Speleology of Georgia: Aspects of its current situation and perspectives

Article *in* Cave and Karst Science · January 2010

CITATIONS
6

READS
461

6 authors, including:

Tsikarishvili K.
The University of Georgia (Tbilisi)
50 PUBLICATIONS **153** CITATIONS
SEE PROFILE

Shalva Barjadze
Ilia State University
98 PUBLICATIONS **420** CITATIONS
SEE PROFILE

Eliso Kvavadze
Georgian National Academy of Sciences
123 PUBLICATIONS **3,482** CITATIONS
SEE PROFILE

Nana Bolashvili
Ivane Javakhishvili Tbilisi State University
41 PUBLICATIONS **119** CITATIONS
SEE PROFILE

Cave and Karst Science, Vol.37, No.3, 2010
Transactions of the British Cave Research Association

ISSN 1356-191X

Speleology of Georgia: aspects of its current situation and perspectives.

Kukuri TSIKARISHVILI [1], Shalva BARJADZE [2], Eliso KVAVADZE [3], Nana BOLASHVILI [1], Revaz DJANASHVILI [2] and Inga MARTKOPLISHVILI [3]

[1] Vakhushti Bagrationi Institute of Geography, 1/8 Aleksidze Street, 0193, Tbilisi, Georgia.
e-mail: kukuritsikarishvili@ymail.com
[2] Entomology and Biocontrol Research Centre of Ilia State University, 31 Chavchavadze Avenue, 0179, Tbilisi, Georgia.
e-mail: shalva1980@yahoo.com
[3] Institute of Palaeobiology of Georgian National Museum, 4 Niagvris Street, 0108, Tbilisi, Georgia.
e-mail: ekvavadze@mail.ru ; imartkoplishvili@yahoo.com

Abstract: Currently there are 1306 known karst caves in Georgia, of which 480 are horizontal caves and 826 are shafts and chasms. Their total length is 240km and their cumulative depth is about 61km. The world's two deepest known caves, Krubera (Voronja) (2,191m deep) and Illyuzia–Mezhonnogo–Snezhnaya (1,753m deep), are located in Georgia. Information about the longest and deepest caves is provided. The histories of speleological and speleobiological investigations are briefly reviewed, and the necessity of advancing local people's speleological education is raised.

Received: 01 December 2010; Accepted: 24 December 2010.

In spite of long history of interest in the caves, some of which have been known since the prehistoric period, only about 60 easily accessible horizontal caves (Sataplia, Shroma, Adzaba, etc.) and chasms were known in Georgia in 1958. Together their length totalled about 7,700m and the maximum depth reached was 160m (Kiknadze, 1984). After the establishment of a laboratory of karstology and speleology at the Institute of Geography of Georgia and the founding of the speleo-committee at the Presidium of the Academy of Sciences of Georgia, systematic and routine research of the karst caves of Georgia began. In just a short time the "Cadastre of Karst Caves" was prepared and published, comprising a list of about 300 caves (Kipiani *et al.*, 1966). Based on the new discoveries made each year, the Cadastre of Karst Caves of Georgia has been updated and enhanced (Table 1).

Western Georgia's karstic outcrops lie along the southern slope of the Greater Caucasus mountain range (see Klimchouk, 2004, Fig.1), extending some 325km from the Psou River to the Ertso Lake area. The total area of karstic rock outcrop amounts to about 4,475km^2, or 6.4% of the total area of Georgia. According to the hypsometrical data the karstic belt is characterized by a sharply delineated vertical zonation of the natural landscape and it is distributed from the Gagra–Gantiadi coastal area (with its submarine springs) to 2,757.6m a.s.l. (at the Peak of Speleologists on the Arabika Massif) (Kipiani, 1974).

Date	Horizontal caves		Shafts and chasms		Total caves
	Number and (%)	Total length, (m)	Number and (%)	Accrued depth (m)	
01.06.1958	–	7,700	–	160	60
01.06.1966	221 (73.4%)	26,670	80 (26.6%)	4,160	301
01.06.1973	340 (71.7%)	55,431	134 (28.3%)	6,690	474
01.01.1989	405 (37.6%)	143,931	673 (62.4%)	43,100	1,078
01.01.2001	452 (36.8%)	195,500	777 (63.2%)	49,476	1,229
01.01.2005	464 (37.3%)	202,140	780 (62.7%)	55,330	1,244
01.01.2009	480 (36.7%)	239,245	826 (63.3%)	60,780	1,306

Table 1: *Quantitative indices of karst caves in Georgia.*

On the basis of the results of complex geographical and speleological investigations the karst of western Georgia is subdivided into:

a) the middle and high mountain limestone massifs (>1,000m a.s.l.), comprising the Arabika, Bzipi, and Gumishkha high mountain and the Okhachkue, Kvira, Gaucha, Mingaria, Askhi, Khvamli, Racha and Kudaro middle mountain limestone massifs;
b) the foothills and intermontane plain (low mountain) limestone massifs (<1,000m a.s.l.). From the Gagra area to the Psirtskha, Gumista, Chaama, Tsebelda and Panavi limestone massifs in Abkhazia; the Urta and Unagira limestone massifs (Ekismta, Abedati and Nakalakevi) in Samegrelo; in the Kvemo Imereti region – the Sataplia–Tskhaltubo and Okriba massifs (Kutaisi–Navenakhevi and Okriba–Argveta) and the Zemo Imereti structural plateau together with all of the Chiatura district;
c) the clasto-karstic massifs of the plain, represented by the Bach–Otkhara and Duripshi plateaus, the Jali and Tsebelda conglomerate massifs (in Abkhazia) and the vast clasto-karstic regions of Central Samegrelo (Tintilozov[1], 1976).

According to data available on 01 July 2010, the number of the caves investigated in Georgia exceeds 1,300, whereas in the 1960s the number of recorded caves barely exceeded 300 (Kipiani *et al.*, 1966; Tatashidze[1] *et al.*, 2009a). The total length of the explored caves is 240km and the accrued depth of the known systems is more than 61km. 855 of the caves investigated (65.5%) lie in the middle and high mountain massifs (1,900 – 2,400m a.s.l.); 397 caves (30.4%) are in the foothills and intermontane plain and 54 caves (4.1%) are developed on the limestone conglomerates of the plain (Table 2).

Limestone massifs	a.s.l. (m)	Karst caves			Accrued depth (m)	Total length (m)
		Total number	Shafts and chasms	Horizontal caves		
Medium and high mountain	>1000	855	712	143	50,800	129,790
Foothills and intermontane plain	<1000	397	108	289	6,575	75,239
Plain clasto-karst massifs	<1000	54	6	48	575	10,360
Total		1,306	826	480	60,780	239,245

Table 2: *Distribution of karst caves according to type of limestone massif (after Tatashidze et al., 2009).*

Depth and length rankings	Shafts and chasms		Horizontal caves	
	Number and (%)	Accrued depth (m)	Number and (%)	Total length (m)
<20	335 (74.4%)	5,160	115 (25.6%)	9,100
21–50	263 (68.8%)	9,290	119 (31.2%)	20,250
51–100	126 (57.8%)	9,150	92 (42.2%)	22,520
101–200	56 (47.4%)	9,300	62 (52.6%)	25,600
201–300	20 (35.7%)	4,895	36 (64.3%)	17,250
301–400	4 (20.0%)	1,485	16 (80.0%)	7,000
401–500	8 (57.1%)	4,150	6 (42.9%)	6,900
501–1000	7 (32.0%)	6,630	18 (68.0%)	26,200
1001–2000	6 (46.2%)	8,280	7 (53.8%)	74,080
2001–3000	1 (16.7%)	2,191	5 (83.3%)	13,550
>3000	–	235	4 (100%)	17,000
Total	826 (63.3%)	60,765	480 (36.7%)	239,450

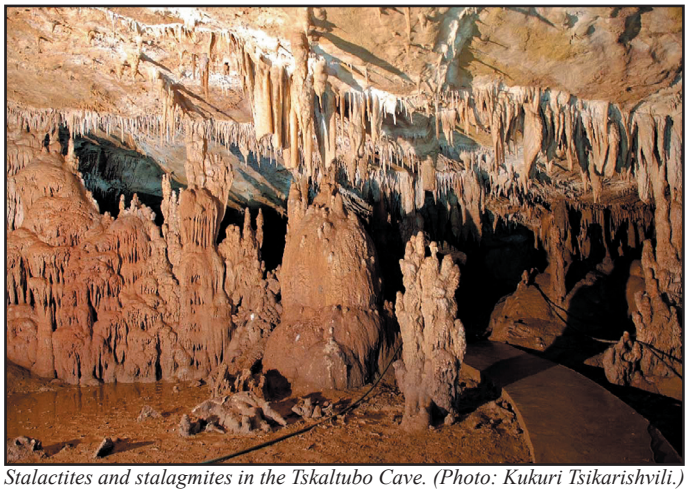
Table 3: *Morphometric values for Georgia's karst caves, according to their depth and length rankings.*

Some 326 caves (67.7%) out of 480 registered horizontal caves are about 100m long, 120 caves (24.9%) are from 101m – to 500m, 25 caves (5.4%) are from 501m – to 2,000m and 9 caves (2%) are more than 2,000m long (Table 3).

Most of the underground sites that have been investigated in recent years were formerly unknown to scientists. Among them are the Mchishta, Tskhaltubo, Sakishore and New Athoni cave systems. The latter system is unique in Georgia because of the gigantic sizes of its underground halls.

The longest and deepest caves

At the beginning of the 1980s important cave discoveries were made in the Tskaltubo limestone massif, where a group of scientists from the Institute of Geography (J Jishkariani, V Kapanadze, A Jamrishvili, T Kobulashvili and K Nizharadze) discovered the multi-entrance labyrinth-type Tskaltubo (Kumistavi) Cave system. The total length of its as yet poorly studied, partly water-filled corridors exceeds 15km (Tatashidze[1] *et al.,* 2009b). Within a short time work was carried out in the 1000m section of the main cave (Attraction Highway); concrete paths were constructed, bridge-flyovers were built, viewing platforms were prepared and an additional tunnel was cut to facilitate discharge of the cave water flows.



Stalactites and stalagmites in the Tskaltubo Cave. (Photo: Kukuri Tsikarishvili.)

Tskaltubo Cave. (Photo: Amiran Jamrishvili.)

№	Cave name	Depth (m)	Length (m)	Country (Region)
1	Krubera (Voronja) Cave	2,191	13,232	Georgia (Abkhazia)
2	Illyuzia-Mezhonnogo – Snezhnaya	1,753	24,080	Georgia (Abkhazia)
3	Lamprechtsofen Vogelschacht Weg Schacht	1,632	51,000	Austria (Salzburg)
4	Gouffre Mirolda / Lucien Bouclier	1,626	13,000	France (Haute Savoie)
5	Reseau Jean Bernard	1,602	20,536	France (Haute Savoie)
6	Torca del Cerro del Cuevon (T.33) – Torca de las Saxifragas	1,589	7,060	Spain (Asturias)
7	Sarma	1,543	6,370	Georgia (Abkhazia)
8	Shakta Vjacheslav Pantjukhina	1,508	5,530	Georgia (Abkhazia)
9	Sima de la Cornisa – Torca Magali	1,507	6,445	Spain (Leon)
10	Cehi 2	1,502	5,291	Slovenia (Julian Alps)

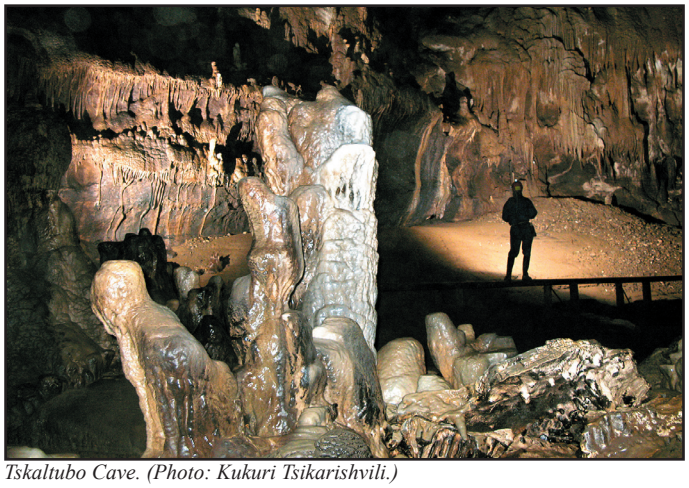
Table 4: *The world's ten deepest karst chasms according to Gulden (2010).*

With the active collaboration of speleologists from the post-Soviet countries, important successes were achieved during studies of the deep karsts. Of the 520 "big" caves recently registered within the countries of the former USSR, 171 (33%) are in Georgia. There are 59 and 51 "big" caves in the vast karst provinces of Middle Asia and Siberia respectively and only 48 are recorded in the mountainous Crimea.

Among the 826 vertical caves currently registered in Georgia, 724 (87.6%) are 100m deep, 88 (10.6%) are from 101m to 500m deep, 7 (0.9%) are from 501m to 1,000m deep and 7 (0.9%) are more than 1,000m deep (Table 3).

Among the world's 89 karst cave systems that are currently more than 1,000m deep, 17 are in Spain, 15 in Austria, 11 in Italy, 9 in Mexico, 7 in Georgia, 6 in France and 5 in Slovenia, with the remainder elsewhere in ones or twos (Gulden, 2010). The current world record depth of 2,191m (Gulden, 2010) was reached in the Georgian karst when the 2km barrier was passed in the Krubera chasm of the Arabika limestone massif. It is significant that four of the world's ten deepest karst chasms are in Georgia (Table 4). Additionally, the Vladimir V Iljukhina System (1,275m) and Arabika–Kuibishev (1,110m) and Dzou (1,090m) chasms on the Arabika limestone massif are more than 1,000m deep.

Tskaltubo Cave. (Photo: Kukuri Tsikarishvili.)



Tskaltubo Cave. (Photo: Kukuri Tsikarishvili.)

Earlier opinions of various Georgian researchers about the possible existence of "super-deep" chasms in Georgia's limestone massifs have been confirmed (Maruashvili, 1973; Gigineishvili, 1979; Kiknadze, 1979; Tintilozov[1], 1988).

In the Mchishta basin the Napra–Mchishta (Bzipi Massif) karst drainage system has also been studied. The Mchishta underground stream's mean discharge exceeds 9.5 m^3/sec throughout the year and its maximum measured discharge is 197m^3/sec. Recent speleological studies have confirmed that the Mchishta underground river collects water from a very extensive area, and almost all the underground waters of the Bzipi Massif run into the Mchishta Basin. Therefore, Mchishta and Tovliani are parts of one and the same hydrological system. This system starts at the entrance of the Tovliani mine (1,950m a.s.l.) and ends at powerful vauclusian exits at 70m a.s.l., a vertical separation of 1,880m. The Napra Chasm has also been recognized to be a part of the Mchishta–Tovliani system. Experiments have confirmed that the Napra–Mchishta karst hydrogeological system (2,345m) is the deepest sink to resurgence connection so far confirmed in the world, and the Vladimir V Iljukhina–Reprua (Arabika Massif) hydrogeological system is 2,307m deep (Tatashidze[1] *et al.,* 2006).

It is important to consider that the areas of the massifs that host the world's currently longest cave systems are significantly smaller than the areas of the Bzipi (200km^2), Askhi (>150km^2) and Arabika (100km^2) massifs (Table 5). These latter three lie on the western periphery of the Georgian karst zone, and the major underground rivers of Mchishta (in the Bzipi Massif), Tsachkhura (in the Askhi Massif) and Tsivtskala (in the Arabika Massif) flow beneath them.

On the basis of the above comparison of drainage system catchments it is reasonable to speculate that even more extensive cave systems might exist in the underground river basins of Georgia.

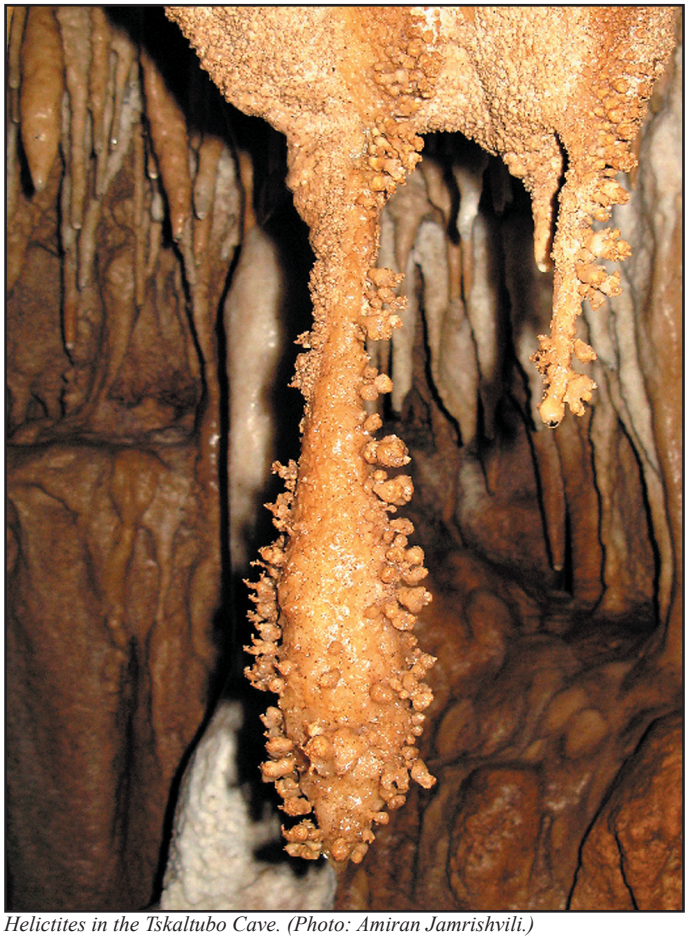
Stalagmites in the Tskaltubo Cave. (Photo: Amiran Jamrishvili.)

Curtain-like stalactites in the Tskaltubo Cave. (Photo: Kukuri Tsikarishvili.)

№	Cave name	Current total length (km)	Area of the massif holding the cave (km^2)	Maximum extent of the massif (km x km)
1	Mammoth Cave System (National Park)	627.6	35 – 45	10.5 x 8.5
2	Jewel Cave (National Monument)	241.6	6.5	6 x 2.5
3	Optymistychna (Optimisticeskaja) (gypsum)	230.1	1.5	1.9 x 2.2
	Mchishta, Georgia	*?*	*200*	*25 x 25*
	Tsachkhura, Georgia	*?*	*>150*	*10 x 15*
	Tsivtskala, Georgia	*?*	*100*	*13 x 11*

Table 5: *Some data relating to the development environments of the world's longest caves.*

Tskaltubo Cave. (Photo: Kukuri Tsikarishvili.)



Helictites in the Tskaltubo Cave. (Photo: Amiran Jamrishvili.)

History of speleological investigation

Important scientific results have been obtained on the basis of complex studies of the Georgian karst regions, supporting development of various theoretical karst issues. For example:

- the Georgian researcher Professor Levan Maruashvili introduced the concept of the "karstosphere" (Maruashvili, 1981);
- ideas about the possibility of caves origin in the fully saturated zone were confirmed (Tintilozov[1], 1976);
- the doctrine of underground landscapes was elaborated (Gergerdava, 1983);
- aspects of karst terminology were created by T Kiknadze and V Dublianski (Kiknadze, 1972);
- problems of the speleological zoning in karst provinces were investigated;
- the concept of the influence of hypsometric factors on cave climate was developed (Tsikarishvili, 1988);
- the Karst Caves Cadastre [Register] of Georgia was completed, refined and augmented;
- activity of karst processes in the limestone zone was studied (Jishkariani, 1970; Kiknadze, 1972; Rakviashvili, 1981);
- problems of hydrology and hydrogeology of mountain massif karsts were studied (Gigineishvili, 1979);
- ideas relating to speleo-morphogenetic cycles were elaborated, alongside the refining of morphological and genetic classifications of karst cavities and connected studies of karst water fissure flow conditions and discharge areas, etc.

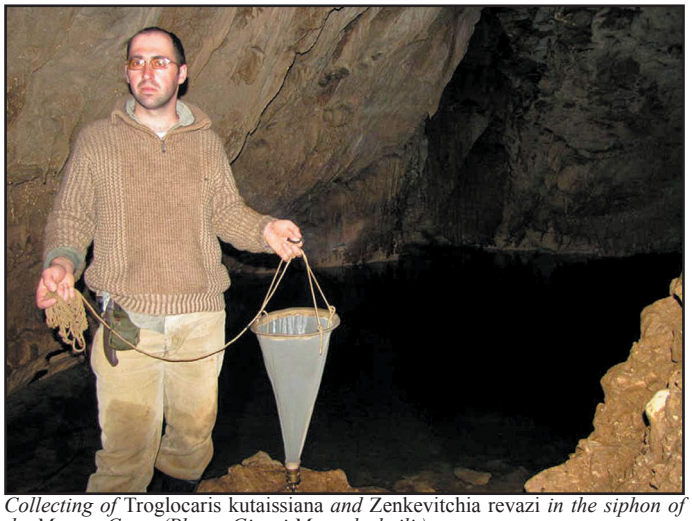
Nowadays much is being done and achieved in speleological investigation, but even more significant discoveries are expected in the future. The major Mchishta, Tsachkhura and Rechkhi basins remain imperfectly understood, with much work still to be done, and dozens of other high-yield underground river basins await detailed investigation.

History of speleobiological investigation

Zoological investigation in the caves

Speleobiological research in Georgian karst caves was commenced early in the 20th century, mainly by Russian or foreign scientists. Studies of the speleofauna proceeded slowly and by the beginning of the 1980s speleofauna from only 71 caves had been investigated (Djanashvili, 1984). The situation changed sharply after the dismantling of the USSR – investigations were cut back and almost stopped. 233 species and subspecies are recorded from Georgian caves in a monograph about the cave fauna of Russia and adjacent countries (Kniss, 2001). The list, which was basically compiled according to old literature sources, is incomplete and needs to be reviewed and updated because the taxonomic status of many genera and species has now changed. Data about the speleofauna of each of the caves investigated) are given in the Cadastre of the Karst Caves of Georgia (Tatashidze[1] *et al.,* 2009a). The monograph includes details of the speleofauna for 226 caves from the total of 1306 currently known caves. Some animal groups are commonly mentioned without indication of Latin names in this monograph, and this indicates that these data were collected by speleologists rather than biospeleologists. Thus these data have less scientific significance.

Entrance of the Motena Cave. (Photo: Shalva Barjadze.)



Collecting of Troglocaris kutaissiana *and* Zenkevitchia revazi *in the siphon of the Motena Cave. (Photo: Giorgi Mamadashvili.)*

During the last decade the cave-dwelling animals list has been enriched with new records and new species. For example:

- 28 species of springtail (Collembola) were recorded for the first time from Georgian karst caves, and one species, *Plutomurus birsteini,* was described as new to science (Barjadze and Djanashvili, 2008; Djanashvili and Barjadze, *In Press*);
- one species of beetle from the Carabidae family – *Meganaphthalmus medvedevi* Belousov and Koval, 2009 – was described from the Otapistavi Cave (Belousov and Koval, 2009)
- *Troglocaris birsteini* Mugue, Zueva & Ershov, 2001 (Decapoda: Atyidae) was described from the Abrskila and Otapistavi caves (Mugue *et al.,* 2001);
- 10 species of bats (Chiroptera) have so far been found in Georgian caves (Bukhnikashvili, 2004).

But it remains necessary to perform detailed analyses of literature sources that deal with cave-dwelling animals and carry out investigation on the biodiversity of Georgian karst caves. Ongoing work should reveal endemic species, new records and species new to science, allowing compilation of a check-list of Georgia's cave-dwelling animals, and facilitating assessment of the influence of anthropogenic factors on the speleofauna, helping to avoid impoverishment of cave biodiversity.

Palaeobotanical investigation in the caves

Pollen and non-pollen fossils were studied in the sediments of two formerly occupied karst caves in the Imereti region (western Georgia). Palynological investigation of the material from two karst caves with Upper Palaeolithic and Eneolithic ["Copper Age"] layers, located in the same region of western Georgia, illustrated both the commonality and differences in the character of the palynological spectra.

Dzudzuana Cave, near Mgvimevi village in the Chiatura region, is surrounded by hornbeam and lies in a deep and closed river gorge at an absolute altitude of 564m. Most studies of karst caves with Upper Palaeolithic fill deposits have revealed layers containing low levels of pollen and spores, but investigations of the NPP (Non Pollen Palynomorphs) group in Dzudzuana Cave revealed large quantities of polynomorphs, giving the site particular importance. 5 profiles were studied during investigations in 2007–2008, when 86 samples were subjected to palynological analysis. Flax fibres, including some twisted, tied in knots and dyed, were found in layers dating back as far as 33–30 thousand years (BC) (Kvavadze *et al.,* 2009). This is the first find of such great age; previously the oldest find (dating from 29,000 BC) was of imprints of fibres of plant origin and the remains of a rope made from unidentified fibres, from Dolni Vestonice (Czech Republic).

As at Dzudzuana Cave, the former occupants of Satsurblia Cave, located in the vicinity of Kumistavi village in the Tskhaltubo region, produced and used flax during the Late Palaeolithic, as evidenced by the spun and dyed fibres found here.

During the Late Palaeolithic humans used wild grasses, as well as many other plants, for food. This is indicated not only by the pollen of grasses found in the cave layers, but also by the remains of their epidermis and *Poaceae* phytolites (Figs 1 and 2). Carbonized parenchyma cells of wood found in the Upper Paleolithic layers might be a reliable indicator of the human habitation of the studied caves.

Members of archaeological expedition near the entrance of the Dzudzuana Cave. (Photo: Eliso Kvavadze.)

Entrance of the Satsurblia Cave. (Photo: Eliso Kvavadze.)

Large quantities of spores of coprophilous fungi (Figs 3 and 4) together with remains of insects, ticks and the eggs of helminths that infest animals show that the caves were used to accommodate cattle during the Eneolithic period (Kvavadze *et al.,* 2010).

It was established that formation of the lower and middle parts of Layer D (36,000–27,000 BP) in the Dzudzuana Cave took place under relatively warm climatic conditions. Deciduous woods with a predominance of oak and chestnut grew in the foothills of Imereti, with an undergrowth of *Vitis silvestris* (wild vines) and *Corylus* (hazel). However, on the boundary between Layer D and Layer C, i.e. nearly 27,000 BP, the climate became colder and dryer for a while. This phase is characterized by the presence of *Betula* (birch), a component of highland forests that is missing from the layers above, and a significant amount of *Artemisia* (wormwood) pollen that indicates a dry and cold climate. The group of the non-pollen polymorphs includes abundant tracheal cells of wood, identified mostly as pine (Figs 1 and 2). There are also many phytoliths of *Poaceae* (grasses). Later, during formation of upper thickness of Layer C (26,000–21,000 BP) the climate again improved and became not only warmer, but also damper. The tree pollen preserved here is characterized by species that are adapted to warmer and wetter conditions than those observed in layer D.

Severe climatic cooling of the studied region is dated at 16,700 BP, at which time deciduous woods were replaced by a high-mountain flora of mixed spruce/fir woods with sub-alpine elements.

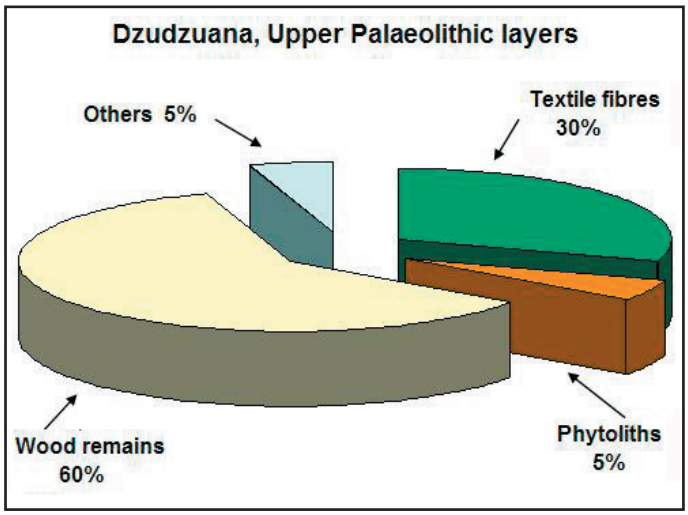


Figure 1: *The dominant components of non-pollen palynomorph spectra from Upper Palaeolithic deposits in the Dzudzuana Cave.*

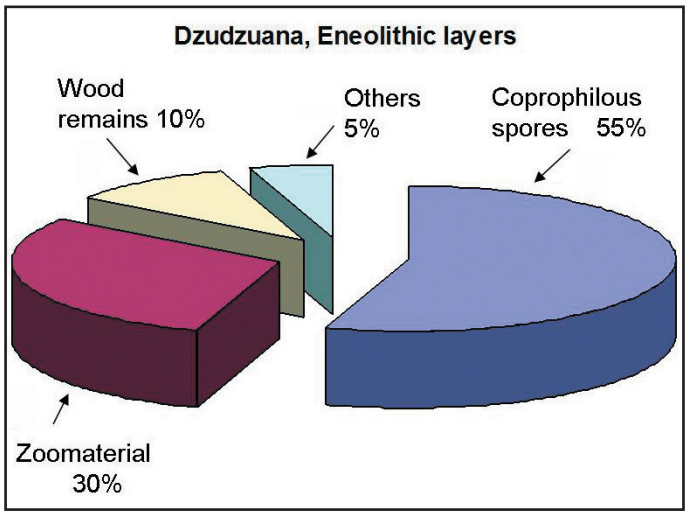


Figure 3: *The dominant components of non-pollen palynomorph spectra from Eneolithic ("Copper Age") deposits in the Dzudzuana Cave.*

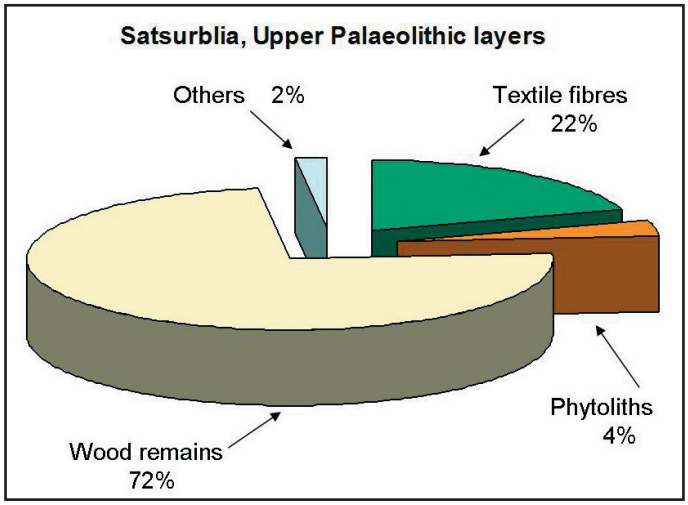


Figure 2: *The dominant components of non-pollen palynomorph spectra from Upper Palaeolithic deposits in the Satsurblia Cave.*

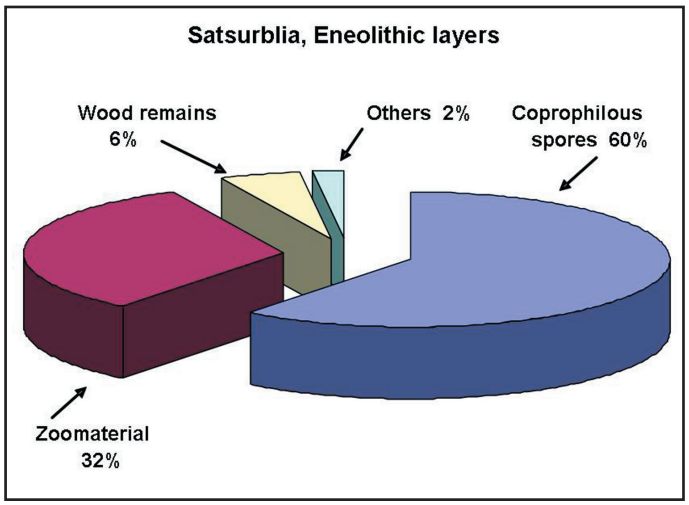


Figure 4: *The dominant components of non-pollen palynomorph spectra from Eneolithic ("Copper Age") deposits in the Satsurblia Cave.*

The necessity of ensuring local people's speleological education

Nowadays, gaining knowledge about caves and cave-dwelling animals normally has a low priority in local communities. This leads to increased anthropogenic pressure on caves due to pollution, quarrying and vandalism. It is important for speleologists and speleobiologists to organize seminars and lead excursions for local people, and especially for school pupils, to educate them about the importance of the caves in the Imereti, Samegrelo and Racha regions, where there are many karst caves.

Such action gives local people and school pupils greater knowledge and understanding of the importance of local caves, and at the same time provides guidance on the protection of local caves. Thus, at least some future impoverishment of cave faunas and destruction of palaeontological material within the caves will be avoided.

Acknowledgements

We thank Nino Chikhradze for translating the manuscript from Georgian into English. Also, we are grateful to the anonymous referees, who provided valuable comments and helped to improve the manuscript.

References

Barjadze, S and Djanashvili, R. 2008. Checklist of the springtails (Colembola) of Georgia. *Caucasian Entomological Bulletin,* Vol.4(2), 187–193.

Belousov, I A and Koval, A G. 2009. To the knowledge of the aphenopsoid Trechine beetles (Coleoptera: Carabidae: Trechini) of the Caucasus. *Caucasian Entomological Bulletin*, Vol.5(2), 163–173. [in Russian.]

Bukhnikashvili, A. 2004. *On Cadastre of Small Mammals (Insectivora, Chiroptera, Lagomorpha, Rodentia).* [Tbilisi: Universal Publishing House.] 132pp.

Djanashvili, R. 1984. *Cave Fauna*. Georgian Soviet Encyclopedia. Vol.7, 237. [in Georgian.]

Djanashvili, R and Barjadze, S. *In Press*. A new species of the genus *Plutomurus* Yosii, 1956 (Collembola, Tomoceridae) from Georgian caves. *Journal of Cave and Karst Studies,* Vol.73(1), 28–30.

Gergedava, B A. 1983. *Subsurface Landscapes.* [Tbilisi: Metsniereba Publishing House.] 132pp. [in Russian.]

Gigineishvili, G N. 1979. The karst waters of the Greater Caucasus and basic problems of karst hydrology. [Tbilisi: Metsniereba Publishing House.] 224pp. [in Russian.]

Gulden, B. World's longest //NSS Geo2 Committee on long and deep caves. http://www.caverbob.com Last updated on 06 December 2010.

Jishkariani, J M. 1970. About karst denudation in the basin of the River Chachkhuri (Askhi massif, Western Georgia). *Bulletin of the Academy of Sciences of the Georgian SSR*, Vol.6, 461–463. [in Russian.]

Kiknadze, T Z. 1972. *Karst of the Arabika Massif.* [Tbilisi: Metsniereba Publishing House.] 276pp. [in Russian.]

Kiknadze, T Z. 1979. *Geology, Hydrogeology and Activity of the Limestone Karst.* [Tbilisi: Metsniereba Publishing House.] 232pp. [in Russian.]

Kiknadze, T. 1984. 50th *Anniversary of the Vakhushti Bagrationi Institute of Geography.* [Tbilisi: Metsniereba Publishing House.] 156pp. [in Georgian.]

Kipiani, S I, Tintilozov, Z K, Okrojanashvili, A A and Jishkariani J M. 1966. *The Cadastre of the karst caves of Georgia.* [Tbilisi: Metsniereba Publishing House.] 260pp. [in Georgian.]

Kipiani, S. 1974. Karst of Georgia (An experience in geomorphological characteristics). Vol.I. Spread, investigation and immediate tasks. [Tbilisi: Metsniereba Publishing House.] 350pp. [in Georgian.]

Klimchouk, A. 2004. *Caucasus, Georgia*. 200–203 *in* Gunn, J (Editor), *Encyclopedia of Caves and Karst Science*. [New York and London: Fitzroy Dearborn.] 902pp.

Kniss, V A. 2001. Cave fauna of Russia and adjacent countries, (History of study, composition and distribution). [Ufa: Pensoft.] 238pp. [in Russian.]

Kvavadze, E, Bar-Yosef, O, Belfer-Cohen, A, Boaretto, E, Jakeli, N, Matskevich, Z and Meshveliani, T. 2009. 30,000-year-old wild flax fibers. *Science*, Vol.325, 1359.

Kvavadze, E, Bar-Yosef, O, Belfer-Cohen, A, Boaretto, E, Jakeli, N, Matskevich, Z and Meshveliani, T. 2010. The main characteristics of the Non-Pollen Palynomorphs (NPP) from the archaeological layers of Dzudzuana and Satsurblia cave (western Georgia). *Abstract book of 4th Workshop of Non Pollen Palynomorphs*, Besançon, France, 25.

Maruashvili, L I. 1973. *Fundamentals of Speleology.* [Tbilisi: Metsniereba Publishing House.] 368pp. [in Georgian.]

Maruashvili, L I. 1981. About problems for investigation of karstosphere. 41–49 *in* Davitaia, F F and Aslanikashvili, A F (eds), *Human and nature in the Geographical science*, [Tbilisi: Metsniereba Publishing House.] 194pp. [in Russian.]

Mugue, N, Zueva, O and Ershov, A. 2001. Cave shrimps, genus *Troglocaris* (Decapoda: Atyidae), in West Transcaucasus: genetics of sympatric and allopatric populations. 38–39 *in* Trajano, E and Pinto-da-Rocha, R (eds.), *Abstracts of the XVth International Symposium of Biospeleology,* São Paulo: Instituto de Biociencias da Universidade.

Rakviashvili, K. 1981. Cavities of the limestone rock and karst in the interfluve of the Rioni–Kvirila rivers. *Georgian Caves. Speleological Transactions,* Vol.9, 25–37. [in Russian.]

Tatashidze, Z K, Tsikarishvili, K D, Rakviashvili, K S, Jishkariani, J M, Jamrishvili, A R and Geladze, G V. 2006. Major results of speleological research in Georgia (1957–2006). *Proceedings of the Vakhushti Bagrationi Institute of Geography of Georgia*, New Series, Vol.1(80), 121–131. [in Georgian.]

Tatashidze, Z K, Tsikarishvili, K D and Jishkariani, J M. 2009a. *The Cadastre of the Karst Caves of Georgia.* [Tbilisi: Petiti Publishing House.] 670pp. [in Georgian.]

Tatashidze, Z K, Tsikarishvili, K, Jishkariani, J, Jamrishvili, A, Geladze, G and Lominadze G. 2009b. *The Tskaltubo cave system.* [Tbilisi: "Petiti" Publishing House.] 72pp. [in Georgian.]

Tintilozov, Z K. 1976. *The Karst caves of Georgia (Morphological analysis).* [Tbilisi: Metsniereba Publishing House.] 276pp. [in Russian.]

Tintilozov, Z K. 1988. *Karst and caves of the Bzipi massif.* [Tbilisi: Metsniereba Publishing House.] 120pp. [in Georgian.]

Tsikarishvili, K D. 1988. Climatic aspects revealed in the karst processes in the mountains (in the case of karst of Georgia). *International symposium on physical, chemical and hydrological research of karst.* Kosice, Czechoslovakia, May 10–15, 1988. 112–115. [in Russian.]

Endnote

[1] *To assist clarity and understanding, the authors point out that Professor Zurab Tatashidze was known as Professor Zurab Tintilozov until 1990.*