Scientific expedition Chimantá – Roraima 2009 (Venezuela)

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Abstract

The last international expedition to the table mountains in Gyana Highland, in the border area of Venezuela, Brazil and Guyana brought again the great speleological and scientific discoveries. Two table mountains (tepuis) were attended – Churí tepuy in Macizó Chimantá and Roraima tepuy in Roraima Group. We discovered two new caves with length more than 1 km – Cueva Colibri (4 km) and Cueva Yanna (1.08 km); and elonged the caves Cueva Zuna (3.52 km) and Cueva Charles Brewer (7.5 km). Total length of new discovered space is more than 8.5 km. The last expedition, Chimantá – Roraima 2009, which scientific tasks were geological, hydrogeochemical and biological field research, also the longest one – Cueva Ojos de Cristal (16.14 km) and the largest one – Cueva Charles Brewer (7.5 km) caves in silicious rocks in the world, were explored. Horizontal shape of those caves is underlined by lithological settings. Our results show that the speleogenesis tooks place in the horizons which were unlithified or only poorly lithified, because they were sheltedred from the diagenetic fluids by the impermeable overlying and underlying rocks. Extensive sampling of biospeleothem surfaces was also carried out during the expedition. New species of living organisms were found in the caves and on the surface of tepuis.

Keywords: Cueva Charles Brewer, Cueva Ojos de Cristal, Chimantá, Roraima, Venezuela, caves, speleology, tepuis, quartzite karst.

INTRODUCTION

In January-February 2009, Charles Brewer-Carías, Branislav Šmída and Federico Mayoral organized an expedition with duration of almost two months, to the underground of the

Chimantá and Roraima massifs in Guyana Highlands of northern South America – southeastern Venezuela, State Bolívar (Fig. 1). The team of speleologists and scientists consisted of 14 persons from Venezuela (GSSVCN/Grupo Espeleológico de la Sociedad Venezolana de Ciencias Naturales, Caracas), from Slovakia (SSS/Slovak Speleological Society and FNS UNIBA/Commenius University, Faculty of Natural Sciences, Bratislava) and Croatia (CSF – HSS/Croatian Speleological Federation). The longest and biggest quartzite caves of the world where again explored during the stay, discovered by us in 2002 – 2007. Nowadays the known length of Cueva Charles Brewer is after connection with Cueva del Diablo Cave 7.5 km and the Cueva Ojos de Cristal cave system, enlarged in 2007, with known length by now more than 16.1 km. Beside standard speleological exploration, topography, photodocumentation also focusing on complex evaluation of natural phenomenon, survey, measurement, sampling (rock material, biospeleothems, water, minerals, microbiological and biospeleological material) also new big cave sites on Churí tepuy were discovered.

SPELEOLOGICAL EXPLORATION

During 8 expeditions since 2002 to 2009 to the table mountains Chimantá, Roraima and Kukenán was discovered by international team of speleologists about 40 km of quartzite caves. 16.14 km long Cueva Ojos de Cristal Cave on Roraima Mountain represents the longest cave in silicic rocks in the world and simultaneously the second longest cave in Venezuela. Cueva Charles Brewer Cave on Macizó Chimantá Massif is the most spacious cave in quartzite karst and one of largest caves in the world. In 2009 was reached the connection between Cueva Charles Brewer and Cueva del Diablo and the length of the cave system reached to more than 7.5 km.

During the expedition in 2009 more than 8.5 km of cave passages were explored. The largest cave named as Cueva Colibri (The Colibri Cave) is 4 km long and starts in the abyss which is about 300 m long, 100 m wide and 120 m deep. The cave is formed by 3 huge branches where the average width of galleries is about 20 to 30 m. A large labyrinth of smaller river channels is formed there, too. The system has 6 entrances; 4 of them are situated directly on the outer, 500 m high wall in the northern corner of the tepuy. The largest entrance is formed by the 100 m wide portal, partially covered by giant fallen blocks. In the cave, several until now not described forms of biospeleothems and mineral aggregates were found. The Cueva Colibri is now the 4th longest and 2nd volumetrically largest quartzite cave in the world. The next cave,

Cueva Juliana, discovered in 2007, was prolonged up to 3 km. For the first time in quartzite caves the standard digging methods were applied. In this cave, giant forms of champignon-type biospeleothems were recognized with diameters up to 1 m. Similar huge biospeleothems and sanjuanite mineral aggregates are localized also in Cueva Zuna, which was mapped to the length of 2.52 km. Other very important result of the expedition was discovery of the connection between the Cueva Charles Brewer and the Cueva del Diablo (The Devil´s Cave) to one common system with actual length of more than 7.5 km. The newly discovered Cueva Yanna is 1.08 km long with potential to connection by Cueva Juliana. Some other smaller caves were found, too. The entire actual length of the cave systems of Chimantá is now more than 20 km.

Simultaneously with the classical speleological exploration, scientific investigations were performed, too by a scientific team from the Comenius University in Bratislava. Geological, geomorphological and biological conditions were investigated repeatedly in the underground and the surface, water samples were analysed and also microclimatic conditions were evaluated.

GEOLOGICAL EXPLORATION AND RESEARCH

The expedition Venezuela 2009 was aimed at continuation of geological research on the basis of the data obtained during the previous expedition in 2007. Based on earlier consultations with distinguished sandstone karst experts, the data on the rock hardness were objectivized using Schmidt's hammer. The preliminary data showed that there is a real dependence between the rock hardness and bed horizons in which the sandstone caves form. The sandy sediments directly in the cave horizon showed much lower values of hardness than for instance the overlying or underlying rocks, or rocks randomly measured in the field. Hence, the subjective evaluations of the researchers from the year 2007 got exact numerical expression. However, these field measurements do not show the reason which caused the lower hardness and resistivity of the rocks. Presently used model of arenization, introduced by Martini (1979), which involves quartz cement dissolution and release of sand grains appears as incorrect. Quatz dissolves mainly in alkaline waters, whereas PH of the water on the Venezuelan tepuis is always lower than 7. Our results show that the speleogenesis tooks place in the horizons which were unlithified or only poorly lithified, because they were sheltedred from the diagenetic fluids by the impermeable overlying and underlying rocks. Another important factor is lateritization of clay minerals (mainly kaolinite) which form matrix of the

sandstones in some horizons. Unlike quartz dissolution, lateritization runs well in acidic conditions. We suppose that it results not only in release of sand grains but the laterittic products also form the well-known red mud ("barro rojo") which forms at many places in the caves. The working hypothesis then says that these are the two main factors influencing speleogenesis on the tepuis. To verify this hypothesis, every measured place was sampled. The samples are being processed in the engineering geology labs. Later they will be used for detailed petrographic research. The SEM study already showed that there is no etching of quartz or quartz cements. Instead, they confirmed presence of kaolinite in the sandstones. Presence of kaolinite, together with goethite (one of the lateritization products), was also verified by the XRD analysis of "barro rojo".

Extensive sampling of speleothem surfaces was also carried out during the expedition. The samples from 2007 were tentatively cultivated by usual biological methods but they failed. The microbes forming the speleothems belong to so-called extremophiles which are difficult to be cultivated by normal methods. Their cultivation requires time-consuming and laborious creating of a special imitation of the natural environment in which the microbes live. The new samples were therefore sent to the Technical University in Munich, Germany (Dr. Natuschka M. Lee) where they will be treated by modern microbiological methods, such as in-situ hybridization which enables determination of microbial groups even from a microbial mixture sampled in the field. The cultivation process is then unnecessary.

HYDROGEOCHEMICAL AND BIOLOGICAL RESEARCH

Within geochemical field exploration during the two expeditions in years 2007 and 2009 41 water samples were collected from surface and underground streams, lakes, swamp pools, cave wall dripping waters and springs on the Mt. Roraima and the Churí tepuy. As a part of field works pH and conductivity measurements were performed. The water samples were filtered through filters with mesh 0.45 μm. Colorimetric measurements of Fe, SiO_2–Si, Al, PO_4^{3}—P and NO_3^{-}—N concentrations were performed using the Merck Spectroquant® Multy portable colorimeter. The range of the measured parameters was extended by Mn and NH_4^{+}-N content in 2009.

The water chemical composition of the studied region is influenced by several processes: rock-water interactions, organic detrit decomposition, evaporation and also the chemical composition of the precipitation water. The weak quartz solubility is causing extremely low conductivity values measured in the water (minimum measured value is 2 $\mu S.cm^{-1}$, maximum

28 μS.cm^{-1}). Typical low pH values measured in the water are caused by the weak neutralization capacity of the quartz dissolution reaction as well as the plant detrit decomposition processes producing different organic acids. Presence of the organic acids is manifested by typical yellowish to reddish color of the water. The measured pH values lies within an interval 3.3 to 5.64.

Hydrobionts, mainly macrozoobenthos, were sampled during several visits of Venezuela, 8 times on Roraima and it´s surroundings, 4 times in the surroundings of Auyán tepuy – Carrao and Churún river and their tributaries. A systematic sampling was realized on Churí tepuy During January-February 2009. The samples were categorized into the taxonomic units in the laboratory and nowadays, the determination mainly of Ephemeroptera and beetles from fam. Elmidae is in progress. New species from the genus *Jolyelmys* and *Roraima* were discovered and will be described. Within the bounds of hydrobiological research we sampled many of types of water biotops. The macrozoobentos assemblages were much richer on Churí tepuy, which is about 400 m lower in comparison with tepuy Roraima. The surface of Churí tepuy is also covered by lush vegetation. Mayflies of the genus *Massartella* were recorded in spring streams and caves on both of tepuis. In Churi tepui other four mayfly species belonging to the fam. Betidae and Leptophlebiidae were captured. Stonefly nymphs (probably *Anacroneuria* sp.) were sampled in cold karst springs. These records can be probably considered the first records of stoneflies in tepuis. The amphibian Orthoptera *Hydrolotus* sp. were common component in cave ecosystems in both tepuis. Many of orders of aquatic insects were found in surface streams; nymphs and imagines of Anisoptera, and imago of Zygoptera. In streams we recorded besides *Massartella* sp. also other species from fam. Leptophlebiidae (probably from the genus *Miroculis*) and 2 unidentified species fam. Beatidae. The nymphs of *Calibaetis* sp. were abundant in stagnant water of swamps. On both tepuis we found Trichoptera fam. Calamoceratidae, Glossosomatidae and Helicopsychidae and other still unidentified Trichoptera. In the periodical waters on Roraima dytiscid *Tepuidesus breweri* was abundant. Gyrinidae were common on Churí tepuy. On Churí we found a new species *Roraima* sp. and some species from *Jolyelmis* sp. (Coleoptera, Elmidae). In stagnant water on Churí we recorded aquatic Heteroptera and grubs of mosquitos (Culicidae); midges (Chironomidae) and Ceratopogonidae were found in all types of aquatic ecosystems. Culicidae and Ceratopogonidae were steadily recorded also in curious aquatic biotop – in jugs of carnivorous plants *Heliamphora* sp.

SUMMARY OF RESULTS

During the scientific expedition Cimantá – Roraima 2009 to the massifs of table mountains Churí (Macizó Chimantá) and Roraima in Venezuela's Guyana Highland were explored underground spaces 8.5 km long. Two new caves longer than 1 km were discovered and geological, hydrological and biological samplings were realized. The geological research shows a new view on the genesis of quartzite karst caves. The sampling form the biospeleothems surface can clarify the genesis of unknown forms of speleothems in those caves. The biological research brought the findings of new orders and species of the surface and caves of Venezuela´s table mountains – tepuis.

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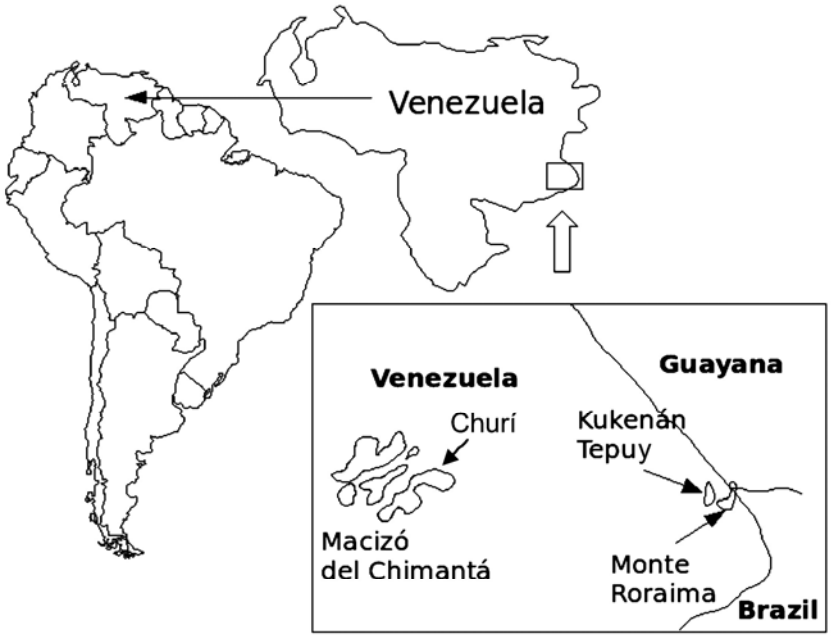

Fig. 1. The localisation of studied area.

Fig. 2. Cueva Zuna – the “Champignons” type of biospeleothems. Photo by J. Stankovič

Fig. 3. One of the main corridors in Cueva Colibri. Photo by J. Stankovič

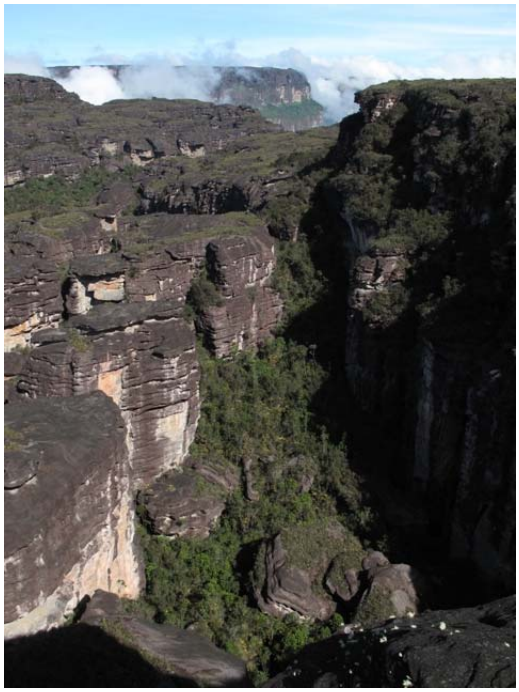

Fig. 4. The view on Churí tepuy “central valley” and the western part of mountain. Photo by B. Šmída

Fig. 5. The corridor in the western part of Cueva Ojos de Cristal. Photo by P. Medzihradský