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Cave Temperatures at Naracoorte Caves

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Abstract

Temperatures in four different caves at Naracoorte were logged for periods of up to two years, during 1998–2001. In Bat Cave temperatures near ground level were 19.0–21.1°C in the maternity chamber, and 10.3–15.6°C near the entrance. In Victoria Fossil Cave temperatures near the fossil chamber were 16.9–18.3°C. In Blanche Cave and the outer chamber of Robertson Cave temperatures were 9.4–15.0°C, with temperatures in the inner chamber of Robertson Cave 14.2–15.0°C. Cave chambers with little air flow had seasonally stable temperatures, and those with high air flow showed seasonal temperature variations of 5–6°C.

Keywords: cave temperature, air flow, Naracoorte Caves.

Introduction

Temperatures in four different caves at Naracoorte Caves National Park (36°58'S, 140°48'E) were logged over periods of up to two years, during 1998–2001. The caves are Bat, Blanche, Victoria Fossil and Robertson (Figures 1, 2). Bat and Blanche Caves are near the Visitor Centre, Victoria Fossil Cave is about 1 km south-south-east, and Robertson Cave about 8 kmt south-south-east from the Visitor Centre. The inner dome of Robertson Cave, which had been opened for guano mining sometime in the 1800s, was sealed in mid 1993 (described by Baudinette *et al.,* 1994) in order to return the cave to a state which might be attractive to bats. Bent-wing bats (*Miniopterus schreibersii*) return to Bat Cave each spring (Hamilton-Smith, 1972), with the first arrivals in the last three years (1999–2001) being in August. They remain in Bat Cave over summer and then disperse to other caves from about April, with some bats remaining in the outer, cooler parts of Bat Cave over winter, and some bats moving to Robertson Cave from February onwards (Sanderson, 2001). Temperature logging was carried out in association with observations of bent-wing bat occupancy of Bat and Robertson Caves, to see if there were any obvious temperature changes that might be used by the bats as cues for movements between caves. Data loggers were also placed in Blanche and Victoria Fossil Caves for comparison purposes, and to check a commonly held belief that temperature in the caves remains constant at 17°C all year.

Methods

T-Tec dataloggers (Temperature Technology, Adelaide, South Australia) were programmed to take readings of temperature at 2 hour intervals, and placed in caves as shown in Table 1. The outer locations in Bat Cave (~28 m inside cave entrance) and Robertson Cave

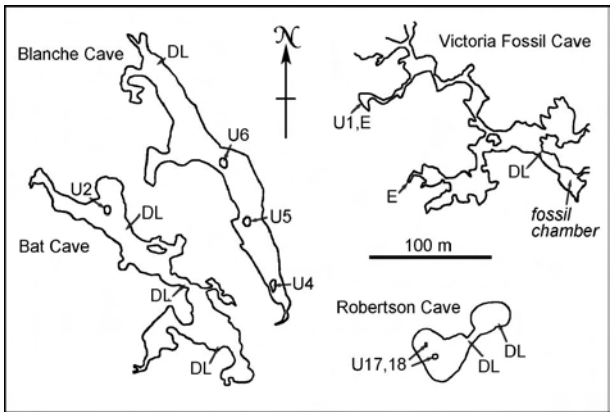

Figure 1: Maps (plan view) of the caves, derived from maps in the Management Plan for the Naracoorte Caves National Park (National Parks and Wildlife SA, 2001: Bat, Blanche and Victoria Fossil Caves) and in Baudinette *et al.* (1994: Bat and Robertson Caves). Locations of dataloggers (DL) are indicated. U1,2,4,5,6,17,18,19 are the codes assigned to the cave entrances (see Management Plan). E = entrance, exit for Victoria Fossil Cave. N = north. Bat and Blanche Caves are shown in true relation to each other, Victoria Fossil Cave and Robertson Cave are actually about 1 and 8 kms distant in a south-south-east direction.

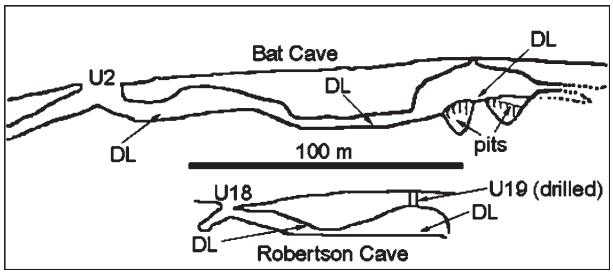

Figure 2: Longitudinal sections of Bat Cave, (from Baudinette *et al.* 1994) and Robertson Cave (mapped 2002 by Steven Brown, Steven Bourne and Liz Reed), showing locations of dataloggers (DL).

Table1: Summary of temperatures and relative humidities (RH) recorded at different locations at Naracoorte Caves 1998-2001 (with dataloggers), plus records of Naracoorte temperatures (from Bureau of Meteorology)

Site Details	Period	Annual (or period) range	Daily Range
Ambient, Naracoorte	Jul 1998 - Dec 2001	-2–43°C	2–32°C
Bat Cave: ~28 m into cave, near ground level	Feb 1998 - Feb 2000 (two years) Sep 1998 - Sep 1999	10.3–15.6°C > 90% RH	0–1.4°C
Bat Cave: ~100 m into cave, near ground level	Feb 1998 - Oct 1998 Nov 1998 - Apr 1999 Dec 1998	13.5–17.3°C 15.0–17.3°C > 90% RH	0–0.9°C 0.1–0.6°C
Bat Cave: ~150 m into cave, near ground level	Jul 1998 - Dec 1999 Sep 1998 - Mar 1999	19.0–21.1°C > 90% RH	0–0.2°C
Blanche Cave: ground level, 200 m into cave (100 m from nearest roof window) in a large airy chamber without constrictions	Dec 1997 - Apr 1998 May 1998 - Feb 2000	12.2–14.4°C 9.4–15.0°C	n.a. 0–0.7°C
Robertson Cave: outer chamber, ~2 m above ground level	Feb 1998 - Nov 1998 Dec 1998 - Feb 2000	8.6–14.3°C 9.4–15.0°C	0–1.0°C 0–1.1°C
Robertson Cave: inner chamber, ~1.5 m above ground level. The tunnel to the inner chamber was gated, and there was only slight air flow into the inner chamber.	Feb 1998 - Feb 2000 (two years)	14.2–15.0°C	0–0.2°C
Victoria Fossil Cave: front of Fossil Chamber, near ground level	Dec 1999 - Feb 2000 Oct 2000 - Mar 2001 Aug 2001 - Nov 2001	16.9–17.3°C 16.9–17.3°C 17.1–18.3°C	0–0.2°C 0–0.2°C 0–0.7°C

(outer chamber) were near where many bats have been seen in a rather inactive state over winter (Sanderson, 2001). Manufacturer's specifications (checked Feb 2002) indicated that data loggers were accurate to ±0.2°C over the range 0–70°C. Confirmation that these specifications are likely to be correct was obtained from replicate temperature data (from loggers placed side by side in Bat Cave) which varied by no more than 0.2°C, and from a logger placed in ice water for 4 hours (Feb 2002), which equilibrated to ice water temperature in

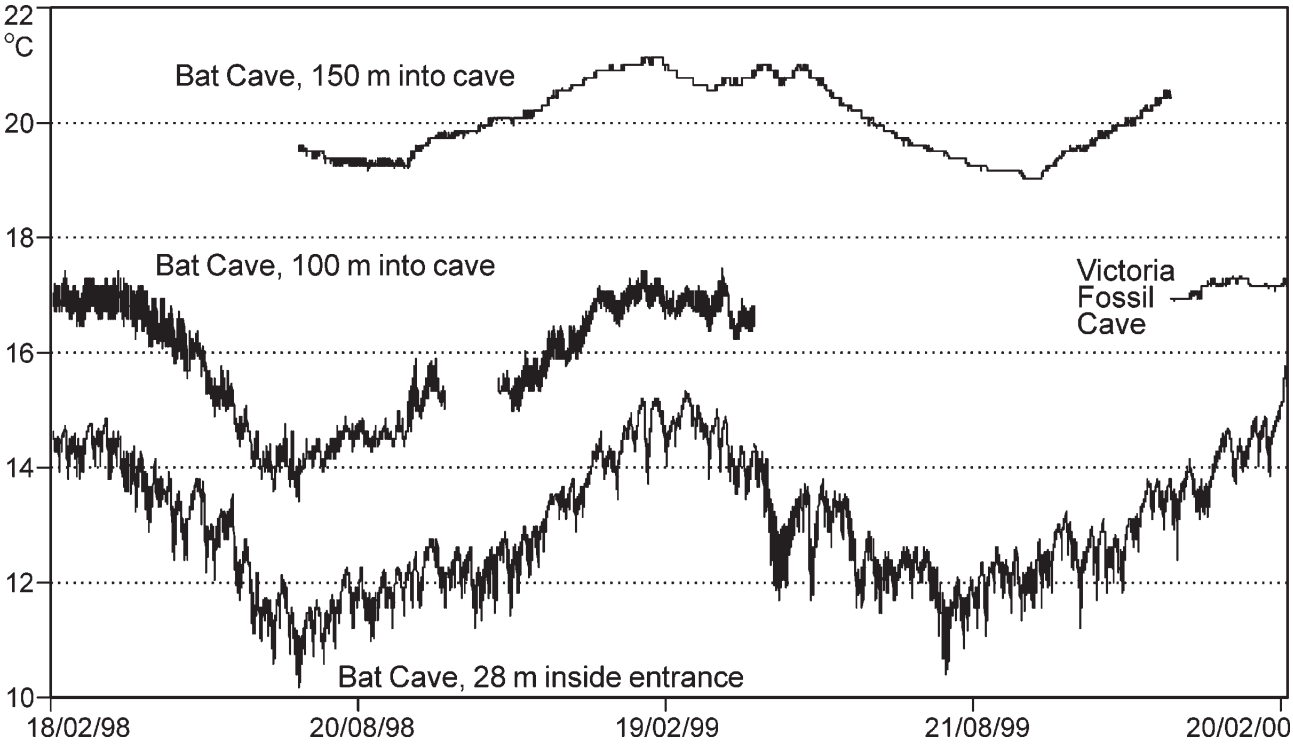

Figure 3. Temperature (°C) logged at 2 hour intervals near ground level at three locations in Bat Cave, and at the front of the fossil chamber in Victoria Fossil Cave.

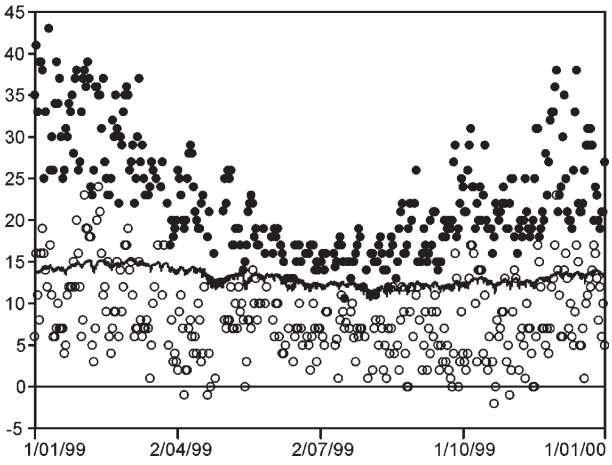

Figure 4. Naracoorte ambient daily maximum (filled circles) and minimum (open circles) temperatures (°C) (from Bureau of Meteorology) plus temperatures logged ~28 m inside Bat Cave (continuous line) for 1999.

about one hour, and then gave measurements at one minute intervals of 0±0.2°C for the next three hours. Ambient temperature data for Naracoorte from July 1998 to December 2001 were provided by the Bureau of Meteorology, Adelaide. Relative humidities (RH) were also recorded with T-Tec dataloggers placed in Bat Cave, as shown in Table 1. Manufacturer's specifications indicated an accuracy of ±3% RH. However we reported values above 90% simply as >90% since it was our perception (also shared by a reviewer) that measurements above 90% RH were not accurate.

Results

Temperatures recorded in the caves are shown in Table 1 and Figures 3-6. Figure 3 shows temperature records at the three locations near ground level in Bat Cave, and at the front of the fossil chamber in Victoria Fossil Cave. The temperature records for Bat Cave show a gradual fall from summer to winter. Near the entrance to Bat Cave, temperatures ranged from winter (June-August) minima of 10–11°C and summer (January-March) maxima of 14–15°C, while 150 m into Bat Cave, the temperature range was 19–21°C. Relative humidities logged near ground level were high (90% or more). Measurements made by Baudinette *et al.* (1994) in February 1993 and 1994 also showed a vertical temperature profile in the maternity chamber of Bat Cave ranging from 22°C at floor level to 30°C within bat roosts in the dome of the chamber, and Hamilton-Smith (1972) reported similar temperature profiles in Bat Cave, both vertically and from the maternity chamber outwards. Figure 4 shows temperatures near the entrance to Bat Cave in relation to Naracoorte ambient maximum and minimum temperatures, for the calendar year 1999. Inspection of figures 3 and 4 shows that significant rapid drops in cave temperatures typically occur following a number of cold nights. Thus the fall in temperature ~28 m inside Bat Cave from 14.2°C on 20 April 1999 to 11.7°C on 27 April 1999 occurred with minimum ambient temperatures of -1, 4, 0 and 1°C recorded in Naracoorte on 22, 23, 24 and 27 April 1999 (minima for 25 and 26 April were not available).

For Victoria Fossil Cave temperatures near the fossil chamber did not vary much from 17–18°C. Blanche Cave had winter minima of 9-10°C and summer maxima of 14–15°C. Temperatures logged in Blanche Cave and in the outer chamber of Robertson Cave were very similar, as shown in Figure 5, where they have been superimposed. Temperatures in the inner chamber of Robertson Cave remained in the range of 14–15°C. Figure 6 illustrates the daily range of temperature variation for Bat (entrance) and Blanche Caves during 1999.

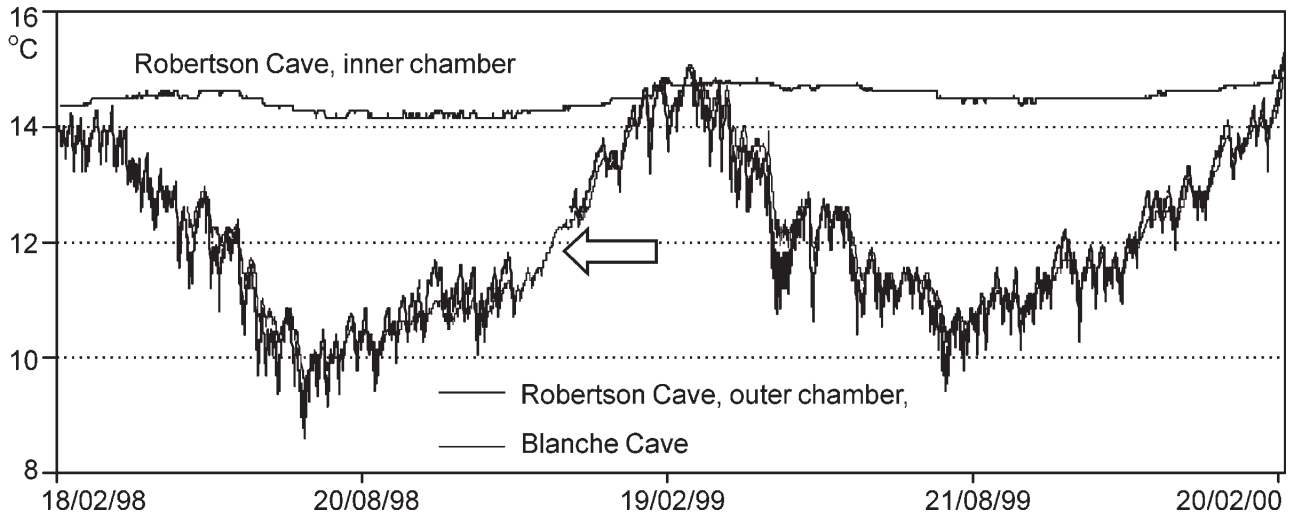

Figure 5. Temperature (°C) logged at 2 hour intervals at 1.5–2 m elevation in the inner and outer chambers of Robertson Cave, and near ground level in Blanche Cave. Arrow indicates period from 19 November to 22 December 1998 when data were collected from Blanche Cave, but not from outer chamber of Robertson Cave. Note that temperatures logged in Blanche Cave and 8 kms away in the outer chamber of Robertson Cave were very similar

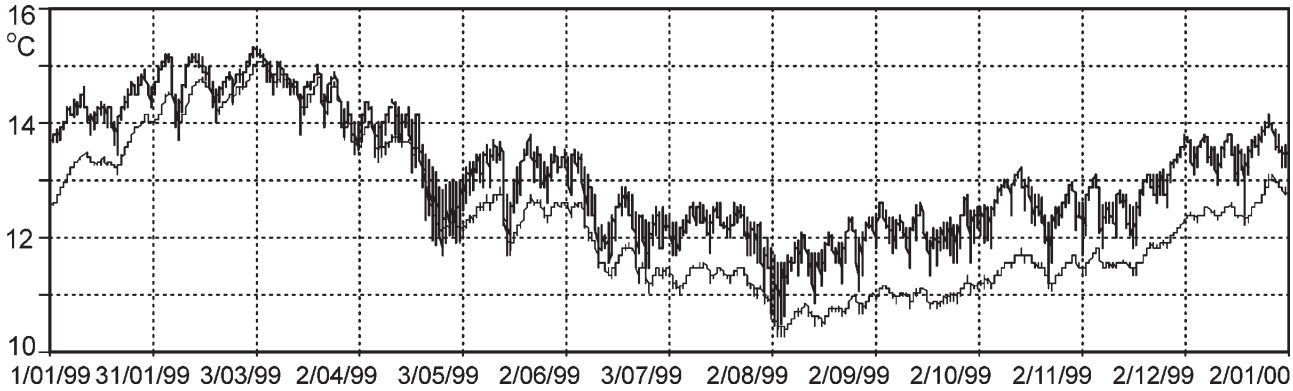

Figure 6. Detailed temperature records for the year 1999 for Blanche Cave (lower, pale record) and Bat Cave (near entrance, upper, dark record), showing daily and seasonal temperature variation.

Discussion

The recordings of cave temperatures show the following:

a) Deep in caves, or where there is little airflow, cave temperature does not change much seasonally. Thus the inner chamber of Robertson Cave remained at 14–15°C from February 1998 to February 2000, the fossil chamber in Victoria Fossil Cave was 17–18°C both summer and winter, and the maternity chamber in Bat Cave near ground level was 19–21°C over a period of 17 months.

The higher temperatures in Bat Cave can be attributed to the bats themselves (Baudinette *et al.,* 1994). The differences in temperature between Victoria Fossil Cave and the inner chamber of Robertson Cave may be due to the fact that the fossil chamber is further into Victoria Fossil Cave, which has entrances sealed by doors, or there may be some increase in temperature in Victoria Fossil Cave attributable to artificial lighting and a regular flow of visitors in the cave.

b) Where there is significant airflow in caves, there can be considerable seasonal variation in cave temperatures. Thus temperatures in the outer chamber of Robertson Cave and in Blanche Cave varied by up to 6°C from summer to winter. This sort of variation has been reported in other caves (Nepstad and Pisarowicz, 1989).

c) Locations favoured by bats for winter roosts (outer chamber of Robertson Cave, near the entrance to Bat Cave) have relatively cool winter temperatures (9–11°C). There may be cues for bat movement between caves that are based on cave temperatures, but these were not obvious from inspection of the temperature records, particularly since some movements occur in late summer.

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Data Files

The cave temperature data described in this report can be downloaded as either tab delimited, or comma delimited ascii text files from the *Helictite* web page at: http://home.pacific.net.au/~gnb/helictite/data.html