Contributions to the Microclimatological and Biospeleological Study of the Olhos D'Água Cave, Castro, PR, Brazil

Silvia Méri CARVALHO
Universidade Estadual de Ponta Grossa. Departamento de Geociências. Ponta Grossa, PR, Brazil.
e-mail: silviamc@convoy.com.br

Abstract

The cavernicolous environment has several peculiar characteristics which influence enormously its ways of life. This study focuses on the underground microclimatology of the "Olhos D'Água Cave", located in the district of Castro, in Paraná state (Brazil). The methodology concerned in collecting and analyzing the variation of the meteorological elements (temperature, relative humidity, evaporation and air pressure). The results showed that the underground microclimate is influenced by the outside atmosphere, specially by the environment nearby opening into and out of the cave and internal variations delay also might happen. The data were collected between 1991 and 1992. Some taxa which were previously observed were confirmed, and some new taxa were listed.

Introduction

The microclimatic studies comprise aspects of high scientific interest such as underground microclimatology. The research on underground climatology, mainly that related to enclosed spaces like grottos and caves, must take into consideration the characteristics of their environments, such as absence of light, shape of the chambers, number of openings, exposition, altitude, geographic position, morphology and capacity to follow external climatic variations, (ANDRIEUX, 1965, 1971; CHEBATAROFF, 1969). The relationship between the characteristic above related and also the presence of a stream of water in the chambers lead to an eventual delay in the assimilation of external events at the cave, influencing the climate behavior.

Methodology

The area of this research was a cave called "Gruta Olhos D'Água", located in the district of Castro, in Paraná State, Brazil. It is a calcareous cave formation, mostly horizontal, and contains a stream in some seasons of the year. Its low depth and good illumination in the openings and light spots were aspects which favored both the installation of instruments and the observation of the meteorological data.

The data collection period (meteorological and biospeleological) was carried through from August 1991 to August 1992, selecting ten days in the peak period of each season. There were two winter seasons (1991 and 1992) in data collecting. The first season also consisted in a test of the registering equipment and the observer and researcher's training (VILLAR et al., 1984). The second was the data collection recording.

The daily data collection refers to the temperature, relative humidity and pressure, as well as evaporation capacity, elements which condition the formation of the underground and surface climates, according to LADDO (1966).

Firstly, among the procedures for the investigation of the climatic elements involved, was the selection of four spots inside the cave named "observation posts". Secondly, it was built a meteorological shelter just outside the main opening. This cave meteorological data were compared with those collected by the Meteorological Station in the district of Castro and with the daily weather forecast bulletins issued by the station.

The meteorological shelter contained a thermo-hygrograph, a barograph and a simple thermometer. Post 1, inside the cave, near the main entrance, contained a thermo-hygrograph; Post 2, further inside, was equipped with a thermo-hygrograph and a barograph; Post 3, in the innermost part of the cave, was equipped with an evaporigraph; Post 4, near the exit, was equipped with a thermo-hygrograph.

The daily records obtained through the diagrams from each instrument in the semi-periods of analysis (seasons) fed tables which then allowed the preparation of daily charts and tables for each season.

The identification of the cave fauna was made by means of collecting and visual identification.

Results and Discussion

The highest temperatures in the collection posts and at the meteorological station of Castro were registered in spring as shown in Table 2.

Hygrometric variation peaks occurred outside the cave environment, as Tables 1-5 demonstrate. Despite the lower variations, the hygrometric degree in "Olhos D'Água Cave" remained high, and it was not constant, generally speaking, Autumn had higher average values. Considering evaporation, the lowest averages were observed in winter, whereas the highest occurred in summer. This behavior is attributed to specific thermal variations in these seasons, as seen in Tables 1-5. Pressure values were higher in winter (Tables 1 and 5) although barometric variations were not very distinct during the other seasons. This can be accounted for by the mostly horizontal development of the cave, so that this variation is related to thermal oscillation.

Through the analysis of the climatic parameters of each post, it was observed that:

- The meteorological shelter, located outside, near the entrance of the cave, registered high temperatures in all seasons, with the maximum temperature always higher than 20°C.

- The highest humidity rates were also high for all seasons, falling below 90% only in the winter of 1992. The highest pressure values were found in winter and the lowest in summer. Post 1, near the entrance of the cave, showed the highest thermal values and the highest averages in spring, as for relative humidity. Values were always above 90% in all seasons and the minimum was never below 70%.

- Post 2, inside the cave, had maximum thermal values of about 18°C to 19°C, except for Autumn, when a maximum of 23°C was recorded.

The spots located far from the entrance in the underground environment, like Post 2, tend to be less influenced by external atmosphere, consequently showing reduced daily ranges.

- Post 3, in which evaporation data were collected, had very low values, always below 2.0 mm in all periods. The low evaporation capacity is due to the high hygrometric degree present throughout the cave.

- In Post 4, the highest temperature was recorded in summer, and the lowest was found in the test period (winter 1991). The maximum relative humidity values were always above 90%, and the minimum above 70%, except for the test period, when it reached 64%.

These conditions are extremely important to the maintenance of life in the cavernicolous environment.

The records listed below complement PINTO-DA-ROCHA´S work (1988) which was specially dedicated to the calcareous caves of Paraná State, including Olhos D'Água Cave. In that occasion two phyla were described: Annelida and Arthropoda.

In this collection which had Olhos D'Água Cave as the main target some extra taxa were observed, such as:

Class Insecta: Order Hymenoptera - *Apis mellifera* (at the entrance)

Order Lepidoptera - Noctuidae (at the entrance)

Class Reptillia: Order Squamata, suborder Ophidia - *Liophis* sp. (near the entrance).

The Opiliones (*Discocyrtus* sp.) were observed in all the periods of the research, especially on the ceiling and the walls near the entrance. Specimens of the Reduviidae family can be found from the entrance to the deeper areas, where there is absence of light.

Only in some collections (spring/summer), the presence of white owls (order Strigiformes) was observed at the second skylight. In the winter of 1991, one rodent was found distant from the entrance, but could not be identified because of its fast movements allowing only visual observation.

A non-poisonous snake, *Liophis* sp., was found in winter. The presence of an ophidian in this cave had already been noticed by visitors and some members of the university group of Speleology Research - GUPE. During the collection, in the summer time (January, 92) many amphibian larvae were photographed in the internal stream, which showed a higher volume than the one which was normally observed before.

The bats can be seen especially in the darkest areas of the cave and at the entrance where a small group was constantly present and through the guano deposited in many places of the cave.

Despite the difficulties of accessing and keeping the equipment in the observation posts and the lack of precise identifications of some specimens, researches like this are very important, because they contribute to

the speleological studies clarifying doubts concerning to such peculiar environments and strengthening the recognition of the ecological conditions.

References

ANDRIEUX, C. 1965. Sur la mesure précise des caractéristiques metéoclimatiques souterraines. Annales de Spéléologie, 20 (3), p. 319-340.

_____, C. 1971. Contribution a l'étude du climat des cavités naturelles des massifs Karstiques-Influence de la morphologie des galeries, de la forme et de l'orientation des ouvertures sur le climat souterrain. Annales de Spéléologie, 26 (1), p. 5-30.

CHEBATAROFF, J. 1969. Introdução ao Estudo dos Microclimas. Boletim Geográfico, 28 (21), p. 17-39.

LLADÓ, N.L. 1966. Karst y Clima. In: Fundamentos de Hidrogeologia Cárstica. Barcelona: Editorial Blume, cap. 14, p. 211-228.

PINTO-DA-ROCHA, R. 1988.Levantamento preliminar da fauna de invertebrados das cavernas calcáreas do Estado do Paraná. XX CONGRESSO NACIONAL DE ESPELEOLOGIA, Brasília, Julho, 1989. Anais. Brasília, 58p.

VILLAR, E. et al. 1984. Air temperatures and air interchanges at Altamira Cave (Spain). Transactions of the British Cave Research Association. Cave Science. 11(2), p.92-98.

Table 1 - Meteorological variations registered in "Olhos D'Água Cave" - Winter/91

	Temperature ºC				Relative Humidity%				Evaporation mm				Pressure mb			
	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver
Shelter	21	5	16	11.7	96	48	38	79.9	-	-	-	-	944	925	19	932.9
Post 1	15	9	6	13.0	100	72	28	91.4	-	-	-	-	-	-	-	-
Post 2	19	17	2	17.8	93	75	18	88.6	-	-	-	-	945	925	20	933.1
Post 3	-	-	-	-	-	-	-	-	2.0	0.5	1.5		-	-	-	-
Post 4	17	7	10	13.5	97	64	33	82.4	-	-	-	-	-	-	-	-
Castro	24.4	0.6	23.8	14.1	100	54	46	89.5								

Table 2 - Meteorological variations registered in "Olhos D'Água Cave" - Spring/92

	Temperature ºC				Relative Humidity%				Evaporation mm				Pressure mb			
	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver
Shelter	29	9	20	16.5	92	35	57	77.4	-	-	-	-	939	929	10	932.3
Post 1	22	15	7	18.1	97	70	27	93.8	-	-	-	-	-	-	-	-
Post 2	19	18	1	18.4	80	74	14	75.6	-	-	-	-	937	923	14	930.1
Post 3	-	-	-	-	-	-	-	-	1.0	0.5	0.5	0.7	-	-	-	-
Post 4	16	10	6	13.4	100	78	22	95.1	-	-	-	-	-	-	-	-
Castro	30.2	13.2	17.0	18.9	100	45	55	78.8								

Table 3 - Meteorological variations registered in "Olhos D'Água Cave" - Summer/92

	Temperature ºC				Relative Humidity%				Evaporation mm				Pressure mb			
	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver
Shelter	25	11	14	17.4	97	55	42	80.9	-	-	-	-	935	920	15	928.3
Post 1	19	13	6	16.0	90	70	20	85.5	-	-	-	-	-	-	-	-
Post 2	18	13	5	15.3	94	86	8	89.8	-	-	-	-	937	924	13	930.9
Post 3	-	-	-	-	-	-	-	-	1.5	0.0	1.5	0.7	-	-	-	-
Post 4	21	11	10	15.2	100	80	20	93.9	-	-	-	-	-	-	-	-
Castro	29.8	15.7	21.5	100	36	64	74.5									

Table 4 - Meteorological variations registered in "Olhos D'Água Cave" - Autumn/92

	Temperature ºC				Relative Humidity%				**Evaporation mm**				**Pressure mb**			
	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver
Shelter	20	5	15	13.3	95	31	64	80.6	-	-	-	-	938	924	14	930.1
Post 1	17	11	6	14.6	97	81	16	92.6	-	-	-	-	-	-	-	-
Post 2	23	17	6	18.0	98	92	6	94.2	-	-	-	-	940	927	13	933.3
Post 3	-	-	-	-	-	-	-	-	1.0	1.0	1.0	0.2	-	-	-	-
Post 4	17	10	7	14.9	93	84	9	88.6	-	-	-	-	-	-	-	-
Castro	24.3	11.4	12.9	16.6	100	43	57	81.4								

Table 5 - Meteorological variations registered in "Olhos D'Água Cave" - Winter/92

	Temperature ºC				Relative Humidity%				**Evaporation mm**				**Pressure mb**			
	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver	Max	Min	Ampl	Aver
Shelter	21	4	17	14.3	84	60	24	78.8	-	-	-	-	946	934	12	940.0
Post 1	16	11	5	13.9	97	80	17	81.8	-	-	-	-	-	-	-	-
Post 2	19	13	6	15.1	89	78	11	82.9	-	-	-	-	944	932	12	938.0
Post 3	-	-	-	-	-	-	-	-	0.5	0.0	0.5	0.5	-	-	-	-
Post 4	18	9	9	15.1	95	78	17	91.0	-	-	-	-	-	-	-	-
Castro	22.7	2.6	20.1	12.7	100	44	56	87.5								