

Last hours of the Iceman: in 1991 the frozen body of a man who lived 5,300 years ago emerged from a melting glacier in the Alps. New forensic evidence reveals that he was killed by an arrow to the back, possibly during an ambush

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Full Text:

It was late spring or early summer, when a modest tree called the hop hornbeam unfurls bright yellow clusters of flowers in the steep valleys that run north into the mountains now known as the Italian Alps. The man hurried through a forest he knew well, wincing from the pain in his injured right hand and pausing occasionally to listen for sounds that he was being pursued. As he fled up the slope, the yellow pollen of the hornbeam blossoms fell like an invisible rain, salting the water and food he consumed when he stopped to rest. Five thousand years later, the Neolithic hunter we call the Iceman would still bear traces of this ancient dusting inside his body--a microscopic record of the time of year it was when he passed through this forest and into the nearby mountains, where fate would finally catch up with him.

Since hikers discovered his mummified corpse in 1991 in a rocky hollow high in the Otztal Alps on Italy's border with Austria, scientists have used ever more sophisticated tools and intellectual cunning to reconstruct the life and times of the Iceman (or "Otzi"), the oldest intact member of the human family. We know that he was a small, sinewy, and, for his times, rather elderly man in his mid-40s. Judging from the precious, copper-bladed ax found with him, we suspect that he was a person of considerable social significance. He set off on his journey wearing three layers of garments and sturdy shoes with bearskin soles. He was well equipped with a flint-tipped dagger, a little fire-starting kit, and a birchbark container holding embers wrapped in maple leaves. Yet he also headed into a harsh wilderness curiously under-armed: The arrows in his deerskin quiver were only half finished, as if he had recently fired all his munitions and was in the process of hastily replenishing them. And he was traveling with a long, roughly shaped stalk of yew--an unfinished longbow, yet to be notched and strung. Why? (Continued on page 76)

The world's best studied mummy holds clues to life in the Stone Age-and maybe a lethal rivalry.

When it comes to the Iceman, there has never been a shortage of questions, or theories to answer them. During the 16 years that scientists have poked, prodded, incised, and x-rayed his body, they have dressed him up in ill speculations that have not worn nearly as

well as his rustic garments. At one time or another, he has been mistakenly described as a lost shepherd, a shaman, a victim of ritual sacrifice, and even a vegan. But all these theories fade in the face of the most startling new fact scientists have learned about the Iceman. Although we still don't know exactly what happened up there on that alpine ridge, we now know that he was murdered, and died very quickly, in the rocky hollow where his body was found.

"Even five years ago, the story was that he fled up there and walked around in the snow and probably died of exposure," said Klaus Oeggl, an archaeobotanist at the University of Innsbruck. "Now it's all changed. It's more like a paleo crime scene."

THE OBJECT OF ALL THIS intense scientific attention is a freeze-dried slab of human jerky, which since 1998 has resided in a refrigerated, high-tech chamber in the South Tyrol Museum of Archaeology in Bolzano, Italy. The temptation to conduct fresh experiments on the body rises with every new twist of technology, each revealing uncannily precise details about his life. Using a sophisticated analysis of isotopes in one of the Iceman's teeth, for example, scientists led by Wolfgang Muller (now at the Royal Holloway, University of London) have shown that he probably grew up in the Valle Isarco, an extensive north-south valley that includes the modern-day town of Bressanone. Isotope levels in his bones, meanwhile, match those in the soil and water of two alpine valleys farther west, the Val Senales and the Val Venosta. Muller's team has also analyzed microscopic chips of mica recovered from the Iceman's intestines, which were probably ingested accidentally in food made from stone-ground grain; geologic ages of the mica best match a small area limited to the lower Val Venosta. The Iceman probably set off on his final journey from this very area, near where the modern-day Adige and Senales Rivers meet.

We also know that he was not in good health when he headed up into the mountains. The one surviving fingernail recovered from his remains suggests that he suffered three episodes of significant disease during the last six months of life, the last bout only two months prior to his death. Doctors inspecting the contents of his intestines have found eggs of the whipworm parasite, so he may well have suffered from stomach distress. But he was not too sick to eat.

In 2002, Franco Rollo and colleagues at the University of Camerino in Italy analyzed tiny amounts of food residue from the mummy's intestines. A day or two before his death, the Iceman had eaten a piece of wild goat and some plant food. The same analysis revealed that his very last meal was red deer and some cereals. The archaeobotanist Klaus Oeggl has concluded from bran-like food residues that the Iceman's diet also included the primitive form of wheat known as einkorn as well as barley, found on his garments, indicating that the Neolithic settlements south of the/hips where he lived cultivated these grains. Oeggl has even found that the small size of the wheat fragments in the gut, along with tiny flecks of charcoal, suggest that the grains

were ground and then baked as primitive bread in open fires.

Archaeobotanists have used equally clever analyses of pollen and plant fragments to plot the Iceman's last movements. James Dickson of the University of Glasgow has identified no less than 80 distinct species of mosses and liverworts in, on, or near the Iceman's body. The most prominent moss, *Neckera complanata*, still grows at several sites in the valleys to the south, in some cases quite near known prehistoric sites. According to Dickson, a clot of stems found in the Iceman's possession suggests he was probably using the moss to wrap food, although other ancient peoples used similar mosses as toilet paper.

Taken together, the evidence strongly indicates that the Iceman's last journey began in the low-altitude deciduous forests to the south, in the springtime when the hop hornbeams were in bloom. But it may not have been a straight hike into the mountains. Oeggl has also found traces of pine pollen in the Iceman's digestive tract, both above and below the hornbeam pollen. This suggests that he may have climbed to a higher altitude where pine trees grow in mixed coniferous forests, then descended to the lower altitude of the hop hornbeams, and finally ascended again into the pine forests in his last day or two. Why? No one knows. But perhaps he wanted to avoid the steep, thickly wooded gorge of the lower Val Senales--especially if he was in a hurry.

When he reached a mountain pass now known as Tisenjoch, he likely paused to rest. He had completed a vertical climb of 6,500 feet from the valley below, and to the north faced a desolate, glacier-riven landscape. Perhaps the rocky hollow where he found himself offered some shelter from the wind. We do not know if his enemies caught up with him at that spot, or were waiting there in ambush for him to arrive. What we do know is that he never left that hollow alive.

IN JUNE 2001, Paul Gostner, director of the Department of Radiology at the Central Hospital in Bolzano, brought a portable x-ray machine to the Iceman's chamber. His intent was to prepare for a routine analysis of some broken ribs. The following day he dropped by the office of Eduard Egarter Vigl, director of the Institute of Pathology at the hospital and principal caretaker of the mummy, to report that the rib fractures were old and of limited interest.

"But I've found another thing that I can't explain," he said. "There is this strange extraneous object in the left shoulder." When he compared his recent x-rays (and CT scans taken three months earlier) of the Iceman's torso with earlier films taken by scientists in Innsbruck, Gostner managed to detect what his Austrian colleagues had missed: a dense triangular shadow smaller than a quarter and lodged beneath the Iceman's left shoulder blade. It turned out to be a stone arrowhead. This "casual discovery," as Egarter Vigl put it, instantly turned an inexplicable death more than 5,000

years ago into archaeology's most fascinating cold case. The forensic evidence became even more intriguing in 2005, shortly after the hospital in Bolzano acquired a new high-resolution multi-slice CT scanning machine. Gostner, Egarter Vigl, Patrizia Pernter, a physician in the Department of Radiology, and Frank Ruhli, a doctor and senior lecturer in anatomy at the University of Zurich, decided to take a closer look at the body with the new CT machine. In August 2005, doctors placed the Iceman on a custom-built foam mattress, covered him with an insulated blanket and heaps of ice, and rushed him by ambulance (with a police escort) on the ten-minute ride from the museum to the hospital. There, with the kind of urgency usually reserved for humans in critical condition, they whisked the mummy into the scanning suite and quickly took a series of scans. "You had to do it before he thawed," Ruhli noted, "so you had to hurry."

The results were astonishing. The sharpened piece of stone, probably flint, had made a half-inch gash in the Iceman's left subclavian artery. This is the main circulatory pipeline carrying fresh oxygenated blood from the pumping chamber of the heart to the left arm. Such a serious tear in a major thoracic artery would almost certainly lead to uncontrolled bleeding and rapid death. "This is a lethal wound," Ruhli says. "It was pretty quick. With this kind of bleeding, you don't go walking uphill for hours."

This new medical evidence suggests that an attacker, positioned behind and below his victim, fired a single arrow that struck the Iceman's left shoulder blade--precisely the area at which prehistoric hunters aimed to bring down game with one shot. The arrow went clean through the bone and pierced the artery. Blood instantly began to gush out, filling the space between the shoulder blade and the ribs. In his few remaining minutes of life, the Iceman became a textbook case of what is now known as hemorrhagic shock. His heart started to race. Sweat drenched his garments, even at an altitude two miles above sea level. He felt increasingly faint because not enough oxygen was reaching his brain. In a matter of a few minutes, the Iceman collapsed, lost consciousness, and bled out.

Then, in a fantastically fortunate cascade of circumstance, the brutal weather of the Otztal Alps conspired with chance to perform one of the greatest embalming jobs in the history of human remains. The frigid glacial environment eventually tucked him in like a cold, wet blanket, immobilizing and preserving his body in snow, ice, and glacial meltwater. The little ravine protected his lifeless form from the bone-grinding action of the Niederjoch Glacier, which passed just a few feet overhead for the next 5,300 years.

WHO KILLED THE ICEMAN, and why? Was this a Neolithic version of highwaymen ambushing a hunter and snatching his catch? Or was he stalked and killed by a person, or persons, who knew him? Experts now believe that the mystery may hinge on a bizarre detail of the crime scene. The shaft of the fatal arrow was nowhere to be found. Someone must have pulled it out, leaving behind the stone arrowhead lodged in his

body.

"I believe--in fact, I am convinced--that the person who shot the Iceman with the arrow is the same person who pulled it out," says Egarter Vigl. In an article that appeared this May in the German archaeology magazine *Germania*, Egarter Vigl and his colleagues noted that telltale markings in the construction of prehistoric arrows could be used to identify the archer much in the way that modern-day ballistics can link a bullet to a gun. They argue that the Iceman's killer yanked out the arrow shaft precisely to cover his tracks. For similar motives, Egarter Vigl reasons, the attacker did not run off with any of the precious artifacts that remained at the scene, especially the distinct copper-bladed ax; the appearance of such a remarkable object in the possession of a villager would automatically implicate its owner in the crime.

Other, more controversial research has suggested that this final mortal blow may have been preceded by fierce, hand-to-hand combat. The late Tom Loy, a molecular archaeologist at the University of Queensland in Australia, claimed in 2003 that human blood from no less than four separate individuals had been identified on the Iceman's garments and weapons. But Loy's research has been aired only in media accounts, and skeptics in the academic community say the claims are impossible to assess until they are published in the scientific literature.

Nonetheless, the idea that the Iceman was attacked by more than one person complements the "theory of the crime" proposed by Walter Leitner, an archaeologist at the University of Innsbruck who is an expert in both archery and Stone Age culture. He believes the bloody mountaintop confrontation was the denouement of a political dispute that began down in the valley, where rivals within the Iceman's own tribe tried to assassinate him. A microscopic analysis of the Iceman's hand wound, and the fact that it had begun to close and heal, suggests that it occurred well before the final mortal blow. "So there must have been some fight, some kind of battle, at least one day--and perhaps even two or three days--earlier," said Egarter Vigl. "The time had come where his opponents had become stronger," Leitner speculates, "but he didn't recognize that his reign was coming to an end and was holding on to his position." Leitner says that after the fight in the village, "It looks as if the Iceman was planning to flee and that his trip was brought to an end by his opponents."

The previous, erroneous theories about the Iceman's demise remind us that much of the current speculation, while plausible, must stand up in the face of continuing research. Above all, this tale of an enigmatic and bloody death atop a desolate alpine ridge is a story about remarkable scientific insight brought to bear on the skimpiest of clues--a fingernail here, a milligram of food residue there, a few grains of pollen--in order to reconstruct a riveting scene of Neolithic noir. Although not a single grunt or cry has passed through the Iceman's mummified lips in more than 5,000 years, the ongoing investigation continues to tell us new and startling things about life--and death--in the

Stone Age.

Inside the Iceman Get an update on the life and death of this Neolithic hunter in an interactive exploration of his remains at ngm.com/0707.

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