Karszt és Barlang, Special Issue 1977, p. 31 — 34, Budapest

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SPELEOCLIMATOLOGICAL RESEARCH IN HUNGARY: RESULTS AND SPELEOTHERAPEUTIC APPLICATIONS

SUMMARY

Speleoclimatological research recently undertaken in Hungary has included the following major works: 1. the meteorological modelling of caves, 2. anthropo-bioclimatological research in caves, with special emphasis on their natural health resort function, 3. meteorological observations as a part of biospeleological research, 4. sporadical meteorological observations in caves in the service of other scientific fields (hydrology, geology, etc.) 5. improvement of instruments used in speleoclimatological research.
The concluding part of the paper deals with the application of speleotherapy which has found a wide use in Hungary in the last decade and a half. At present, three cave-sanatoria are in service in Hungary, where patients suffering from asthma bronchiale and cronicus bronchitis are cured.

Extensive speleoclimatological research began in Hungary in the 1920's and 1930's where it was associated with L. Steiner, D. Berényi, E. Dudich and A. Gebhardt. For example, Berényi investigated the thermal regime of Zichy Cave and environs at Rév village and compared the cave to the famous Baradla Cave at Aggtelek (Berényi, 1943).

A different approach was introduced in the same years by biospeleologists who measured many parameters of cave climate as a part of their investigations of the particularities of the cave biotope. They were principally concerned with the effects of cave climate stability or instability upon cave fauna. For example, in 1928—29 Dudich made detailed measurements of temperature, atmospheric moisture, airflow, limit of light penetration and hydrological and soil conditions at Baradla. Inside of the immediate entrance zone he found maximum and minimum temperatures were 4.5° C and 11.5° C, with a mean value of 9.5° C. He considered this variation to be comparatively low and did not find, either in the principal passage or secondary passages of the cave, any places of strikingly different and peculiar thermal characteristics. Consequently, the cave represents an oligothermous and stenothermous biotope, i.e. a biotope favourable for psychrothermous fauna (Dudich, 1932). Dudich also determined that relative humidity of the Baradla was high and displayed little fluctuation, making the cave a biotope suitable for polyhygrous animals. He established the limits of daylight penetration at 60 metres from entrance No. 1, at 95—100 metres from entrance No. 2, and at 70 metres from entrance No. 3.

Cave ecology and the behaviour of cave organisms were also investigated by A. Gebhardt at Abaliget Cave (Gebhardt, 1934). In a valuable study, he describes 287 species and groups of animals collected by himself and collaborators between 1900 and 1930. In addition to systematic description of these fauna, the paper reports on the particular living conditions prevailing in the cave, so furnishing a good deal of valuable information on its climate; for example, from year-round observations he established a mean annual temperature of 12.6° C, a minimum of 10° C and a maximum of 13.6° C. He also evaluated absolute and relative humidity conditions and the nature of air circulation in the cave.

Since the 1950's researchers have made many new contributions to the national and international literature on cave climate. The increased activities of recent years may be ascribed to two factors:
1. the development of many new meteorological instruments with the consequent increase in the range of topics that may be investigated,
2. new concepts for the practical utilisation of caves.

Considering the first factor, a common problem in speleoclimate research is that the daily and annual variability of external climatic parameters is con-

siderably higher than that of corresponding parameters underground. There is a need for instruments of high resolution, including electronic recorders. However, if such instruments are introduced without an increase in the accuracy of specific measurements, the reliability of the results is decreased due to superimposed secondary phenomena. With new developments in instrumentation, speleoclimatic research will embrace continuous recording of air temperature, humidity, airflow, atmospheric pressure, atmospheric pollution, ionisation, radioactivity and measurement of airborne bacteria content etc., etc.

The second factor is a consequence of the accidental discovery in the post-war years by physicians and other specialists working at Klutert Cave in the Federal Republic of Germany, that cave atmospheres have special and helpful physiological effects upon human respiratory organs. This discovery has underlined the need for very detailed instrumental measurements based upon the new generation of instruments.

A new approach to climatological research in natural and artifical underground voids has been proposed by B. Béll. He was the first to discuss an energy-based approach to the subject. In a paper discussing air circulation in mines he develops a set of theoretical statements which also apply to caves but he indicates as well the differences that stem from the artificial energy sources operating in the mining situation (Béll, 1945).

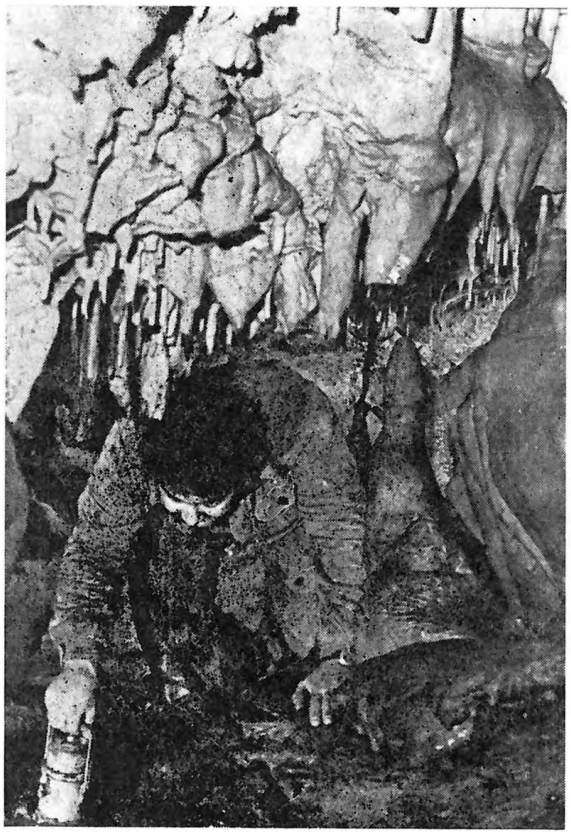
Our comprehension of air circulation conditions in caves has been expanded by L. Jakucs (1953) and Jakucs and L. Markó (1956) who explain physical circumstances responsible for the generation of air currents, tracing the pressure differences that provoke air currents back to differences of air temperature in most instances. D. Balázs, from his own work and that of earlier researchers attributed the generation of air currents in caves to differences between external and internal air density (Balázs, 1969).

D. Berényi and J. Justyák (1960) examined the climate close to the entrance of Baradla Cave in detail. They are the first to show that in addition to horizontal temperature gradings, vertical temperature gradients also occur in the cave. They make an interesting comparison with the climate of a wine cellar. "The temperature differences as a rule are smaller than the values measured in the entrances of wine cellars. Whereas in cellar entrances differences in temperature over the ten to two hundred centimetre extent of the entrance are higher than 1° C, at grottoes with actively growing stalactites or stalagmites in the caves, this figure is 0.5° C or less" (Berényi—Justyák, 1960).

L. Kordos has examined many aspects of cave climate especially at and near to cave entrances and particular attention is drawn to his detailed work (Kordos, 1970, 1975).

Valuable data on the meteorological conditions of the caves of Aggtelek have been published by M. Csomor and L. Zalavári (1964). They used mainly self-recording instruments in Baradla Cave and Béke Cave. Although, "the self-recording instruments are not completely suitable for speleoclimate measurements because their measuring range is too large compared to the actual range" (Csomor—Zalavári, 1964), nevertheless, it seems expedient to use them in both entrance and interior parts of caves, although S. Holly (1956) has rejected this. If manual instruments of high resolution are operated for short periods together with long-period, self-recording instruments the latter may be precisely calibrated. Csomor and Zalavári summed up results of air pressure measurements "the variation of the air pressure is steady and uniform, irrespective of the irruption or transits of single fronts. The curves cover one another; in other words, there is no essential difference in time or in scale of change" (Csomor—Zalavári, 1964).

Climatic conditions in caves in the Bükk Mountains were investigated by Gy. Szabó and L. Lénárt (Lénárt, 1975). Detailed examination of the climate of vertical shafts in Hungary was started by A. Walkovszky (1970) who analysed variations of vertical temperature and moisture gradients in Vecsembükk Shaft.



Characteristic narrow passage in the Szabadság Cave, Égerszög (by T. Seregélyes)

L. Kordos (1975) has discussed the broad problems of environmental equilibrium, including cave climate, as a part of the question of cave protection. I. Fodor examines effects of tourists and tourism on cave microclimate. He has sought to measure the amount of the anthropogenic impact—in physical, chemical and biological terms—that the atmosphere of a cave can endure without any lasting damage; in other words to discover the physical conditions under which or by which the natural state of a cave's climate is restored or regenerated. By developing a bioclimatological classification of caves he has produced a man-centered classification scheme. This is based upon the impacts, positive or negative, that a man would have in a cave. His system is expressed by the Bradtke index which uses temperature, moisture and air circulation (Fodor, 1975).

Use of caves for speleotherapeutic purposes has already been mentioned. Following the example at Klutert Cave, medical experiments in Hungary were first undertaken in Béke Cave at Aggtelek upon the initiative of L. Jakucs (1953, 1959). Since 1969 a sanatorium has been functioning at Jósvafő above the cave. At Abaliget the first medical observations were started in 1959 and experiments have continued since that time, with physicians taking part. Regular speleoclimatological-therapeutic experiments are pursued in a portion of Tapolca cave system underlying a hospital. Similar experiments have been carried out at Tavas Cave.

First results of the Béke Cave experiments were published by L. Jakucs (1959). On the basis of the statistically significant favourable results obtained from treatment of the first 100 patients, experiments have been continued and expanded in scope. A new entrance is being opened into the cave in order to permit easier access for patients. With its Jósvafő entrance opened the Béke Cave will provide lots of possibilities for speleotherapy. A comprehensive description of the cave sanatorium is given by B. Kerényi, Zs. Bíró and M. Kirchknopf (1960).

Medical tests in Béke Cave were continued by P. Kraszkó, T. Szoboszlay and J. Jónás who conclude that cures in the cave are "Useful in the case of chronic obstructive bronchitis and chronic bronchial asthma unless a status asthmaticus, purulens superinfectio, cardialis decompensatio or other organic lung diseases are present in the period concerned" (Kraszkó, Szoboszlay, Jónás, 1972).

The climate of Abaliget Cave and its curing effect have been studied by A. Urbán (1970), L. Szabó (1963), J. Páter, E. Pintér, I. Somogyi, E. Tóth and Mrs. K. Tímár (1974) and I. Fodor (1969, 1970—71, 1970a, b, 1971, 1973, 1975). Speleotherapeutic results are summarised by Gy. Kövesi, J. Háber and M. Poniczky (1974). Patients attending Abaliget Cave spend two hours underground each day during a period of cure of one month.

Valuable scientific information on the bioclimatological conditions of Tavas Cave, Tapolca, has been published by H. Kessler, J. Mórik, Z. Morlin and T. Várkonyi (1973). These authors examined the purity of the air, its temperature, moisture and circulation conditions and the aerosol condition of the vapour condensate. Speleotherapeutical tests began in 1969. Patients spend three week terms in the hospital above the cave, including a daily four hours inside the cave. A total of 536 persons suffering from respiratory illnesses have so far been treated at Tapolca. The two entrances of the Béke Cave have been declared to be "medicinal caves" by official decree of the Ministry of Health and the Tavas Cave at Tapolca is now being considered for this designation.

A group of patients in the Abaliget Cave

English translation revised by D.C. Ford.

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REFERENCES

BALÁZS, D. (1969): Adalékok a barlangi légáramlás tanulmányozásához. (Beiträge zum Studium der Höhlenluftströmung.) Karszt és Barlang, I. 15—24.

BERÉNYI, D. (1943/a): Hőmérséklet-észlelések a révi Zichy-barlangban és környékén. — Pótfüzetek a Term. Tud. Közlönyhöz. 4.

BERÉNYI, D. (*1943/b*): Magyarország Thornthwaite rendszerű éghajlati térképe és az éghajlati térképek növényföldrajzi vonatkozásai. — Időjárás, 47. 5—6.
BERÉNYI, D.—JUSTYÁK, J. (*1960*): Mikroklimatológiai megfigyelések az Aggteleki-cseppkőbarlangban. — Kossuth L. Tud. Egy. Mat. Int. Közl. 17., Debrecen.
BÉLL, B. (*1945*): A levegő áramlása bányákban és barlangokban. — Időjárás. 1—12.
CSOMOR, M.—ZALAVÁRI, L. (*1964*): Barlangklímamérések a Baradlában és a Béke-barlangban. — Karszt és Barlang, II. 45—51.
DÉNES, GY. (*1970*): A Dobsinai-jégbarlang és klímájának kutatása. — Karszt és Barlang, II. 85—88.
DUDICH, E. (*1932*): Biologie der Aggteleker Tropfsteinhöhle „Baradla" in Ungarn. — Wien.
FODOR, I. (*1969*): Az Abaligeti-barlang mikroklímája és hatása az élő szervezetre. — Pécsi Műszaki Szemle, júl.—szept. Vol. XIV. 3.
FODOR, I. (*1969—1970*): Einige Eigenschaften der Luftbewegungsverhältnisse in der Höhlen. — Acta Geographica Debrecenia. Tomus XV—XVI. 267—273.
FODOR, I. (*1970/a*): A Baradla- és a Béke-barlang hőmérsékletének vizsgálata. — Földr. Tanulmányok a Dél-Dunántúl területéről. — Budapest.
FODOR, I. (*1970/b*): Az Abaligeti és a Baradla barlangok légáramlási viszonyai. — MTA Dunántúli Tud. Int., Közl. 11. Pécs.
FODOR, I. (*1971*): Angaben zum Mikroklima von Eishöhlen. — Slovensky Kras, Rocnik 9.
FODOR, I. (*1973*): Cave-climatic investigations of the Karstic Region of Aggtelek and the Mecsek. — Karszt- és Barlangkutatás, VII.
FODOR, I. (*1975*): A barlangok főbb típusainak éghajlati és bioklimatológiai sajátosságai. — Kandidátusi Értekezés. Pécs.
GEBHARDT, A. (*1934*): Az Abaligeti-barlang élővilága. — Mat. és Term. Tud. Közl.
HOLLY, S. (*1956*): Sulle misure di meteorologia ipogea. — Atti del VI. Congr. Naz. di Speleologia Trieste. — Trieste.
JAKUCS, L. (*1953*): A Béke-barlang felfedezése. — Budapest.
JAKUCS, L. (*1959*): A Békebarlang gyógyhatásvizsgálatának első eredményei. — Term. Tud. Közl., 1959. I.
JAKUCS, L.—MARKÓ, L. (*1956*): A barlangi légáramlás keletkezése. — Hidr. Közl. IV.
KERÉNYI, B.—BÍRÓ, ZS.—KIRCHKNOPF, M. (*1960?*): A Béke barlang gyógyhatásának hasznosítása.
KESSLER, H.—MÓRIK, J.—MORLIN, Z.—VÁRKONYI T. (*1973*): Lufthygienische Untersuchungen in der Tavas-barlang von Tapolca. — Karszt- és Barlangkutatás, Vol. VII.
KORDOS, L. (*1970*): Klímamegfigyelések a barlangok bejárati szakaszaiban. — Karszt és Barlang, I. 31—34.
KORDOS, L. (*1975/a*): A barlagok bejárati szakaszainak klímavizsgálata. — Bericht über das II. Speläotherapische Symposium der Int. U. für Höhlenkunde, 1972.
KORDOS, L. (*1975*): A barlangok komplex védelmének kérdései és feladatai. — Int. Conf. „Baradla 150". Budapest.
KÖVESI, GY.—HÁBER, J.—PONICZKY, M. (*1974*): Az abaligeti barlangszanatóriumban kezelt chronicus aspecifikus tüdőbetegek vizsgálata során szerzett tapasztalatok. — Manuscript. Pécs.
KRASZKÓ, P.—SZOBOSZLAY, F—JÓNÁS, J. (*1972*): A barlangklímatherápia obstructív syndromában. — Manuscript.
LÉNÁRT, L. (*1975*): Klimatológiai mérések a Bükk-fennsíkon levő Létrási-Vizes-barlangban. — Int. Conf. „Baradla 150". Budapest.
PÁTER, J.—PINTÉR, E.—SOMOGYI, I.—TÓTH, E.—TIMÁR, K. (*1974*): Az Abaligeti-barlang komplex egészségügyi vizsgálata. — Manuscript.
SOMOGYI, J. (*1975*): Kísérleti eredmények és további tervek a Tapolcai-Tavas-barlangban. — Bericht über das II. Speläotherapische Symposium der Int. U. für Höhlenkunde, 1972. Budapest.
SZABÓ, L.—KOVÁCS, I.—NOSSMÜLLER, S. (*1963*): Klímavizsgálatok az Abaligeti-barlangban. — Pécsi Műszaki Szemle, VIII. 3.
URBÁN, A. (*1970?*): Klímavizsgálatok az Abaligeti-cseppkőbarlangban. — Baranya megyei KÖJÁL kiadványa.
WALKOVSZKY, A. (*1970*): Mikroklímamérések a Vecsembükkizsombolyban. — Karszt és Barlang, I.

Cave divers in the lower passage of Baradla Cave (by L. Kunkovács)