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WOODVILLE ICE CAVE (HANTS COUNTY, NOVA SCOTIA) AND NOTES ON THE 'ICE CAVES' OF THE MARITIME PROVINCES

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Several caves and sinkholes where snow and ice persist well into the summer exist in Nova Scotia and New Brunswick. In the past they were sometimes used as a source of ice or for cold storage, and are known locally as 'ice caves' or 'ice holes'. Although they are not true ice caves in the speleological sense of the term because they do not contain perennial ice, they are very similar. Woodville Ice Cave in Hants County, Nova Scotia, described here, is a particularly good example. Invertebrates and bats recorded from such sites are briefly discussed and the possibility of finding psychrophilic fauna in them is suggested.

Plusieurs grottes et dolines sont présentes là où la neige et la glace ne disparaissent que tard durant l'été en Nouvelle-Écosse et au Nouveau-Brunswick. Autrefois, elles étaient parfois utilisées comme sources de glace ou aux fins d'entreposage sous froid. À l'échelle locale, elles sont connues sous le nom de glacières ou de puits de neige. Elles ne sont pas de véritables glacières au sens habituel dans le domaine de la spéléologie parce qu'elles ne contiennent pas de glace pérenne, mais elles sont très semblables. La grotte Woodville (Woodville Ice Cave) dans le comté de Hants (N.-É.) décrite dans le présent document, est un très bon exemple. Nous discutons brièvement des invertébrés et des chauves-souris observés dans de telles grottes et dolines, et nous suggérons qu'il est peut-être possible d'y observer des organismes psychrophiles.

INTRODUCTION

Although many caves in geographical areas where temperatures fall below freezing contain ice during the winter, speleologically the term 'ice cave' is restricted to caves containing permanent ice. Not all ice caves, however, are in areas where there is a glacial climate on the surface: caves with permanent ice can exist in places where the climate is relatively moderate. Examples are known from many parts of the world including the Alps, Pyrenees, elsewhere in Europe and in western Canada.

The anomalous year-round ice and below freezing temperatures in true ice caves occur mainly as a result of the thermo-circulation within the cave. Usually the site has only a single entrance opening leading to a downward-sloping chamber or passage with a seasonal and bi-directional ventilation pattern with air exchange occurring only in winter (Racovitza 2000). Drainage and humidity are also important factors: ice does not survive long where there is liquid water, either as a stream or pond as a result of poor drainage.

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Evaporative cooling in conditions of low relative humidity may be significant in some cases as well as the aspect and shading of the entrance.

There are several natural features in the Maritime Provinces known to local residents variously as 'ice caves', 'ice holes' or by similar terms. Haliburton (1829) mentions "a deep ravine, in which ice may be found throughout the summer: it is known by the name of the 'Natural Ice-House'" near Granville (Annapolis County, NS). Decker (1950) reported a deep gypsum sinkhole near Antigonish, Nova Scotia that "contains ice and snow throughout the summer and used to be used as a meat storehouse before this region received electric power". There is a similar feature in Inverness County, Cape Breton, called the Ice Hole, also said by local informants to have been used for storing meat. It consists of a deep gypsum sinkhole with a shaft at the bottom: ice was observed to be present in July 1971 (Moseley 1976).

In some caves ice persists into the summer; one example is the well-known Frenchman's Cave (Hants County, NS) where ice can be present until early June (Calder & Bleakney 1967). Some of these local caves are also reported to have been used for cold storage and even as a source of ice for making ice cream prior to the widespread availability of domestic electrical power and modern refrigerators. Those referred to locally as 'ice caves' include Woodville Ice Cave and Minasville Ice Cave (Hants County, NS), both in gypsum, and Waterford Ice Cave, a limestone cave in Kings County, NB.

The distinctive landforms known collectively as 'karst' (landscape containing sinkholes, gorges, caves, underground streams, etc.), that develop on gypsum-anhydrite, limestone and other soluble rocks, have been little described in Nova Scotia or New Brunswick. Ice caves are an interesting physical feature of provincial karsts and Woodville Ice Cave in particular is not only of considerable geomorphological and biological interest in itself but is also situated within a fine example of eastern Canadian sulphate (gypsum-anhydrite) karst with large dolines (sinkholes), polygonal karst (i.e. multiple deep sinkholes separated only by narrow ridges) and a dry valley. The cave together with its environs are deserving of protection and preservation.

None of the known local sites are true ice caves, but they are similar in that the physical shape and aspect of the cave produce atypical temperature conditions. Dense, cold air tends to sit in the cave in the spring as ambient temperatures increase whilst in the autumn warm air flows outwards. In consequence, the annual temperature curve is skewed, ice and low temperatures can persist quite late into the summer and the average annual temperature inside the cave is lower than that outside (Moseley 2007a).

DESCRIPTION OF WOODVILLE ICE CAVE

The existence of these 'ice caves' has been briefly noted elsewhere (Moseley 1996, 1998), but none has previously been fully described or mapped.

Woodville Ice Cave (Woodville, Hants County. 45.0341 N. 63.9555 W.), also known as Bear Cave, or locally as 'the ice cave' or 'the cave' (Fig 1), is of particular interest because morphologically and microclimatically it closely resembles a true ice cave. It has a single well shaded east facing entrance situated at the head of a deep steep-sided karst valley, and evidently contained a stream at one time, but is almost dry today. The entrance forms a low arch, approximately 2 m high and 6 m wide. It opens onto a large, sub-circular chamber (20 m x 15 m) with a high ceiling estimated as 12 m at the highest point. The well-drained downward-sloping floor, formed of broken rock with some large boulders, acts as a cold air trap. These are the kind of conditions that produce *bona fide* ice caves elsewhere.

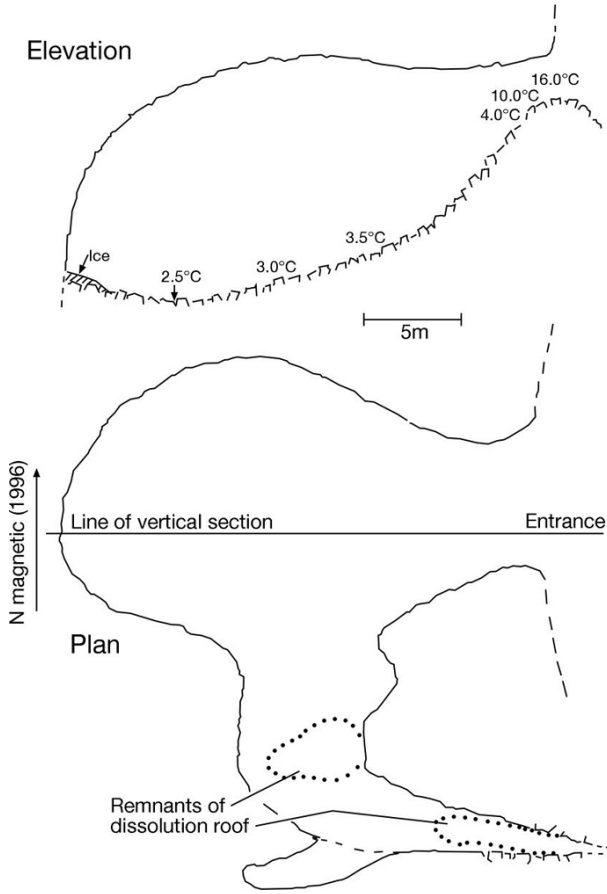

Fig 1. Woodville Ice Cave, Hants County, Nova Scotia. Plan view (Plan) and vertical section along an east-west line through the mid-point of the entrance (Projected Elevation). Survey (Suunto compass and tape): Moseley, Sawatzky and Newberry, 26th April 1996. [Air temperatures measured on 29th July 1997.]

Woodville Ice Cave is a natural dissolution ('solution') cave formed in Mississippian Windsor Group gypsum-anhydrite beds. In terms of its speleogenetic history it is not atypical for an eastern Canadian gypsum cave. Apart from small seeps, there is now no stream in the cave and it is no longer hydrologically active: its present-day physical features are mainly a result of cavern breakdown due to the mechanical weakness of the host rock. Somewhat ironically this is the most stable stage of development of local gypsum caves (Moseley 1996). Extensive blockfall in the chamber has buried the floor, which accordingly is well drained, and there is no remaining trace of the roof formed during the original dissolution. A walking height passage which is probably an old inlet opens off the south side of the chamber, but does not extend very far before becoming sealed by blockfall. Parts of the roof in this passage still retain the original surface. The present-day physical shape of the chamber is a result of partial sealing of the cave mouth by an accumulation of gypsum scree and talus from the roof and the cliff face outside caused mainly by winter freeze-thaw cycles.

Snow and ice which accumulate in the chamber during the winter have been observed to survive until early August: a bank of ice was still present towards the rear, western, wall in the mid-summer of 1997 and the air temperature measured just above the lowest point of the floor was only 2.5°C (Fig 1). By mid-October the ice had melted, and the minimum air temperature had risen to 3.9°C.

Perennial ice may exist deep within the scree and talus that partly closes the entrance. On 6th August 1999, a telethermometer probe (Yellow Springs Instruments) measured a temperature of 0.4°C at a depth of 5cm at a point near the bottom of the talus pile (Hebda 2006). It is interesting to note that if the mean annual temperature at Woodville was as little as 1°C lower, the cave itself might be a true ice cave containing perennial ice (Moseley 1998). As this cave, or similar sites elsewhere, might be sensitive indicators of climate change, it could be worthwhile subjecting them to long term monitoring.

It is speculated that an unexplored cave passage exists leading westward from somewhere below the wall at the end of the chamber; sinkhole topography including an unusually well developed area of polygonal karst continues on the surface in this direction. There may also be inaccessible cave development to the south or east beyond the end of the inlet passage.

Maritime Canadian ice caves and ice holes may be zoogeographically significant because they may harbour psychrophilic invertebrates at the southernmost limit of their range: perhaps even late-glacial relicts. To date collections of invertebrates have been made only in Woodville Ice Cave and Minasville Ice Cave (45.2750 N. 63.8170 W.). The biological fieldwork to establish the presence of psychrophiles has been insufficient, though the presence at Woodville of the springtail *Willemia scandinavia* Stach (Collembola: Poduridae), which has a northerly distribution, is suggestive (Moseley 1998). A list of other invertebrates collected in these caves has been provided by Moseley (2007). Further taxonomic study, especially of

enchytraeid worms (Enchytraeidae), springtails (Collembola), mites (Acari) and fungus gnats (Sciaridae and Mycetophilidae) is desirable.

Because the late summer-early fall cave temperature of *circa* 4°C is significantly lower than that found elsewhere when bats are just entering their hibernation sites, i.e. typically at temperatures greater than 7°C, and the chamber is very exposed experiencing low winter temperatures with a build-up of snow and ice, Woodville Cave is unsuitable for hibernating bats. A single yearling *Myotis lucifugus* seen in the small branch off the inlet passage in October 1996 is thought to have been an inexperienced individual (Hebda 2006). A solitary bat seen in April of the following year (Moseley, 2007b) was assumed to be the same individual.

Minasville Ice Cave (a longer more sheltered cave than Woodville) is a bat hibernaculum housing several hundred *M. lucifugus*. According to Taylor (1997) the two other confirmed local species of cave-hibernating bats (*M. septentrionalis* and *Pipistrellus subflavus*) were also present during winter 1996/97 but only *M. lucifugus* has been found subsequently (Hebda 2006).

Finally, a practical word of caution is necessary. It can be almost impossible to free-climb out of Woodville Cave when there is ice on the scree leading down into the chamber; a rope is essential.

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