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Decorah Ice Cave State Preserve

GEORGE E. KNUDSON[1] and JAMES HEDGES[2]

KNUDSON, GEORGE E. and JAMES HEDGES. (Luther College, Decorah, Iowa 52101.) Decorah Ice Cave State Preserve. *Proc. Iowa Acad. Sci.* 80(4):178-181, 1973.
The Ice Cave at Decorah, Iowa, is the largest known glacière in North America east of the Black Hills and the subject of much international speculation during the latter half of the nineteenth century. A satisfactory theory for the formation of ice in late spring in this and other caverns was first proposed by Alois Kovarik after a series of meteorological measurements. Recent observations confirm his hypothesis. Because of its historical and geological interest and because it is the habitat of insects found nowhere else in North America, it has recently been included in the Iowa State Preserves System.
INDEX DESCRIPTORS: Glacières; Ice Cave; Preserve.

The Ice Cave at Decorah, Iowa, is the largest known glacière in North America east of the Black Hills. Ice usually appears in the cave in March, after the coldest days of winter are past, reaches a maximum thickness of 8-10 inches on the walls in early June, and does not disappear until August or September. This is in sharp contrast to other caves which maintain a constant temperature equal to the mean annual temperature of the region—about 47° in the Decorah area.

In 1860, only 12 years after the first white settlers arrived in the area, a note was published in the *Scientific American* commenting on the unusual behavior of the cave (JWH, 1860). Over the next 40 years a long series of articles in this and other scientific publications speculated on the possible mechanisms of ice formation and brought international recognition to the cave. The series culminated in an article in 1898 in the *Scientific American Supplement* by Alois Kovarik, who proposed a mechanism which was accepted by the leading authorities of the day and which still seems to be the most reasonable explanation of the phenomenon.

The Ice Cave is located near the north bank of the Upper Iowa River, only about one-fourth mile northeast of the City Hall. It is in a relatively wild part of the 330-acre city park system where deer, beaver and grouse are not uncommon. In the immediate area of the cave, large blocks of limestone at the base of a vertical cliff of the Galena formation have moved horizontally and tilted, producing numerous large crevices, some of which are closed at the top.

Hedges (1972) recently pointed out that many small caves are formed by similar crevices along the crest of the Niagara escarpment, extending from Fayette County in Iowa southeastward into Illinois. He has also described evidence to show that these are expanded joints formed by the development of ice wedges in joint openings parallel to the local face of the escarpment. Small joints which filled with ice during the time of recent glacial advances were annually enlarged a slight amount by horizontal movement of large blocks forced outward toward the adjacent valley. Along the Niagara escarpment the movement was facilitated by slippage on the Maquoketa shale. At the Decorah Ice Cave the slippage is on the top of the shaly strata known as the Decorah formation.

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While the Devil's Hole, at the top of the cliff, is typical of an ice-expanded joint, the main chamber of the ice cave is probably the result of slumping or collapse of the original enlarged joint. There is no evidence of water erosion—opposite sides of the joints consist of matching sections of fractured rock. Large crevices, of difficult access, continue about 60 feet west of the mapped portion.

Former State Geologist Charles A. White, who visited the cave in 1869, suggested that the ice was formed when evaporation of water in the cave absorbed enough heat to cause the remaining water to freeze. N. M. Lowe of Boston suggested in the *Scientific Observer* in 1879 that air which is entrained in water descending along fissures above the cave is compressed, gives up its heat of compression to the adjacent rocks, and subsequently absorbs heat from the cave upon being liberated in it. This theory was supported in later articles in the same journal by a number of prominent scientists. The Royal Astronomer of Scotland, Piazzi Smith, is also reported as one who supported what today we would regard as a very improbable idea (Anon, 1879). A. I. Benedict of Decorah reported in 1879 that cold winters and wet springs are followed by great amounts of ice, while warm winters and dry springs produce relatively little ice. He also pointed out that cold air would be trapped by gravity in the lower portions of the cave in winter.

Over a three-year period, 1897-99, Alois Kovarik made frequent observations at the cave, collected meteorological information and published the data in articles in the *Scientific American Supplement*, the *Decorah Public Opinion* and the *Decorah Institute* (Kovarik 1898, 1899, 1900). He explained that cold air circulates freely through the cave in winter, cooling the rocks to a temperature below the freezing point of water. The warmed air ascends out of the cave through fissures in the roof. Moisture in the air produces a coating of hoarfrost in some locations but production of thick layers of ice must await the arrival of water following a thawing of the bluff surface above. Since the mouth of the cave is higher than the ice chamber, cold air is trapped in the interior in the summer, there is little circulation to bring in heat, and ice is able to persist until August or September.

In 1972 ice remained on the north wall of the deepest portion of the cave until mid-September. Ice formed again in the upper portions of the cave during a thaw in early January. The first ice appeared on the lower wall after a rain in early March, forming when meltwater from above trickled down a crevice onto the cold rocks below.

Kovarik, who was born in Spillville, about twelve miles

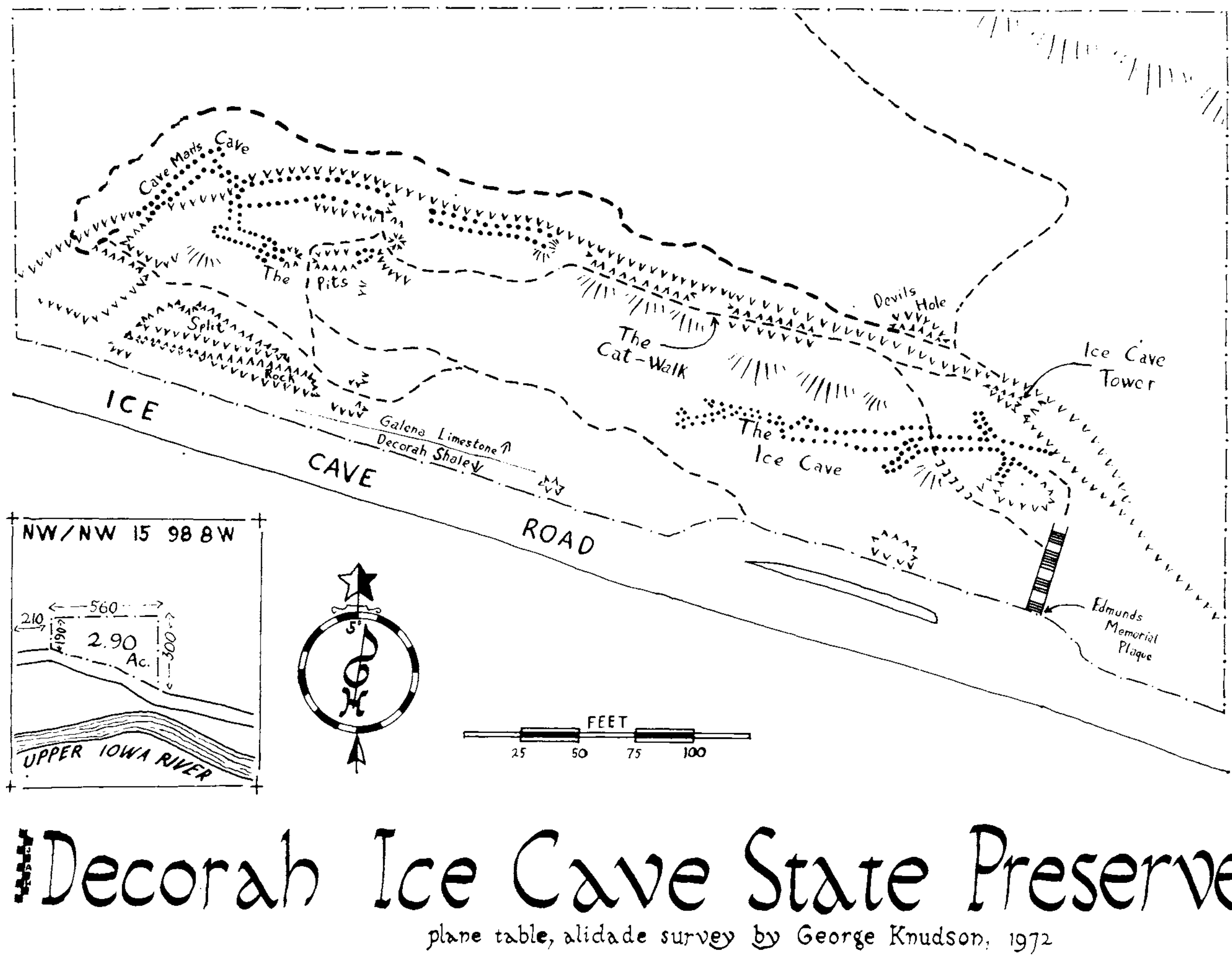

Figure 1. Map of the Ice Cave Preserve.

from Decorah, was an 18-year-old instructor in the Decorah Institute when he made his observations and published his first scientific paper. His reports on the Ice Cave were the first of a long series of scientific publications, as he went on to earn the Ph.D. at the University of Minnesota and to achieve international recognition as a nuclear physicist while a professor at Yale University. He delayed his undergraduate work at Minnesota to stay in Decorah in 1900 to teach another year at the Institute following the sudden death of its director. During this time he made an extensive collection of plants and fungi in the area, reporting at least one new species. His collection, together with some of his equipment and notes, is now in the biology department at Luther College. Later, while a professor at Yale University, he was the first physicist to estimate the age of the earth as calculated by radioactivity measurements.

It is doubtful that Kovarik's explanation of the formation of subterranean ice would have been accepted if this viewpoint had not frequently been endorsed by the prominent Philadelphia scholar Edwin Swift Balch, who had investigated a number of ice caves over a period of years and who published a book on the subject in 1900. Samuel Calvin, while Iowa State Geologist, quoted extensively from Kovarik's work in his 1905 "Geology of Winneshiek County." It is, therefore, difficult to understand why James H. Lees, then Assistant State Geologist, should have advanced a different theory before the Iowa Academy of Science in 1917. He proposed that cold air which was drawn in winter into the numerous fissures was forced out in the warm days of spring and summer, causing the precipitation and freezing of moisture in warm air at the cave entrance. Cold air coming in contact with warm cave air might result in hoarfrost deposition but not, however, in the formation of ice.

Lees ignored Kovarik's explanation that cold was stored in the rocks of the cave rather than in the air. With data available today on specific heats it is possible to show that the heat capacity of limestone is about 5400 times as great as that of an equal volume of air. To freeze the quantity of ice found in the cave, it is essential that there be a continuing circulation of air during winter to cool large quantities of rock below freezing.

Although recent explorations have not revealed any direct passage between the Devil's Hole and the ice chamber, it is not unlikely that air may be able to pass freely between the

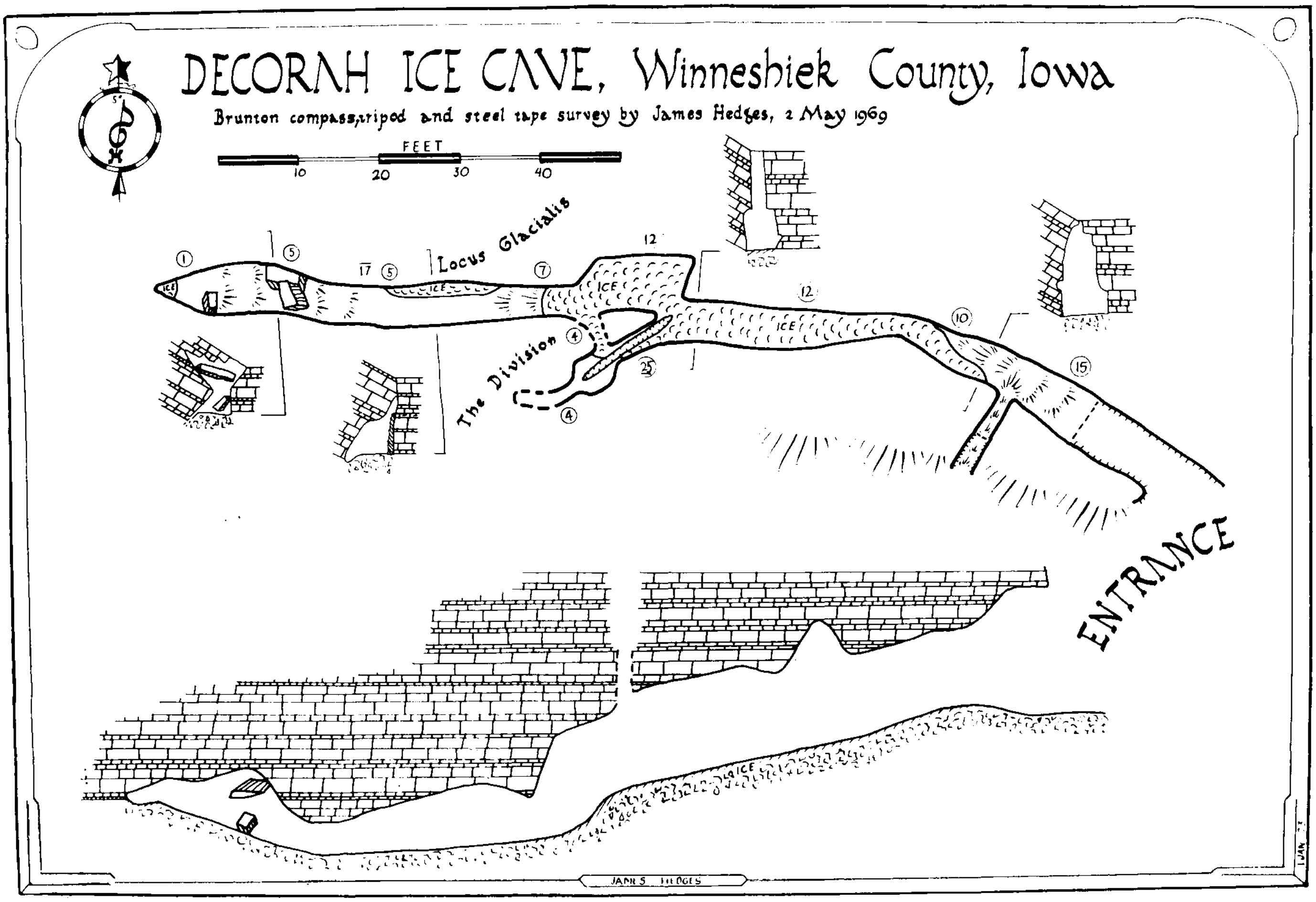

Figure 2. Readily accessible portion of Ice Cave.

two by means of crevices filled with loose debris. The presence of hoarfrost on the surface around Devil's Hole on cold winter mornings indicates that it is indeed serving as a chimney. This large crevice also serves to insulate the Ice Cave from flow of heat from the 47° temperature rocks deep within the cliff.

Because of national publicity generated by scientific articles, the Decorah Ice Cave became the first cave in Iowa to attract large numbers of tourists. City businessmen soon were promoting it and making small improvements. On one Sunday in 1929, a total of 597 visitors from out of the city signed the guest register (*Decorah Public Opinion*, 1 August 1929). In 1930, it became the second cave in Iowa to be commercialized after Stanley Scarvie leased the site and made further improvements (Carleton P. Baker, personal communication, 1972). It attracted as many as 5000 visitors a year and its success led local men to search for other caves in the vicinity (Stanley Scarvie, personal communication, 1972). By 1935 it was in competition with five other caves in the area, and as business declined it received less supervision, until the operation was abandoned with the outbreak of World War II. The bluff which includes the cave was acquired by condemnation in 1954 by the City Park Commission.

In 1957, Kenneth Christiansen, of Grinnell College, found in the deepest portion of the cave a species of Collembola which has been reported nowhere else in North America (personal communication, 1957). This insect, together with two other species of Collembola and several mites, was found again in 1972 by David Roslien of Luther College.

The Decorah formation, recognized by geologists in outcrops of sedimentary rocks in many other places in the midwest, was given this name in 1905 by State Geologist Samuel Calvin after he had described the type section as observed on the Ice Cave road and other places in the city of Decorah. The Galena-Decorah contact is near the top of the talus slope about 50 feet east of the steps leading to the cave. However, the contact is best observed about 250 feet west of the steps, where most of the Decorah formation is exposed on the north side of the road cut.

Levorson and Gerk (1972) recently presented in this journal a detailed stratigraphic study of the Galena group in Winneshiek County, together with suggested methods of identification. Recognizing the interest in the Ice Cave site,

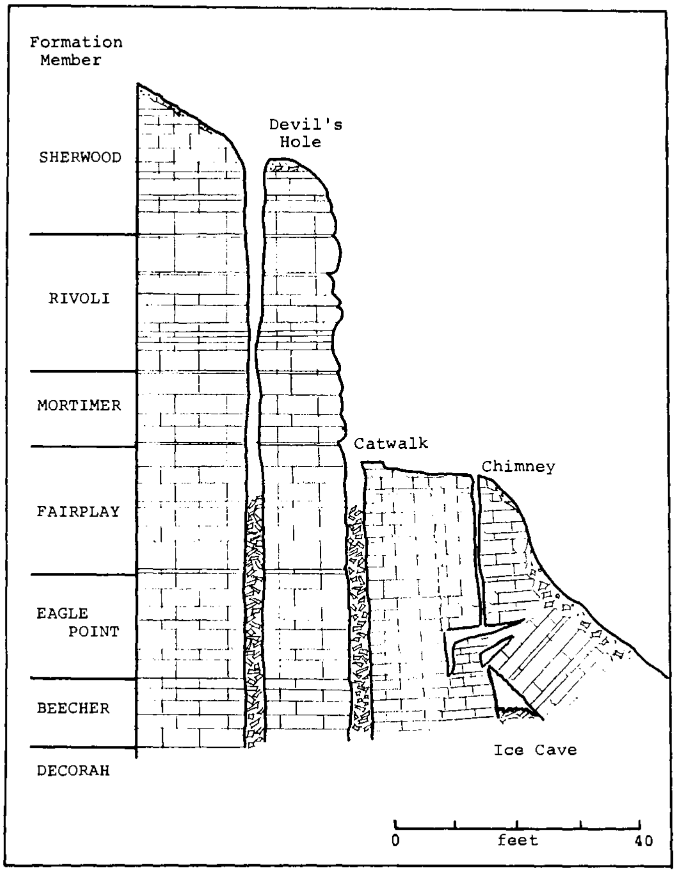

Figure 3. North-south cross-section through Ice Cave and Devil's Hole.

they have now prepared a detailed description of the lowest 85 feet of the Galena beds exposed here. Copies of this report are on file at Luther College and at The University of Iowa. The contact between the Beecher and Eagle Point members is about 12 inches above the steps at the entrance to the cave. The bottom of the Fairplay is the ceiling of the entrance and the top is near the top of the Catwalk. The Rivoli Bentonite is clearly seen near the top of the cliff, 30 inches above the top of the Tower. Two chert sequences used in identification are clearly visible. Two sparry calcarenite bands and several corrosion surfaces used in the identification will be marked, as will contact surfaces between members.

In 1973 the City Park Commission agreed to include the Ice Cave in the State Preserves System because of its geological, historical and biological importance. The only development contemplated is the erection of interpretive signs and markers. Management rules are designed to prevent any change in the present heat balance of the cave and to prevent intrusions which might destroy the life which inhabits this strange environment.

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