterior aspect of the vertebral bodies. Moreover, the moderate subchondral sclerosis of the coxo-femoral articulation, associated with the radiologic evidence of tibio-tarsal sclerosis, indicate that the articulations were subjected to mechanical stresses, probably related to the lifestyle of a prehistoric hunter/shepherd.

In the context of the skeletal alterations, it should be added that three-dimensional reconstructions of the skull, based on computerized tomography data, reveal apparent frontal and temporal bone defects. However, these defects appear to indicate areas with deep granular foveolae (also designated *Pacchioni's granulations*) and sinus grooves on the inner table, rather than pathological conditions<sup>9</sup>.



## Conclusions

The study of the Val Senales mummy is still at its beginnings, but already yielded a wealth of data that dramatically increase our knowledge of humans of the European Copper Age. The paleopathological analysis of this unique mummy sheds vivid light on the mutual interactions between disease, environment, and culture, that shaped human life in that distant past.

## NOTES AND BIBLIOGRAPHY

1. REINHARD J., *Sacred peaks of the Andes*. National Geographic, 1992; 181: 84-111.
2. GULLOW H.C., *The mummies from Quilakitsoq: Eskimos in the 15th century*. Meddeleser om Grömland. Man and Society, 1979, 12.
3. EGG M., GOEDECKER-CIOLEK R., GROENMAN-VAN WAATERINGE W., SPINDLER K., *Die Gletschermumie vom Ende der Steinzeit aus den Otztaler Alpen*. Jahrbuch des Romisch-Germanisches Zentral Museums, 39, 1992; Mainz, 1993.
4. BONANI G., IVY S.D., NIKLAUS T.R., SUTER M., HOUSLEY R.A., BRONK C.R., VAN KLINCKEN G.J., HEDGES R.E.M., *Altersbestimmung von milligramproben der Otztaler Gletscherleiche mit der Beschleunigungsmassenspektrometrie-Methode (AMS)*. In: HOPFER F., PLATZER W., SPINDLER K. (Eds), Veröffentlichungen der Universität Innsbruck 187: Der Mann im Eis, Band I, Innsbruck, 1992: 108-116.
5. BERNHARD W., *Vergleichende Untersuchungen zur Anthropologie des Mannes vom Hauslabjoch*. In: HOPFER F., PLATZER W., SPINDLER K. (Eds), Veröffentlichungen der Universität Innsbruck 187: Der Mann im Eis, Band I, Innsbruck, 1992: 163-187.
6. TIEFENBRUNNER F., *Bakterien und pilze, ein problem für unseren ältesten Tiroler?* In: HOPFER F., PLATZER W., SPINDLER K. (Eds), Veröffentlichungen der Universität Innsbruck 187: Der Mann im Eis, Band I, Innsbruck, 1992: 100-107.
7. ASPOCK H., AUER H., *Zur parasitologischen Untersuchung des Mannes vom Hauslabjoch*. In: HOPFER F., PLATZER W., SPINDLER K. (Eds), Veröffentlichungen der Universität Innsbruck 187: Der Mann im Eis, Band I, Innsbruck, 1992: 214-217.
8. CAPASSO L., CAPELLI A., FRATI L., MARIANI-COSTANTINI R., *Notes on the paleopathology of the mummy from Hauslabjoch/Val Senales (Southern Tyrol, Italy)*. In: HOPFER F., PLATZER W., SPINDLER K. (Eds), Veröffentlichungen der Universität Innsbruck 187: Der Mann im Eis, Band I, Innsbruck, 1992: 209-214.
9. KUNZEL K.H., STEINLECHNER M., GABER O., PLATZER W., *Morphologische Vergleichsstudie an Schädeln zur Schädel-CT-Rekonstruktion des Eismannes*. In: HOPFER F., PLATZER W., SPINDLER K. (Eds), Veröffentlichungen der Universität Innsbruck 187: Der Mann im Eis, Band I, Innsbruck, 1992: 117-130.

10. SANDISON A.T., *Diseases of the skin*. In: BROTHWELL D., & SANDISON A.T., *Diseases in Antiquity*, Springfield, C.C. Thomas 1967, pp. 449-456.
11. WITTIG M., WORTMANN G., *Untersuchungen an Haaren aus den Begleitfunden des Eismannes vom Hauslabjoch. Vorläufige Ergebnisse*. In: HOPFER F., PLATZER W., SPINDLER K. (Eds), Veröffentlichungen der Universität Innsbruck 187: Der Mann im Eis, Band I, Innsbruck 1992, 273-298.
12. CAPASSO L., PIERFELICE V., LEGGE A., *Morfologia e patologia ungueale della mummia umana di Val Senales*, G. It. Dermatol. Veneorol. 1993; 128: 463-471.
13. CAPASSO L., PIERFELICE V., LEGGE A., *I tatuaggi della mummia di Val Senales*. G. It. Dermat. Veneorol. 1993; 128: 473-477.
14. WELLS C., *Bones, bodies and disease*. New York, F.A. Praeger, 1964.
15. RUDENKO, S.I., *Frozen tombs of Siberia: the Pazyryk burials of iron age horsemen*, translated from Russian by M.W. Thompson, University of California Press, 1970.
16. KROMANN N.P., KAPEL H., LOOYTAVED E.R., HART HANSEN J.P., *The tattooings of the Quilakitsoq Eskimo mummies*. In: HANSEN J.P. and GULLOW H.C., *The mummies from Quilakitsoq: Eskimos in the 15th century*. Meddeleser om Grömland. Man and Society, 1979, 12.
17. CAPELLI A., CAPASSO L., *Dal Neolitico una terapia chirurgica dell'artrosi? In: Le origini della chirurgia Italiana*, a cura del Servizio Tecnico per le Ricerche Antropologiche e Paleopatologiche, Ministero per i Beni Culturali ed Ambientali, Roma, 1993, pp. 29-33.
18. PASSARELLO P., *Scheda dentaria*. In: GIOVE M.R., *Norme per la redazione della scheda "MA" per le sepolture e della Scheda Antropologica*. Ministero per i Beni Culturali ed Ambientali-Istituto Centrale per il Catalogo e la Documentazione, Roma, 1985.
19. UBELAKER D.H., *Human skeletal remains*. Washington D.C., Taraxacum, 1984.
20. ZUR NEDDEN D., WICKE K., *Der Eismann aus der Sicht der Radiologischen und Computertomographischen Daten*. In: HOPFER F., PLATZER W., SPINDLER K. (Eds), Veröffentlichungen der Universität Innsbruck 187: Der Mann im Eis, Band I, Innsbruck, 1992: 131-148.

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