



Ötzi died with his boots on

In 1991, a deep frozen corpse was discovered at 3,210 metres on top of a mountain called the Hauslabjoch on the border between Austria and Italy. He has been nicknamed Ötzi and is possibly the oldest mummy in history. He has also been the subject of intense scientific research, which has proved that he died in the snow on this mountain pass some 5,300 years ago. What has fascinated researchers is the fact that his clothes, footwear, tools and ornaments were found in an astonishing state of preservation and have allowed a picture to be built up of the sophisticated technology of this period.

Although Ötzi has now taken up residence in a deep freeze display cabinet in Bolzano in Northern Italy, his death has turned into the oldest 'whodunnit' in history. As reported in *World Leather* at the time, in 2001 the research turned into a murder enquiry when an arrowhead was discovered buried in his back.

The latest theories are that he was a high status individual, because of the sophisticated copper axe head he was carrying. He was possibly running away from a violent situation as only two of his 10 arrows were fletched (flight feathers attached) and his bow was not ready for use.

The arrowhead in his back would not have been fatal immediately, but could have led to blood loss and weakness. He also had a severe cut on his right hand. In a DNA analysis, blood from four other individuals was found on his body or clothing and on one of his arrowheads. This would suggest some sort of violent confrontation.

Ötzi grew up in the Southern Alps, not more than 60 kilometres away from where he died, according to an analysis of his bones and teeth. He was about 46-years-old and was suffering from severe arthritis in his feet and joints. So what was he wearing when he fled into the snow-covered mountains?

Leather tanning was clearly understood in those days. He wore leggings made from red deer skin suspended with straps from a leather belt. A goatskin loincloth acted as underpants and was also looped into the belt. His fur hat was made of bearskin. From the few fragments available, it would seem that he had some sort of fur jacket or shirt on. Over all this he wore an insulating cape made of woven grass.

The Iceman's footwear

Ötzi's footwear fascinated Petr Hlavacek, a professor in the Footwear Department at Zlin's Tomas Bata University in the Czech Republic. He is one of a very small number of academic footwear technologists and is well-known internationally for his research into comfort footwear in general and in the important area of footwear for diabetics. Hlavacek was keen to study the footwear, to reconstruct it if possible and perhaps learn some useful lessons. In conjunction with his colleague Václav Gresak, a lecturer at the university, he has now succeeded in reconstructing five pairs of the boots (*Figure 1*) and has also undertaken wear and comfort trials.



To study the shoes, Hlavacek travelled to a museum in Mainz, Germany, where the remnants of the shoes are stored. The next step on the way to reconstruction was to obtain the correct materials. Microscopic research showed that the leather used in Ötzi's clothing and footwear was from calf and deer and these could be easily obtained. The soles and hat, however, were made from bearskin and that posed more of a problem.

Eventually his colleague Gresak found the skin from a bear killed in Canada and then had to try to work out how the skin was tanned or preserved. An old Indian recipe—comprising a paste made from boiled pig's liver and raw pig's brain—provided the answer. This was smeared on the skin and left for three days, after which it was found to successfully preserve the bearskin, even if it was a rather smelly process.

At one stage of the research Ötzi was moved to a deep freeze in Innsbruck. Hlavacek managed to get permission to go there and take a plaster cast of his foot. This was actually quite slim and small, perhaps the same size as a 12-year-old boy of today.

The next step for Hlavacek and Gresak was to study the method of construction. This proved to be a simple version of a Veldtschoen or Ideal construction, with the upper turned



Figure 1: Replica boots showing upper construction



Figure 2: Soles showing stitching and loops to secure the fibre net

outwards and secured to the sole with stitches. The clever part of the technology was the use of a thick layer of grass to act as insulation underneath the bearskin sole. The grass was encapsulated in a network of fibrous string and they went to some trouble to find a soft grass that was neither abrasive nor an

irritant. This layer was effective not only for heat insulation but it also provided good pressure distribution.

Three replicas were made plus some larger pairs to allow for wear trials. They were worn by Hlavacek (*see opening photograph*) and a mountaineer during a two-day hike in the Austrian Alps near the place where Ötzi had been discovered. They were found to be remarkably practical and satisfactory even in cold conditions. They were not waterproof, of course, but the insulation of the grass allowed the foot to keep warm even when wet. Petr Hlavacek is a serious scientist, so he also tested the replicas for pressure absorption and thermal insulation. They were found to be quite as good as most modern footwear.

He is hoping to learn some lessons from this ancient technology to bring comfort and improved foot health to modern footwear and, in particular, shoes for diabetics. They often suffer with foot problems and require comfort and insulation against pressure and extremes of temperature in order to maintain mobility, and to provide comfort in cases of diabetic neuropathy where the feeling in the feet is lost. 🌐

Roger Beeby

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