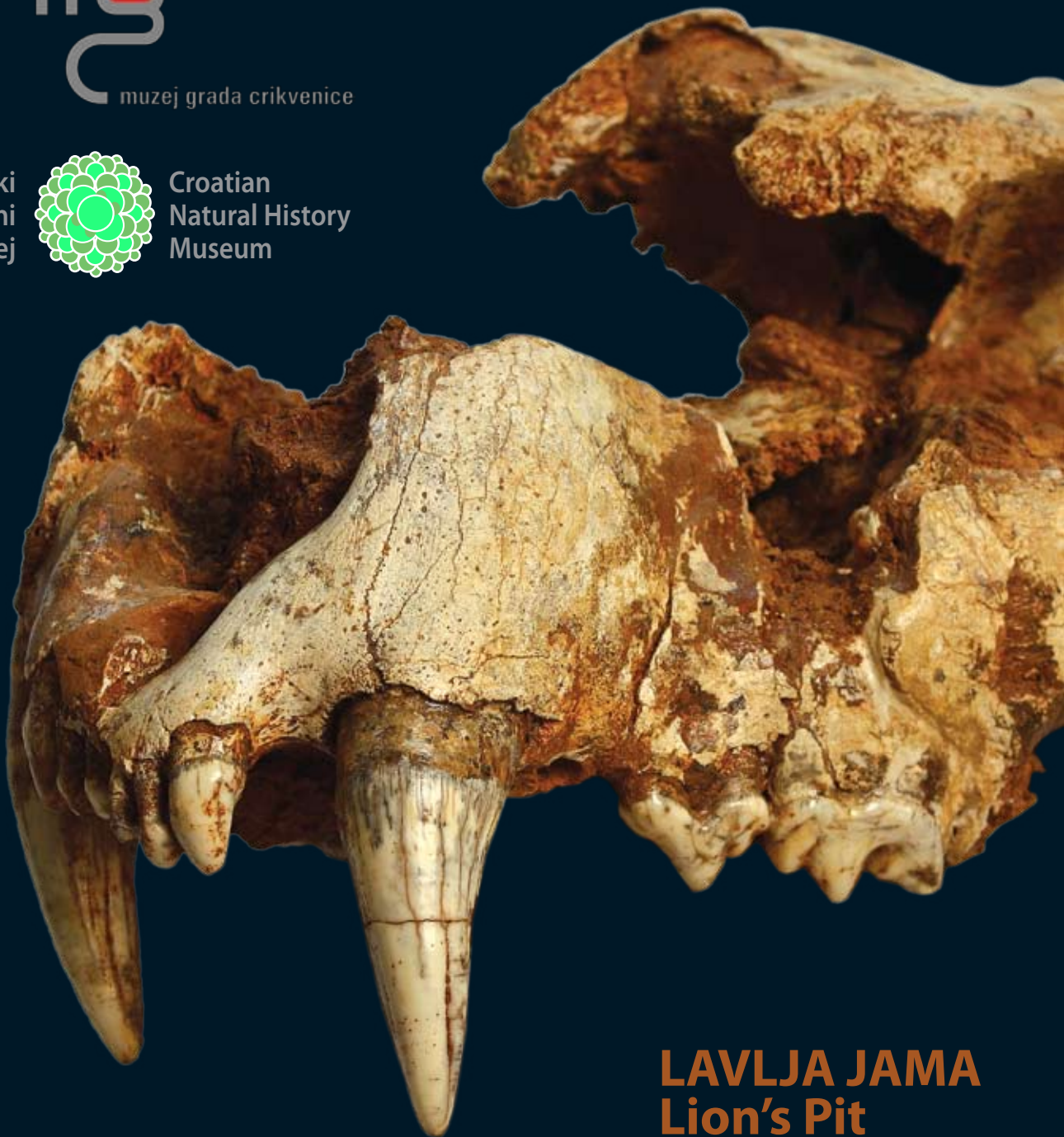




Hrvatski
prirodoslovni
muzej



Croatian
Natural History
Museum



LAVLJA JAMA
Lion's Pit



CATALOGUE

Publisher: The Crikvenica City Museum

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Computer layout: Trampi d.o.o.

Printed by: Zambelli

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Lion model: KUD Sveta Jelena Dramalj and Carnival Society Dramalj

Digital print: Pruša d.o.o.

We are thankful to: The City of Crikvenica, Croatian Academy of Sciences and Arts, Croatian Biospeleological Society and all researchers, <KUD Sveta Jelena Dramalj> and Carnival Society Dramalj, GKTD "Murvica" d.o.o., "Elektrotehnika" - Skrbín, "Pero-Struja", "Sunflower" d.o.o., Glazieri "Crikvenica", Carpentry Špalj, <Jela d.o.o.>, Construction locksmithery <Bruno Brozović>, Mr. Siniša Laginja, Mr. Zoran Cuković

"While the astonished tourist rightfully admires the magic and fairy forms, which richly decorate the underground palaces of our karst, at the same time the scholar reveals in them many interesting mysteries that repeatedly enable him to clarify various forms and phenomena occurring in the karstic areas. Karst caves and pits are particularly rich treasuries from which the various disciplines draw extremely interesting material for their studies."

Umberto Girometta, 1935.

The exhibition **"Lavlja jama" ("Lion's Pit")** is a story of tremendously rich collection of unique fossil treasures discovered in the underground regions of Dramalj, only partially excavated, but still enough, due to previously revealed material, to make you acquainted with the astonishing and dynamic life on Earth during the Upper Pleistocene, or by the end of a long period called "Ice Age".

On the existence and discovery

The largest cave lion skeleton found is the headline printed in *Novi list* on October 2nd 2007. Publishing the story in the newspaper initiated *above-ground*, vibrant and public interest in the dark pit called Vrtare Male in Dramalj. Vivid interest in the extinct subsurface life petrified in this pit started with a media sensation, and in this way a world that had been hidden for millennia, knowledge of it being known recently only to palaeontologists and geologists who explore the past of our distant and ancient history, became a topic of widespread and common interest.

The pits in the Vrtare area have long been known to the locals of Dramalj. In the version of Grandmother Lojza Jurić, here is one of the most famous legends of the region:

"The Markaci Fairy" („Vila Markačeva")

Once upon a time, a girl from the village Markaci was preparing for marriage. The evening before the wedding she suddenly disappeared. Looking for her, the locals found traces that led to Vrtare. Only the bravest descended into the pit and there they found the girl sitting still. Her clothes were dirty and torn, but the most unusual was her hair. One braid was still firmly plaited, the other loose and combed out.

According to old legends, fairies with loosened hair that contained all their power lived in the pits around Vrtare. If their hair got tangled, the power would be lost and tearing off fairy's hair meant killing her. If an ordinary girl wandered somewhere near a pit, they would kidnap her and make her into a fairy.

That one of the girl's braids was loosened could mean only one thing - the fairies had captured her and tried to make her one of them. However, the locals had found her before the final metamorphosis so the girl from Markaci forever remained a living creature.

Legend says that she never recovered from the event, lost her power of speech, and in no way tells anyone what actually happened that night. The girl never got married, and people still remember her as "Vila Markačeva" or "the Markaci Fairy".

The first to descend into the dark world of the *Lion's pit* were speleologists of the Mountaineering Society "Velebit" in 1966, followed by Dragan Pelić in 1995. The entrance to the pit was revealed to Pelić in 1991 by Zenon Domijan from Dramalj. At the bottom of the pit this new visitor with the keen eye of a photographer spotted the lake and the endemic cave shrimp in it. That motivated him to invite speleologist Branko Jalžić to continue collecting sam-



of this chapter.

On the geology and genesis of the pit

The pit Vrtare Male is located near Dramalj, three and a half kilometers northwest of the centre of Crikvenica and about one hundred meters distant from the shore. It is a part of Hrvatsko Primorje (Croatian Coast), which includes the southern slope of Gorski Kotar, or the coastal areas from Preluka in Rijeka up to Senj. This region is cut longitudinally by Vinodol Valley, with its lowest part in the Bakar Bay area flooded by the sea. The valley is built of impermeable flysch rocks, deposits of sandy and marly Eocene sediments, which over most of the extent act as a hydrogeological barrier, causing the appearance of many ascending karst springs on the edge of the valley (Rječina, springs in Bakar Bay, Sušik). In places it forms a hanging barrier so the underground waters flow through the deep karst subsurface to the coast. The largest water course is the Rječina that in city of Rijeka flows into the sea, and the second most important water course, also periodical, is the Dubračina, which enters the sea near Crikvenica.

The pit Vrtare Male originated in the southern wing of geotectonically curved younger Eocene foraminiferal limestones and older Upper Cretaceous reef limestones along the erosional boundary. All of these deposits were formed in ancient seas and geological periods of about one hundred to forty million years before the genesis of the *Lion's pit*. Strong karstification of limestones, the rocks in which the underground cavity Vrtare Male was formed, is the consequence of tectonic fragmentation of the terrain, which is a geological predisposition for the formation of a pit. In the vicinity of the *Lion's pit*, or Vrtare Male, there are the pits Vrtare Nove and Vrtare Vele as well. Therefore it can be assumed that these pits are remnants of a much larger cave system which was created and then underwent intense geomorphological changes by the end of and during the Pleistocene, i.e. glacial and interglacial periods that in the Mediterranean area began some 700 to 800 thousand years ago. The fact that part of the cave is covered with coarse-clastic sediment points to catastrophic events like earthquakes and many processes that could result in large-scale landslides and filling in of the former openings, thus constantly changing the former morphology of the underground.

The genesis of Vrtare is further connected to the processes of the chemical weathering of carbonate rocks that

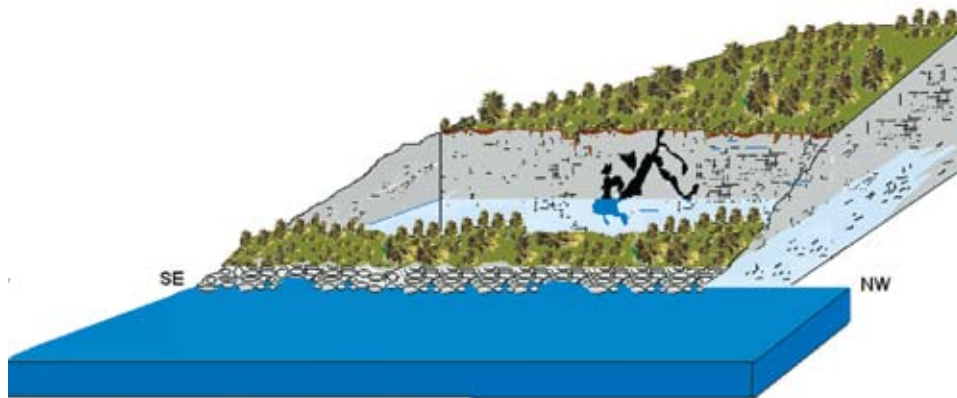
ples of this rare decapod crab. Even then, in 1995, they noticed bones that protruded from cave soil deposits and so the story of the *Lion's pit* began. Members of the Croatian Biospeleological Society investigated the pit in 2005, under the auspices of Crikvenica municipal authority, searching for life hidden in this, apparently lifeless vertical subsurface hole.

Since it was immediately assumed that those were fossil bones, in 2006 experts from the Institute for Quaternary Palaeontology and Geology of the Croatian Academy of Arts and Sciences took part in the research, and subsequently, in 2007 the staff of the Croatian Natural History Museum joined in as well. The discovery of the Pleistocene, i.e. Ice-Age "Zoo" has become a sensation, so we come back again in a circle, to the beginning

build up the surrounding terrain. These processes, aided by water enriched with carbon dioxide that acts as a weak carbonic acid, lead to karstification, and thus the carbonate rocks affected by these processes turn into karst. For intensive karstification a relatively moist - humid climate is needed, to provide the process with enough fresh water in the subterranean vadose and phreatic zones.

Karstification processes on the surface of carbonate rocks form particular geomorphologic features such as limestone pavement, sinkholes (dolines), blind valleys and poljes, as well as underground pits, caverns and caves. These are features that impart a distinctive stamp to our entire coast, and are known and recognized as geomorphological phenomena unique and characteristic in the world. All these features formed in older rocks are sporadically or completely filled with the youngest Quaternary deposits, among which the most abundant deposits are reddish soil (*terra rossa*). *Terra rossa* is considered to be the product of the hydrochemical dissolution of carbonate rocks. Yet, part of the *terra rossa* is definitely formed by weathering of the land, and by eolian and fluvial processes that transported terrigenous, mostly





sandy material, from the flysch area. Precisely these sediments in the Vrtare Male pit contain conserved, paleontologically preserved, rich fossil and petrified fauna of which the most abundant are bones of Pleistocene, i.e. Upper Pleistocene, mammals. It is considered that only ten percent of the Quaternary fossiliferous sediments of the Lion's Pit have been investigated so far.

The assumed depth of the cave is about 39 meters. The cave is "dry" to a depth of 29 m, while the rest is submerged. Water that floods the deepest part of the cave is connected

underground with the nearby sea. The upper layer of water, to a depth of 3 m, is made fresh by fresh water that flows in from the hinterland. The "lake" level oscillates due to rainfall waters and the ebb and flow of the tides. Besides the vertical entrance, the pit consists of two branches and a few side channels. Cave decorations - stalactites, stalagmites and flowstones give an exceptional beauty to some parts of the pit.

Space and time

Determination of the time when the fossil bones of the cave lion and other extinct and coeval animals ended up in the pit, is the sum and consequence of the results of various geological, palaeontological and geophysical investigations. The Pleistocene, or more precisely the Upper Pleistocene, is the geological period to which the age of fossil finds from the Vrtare Male pit can be assigned. The Pleistocene is, unfortunately, a long period of time that began approximately 1.65 million years ago and lasted until 10,000 years ago, which is geologically recent.

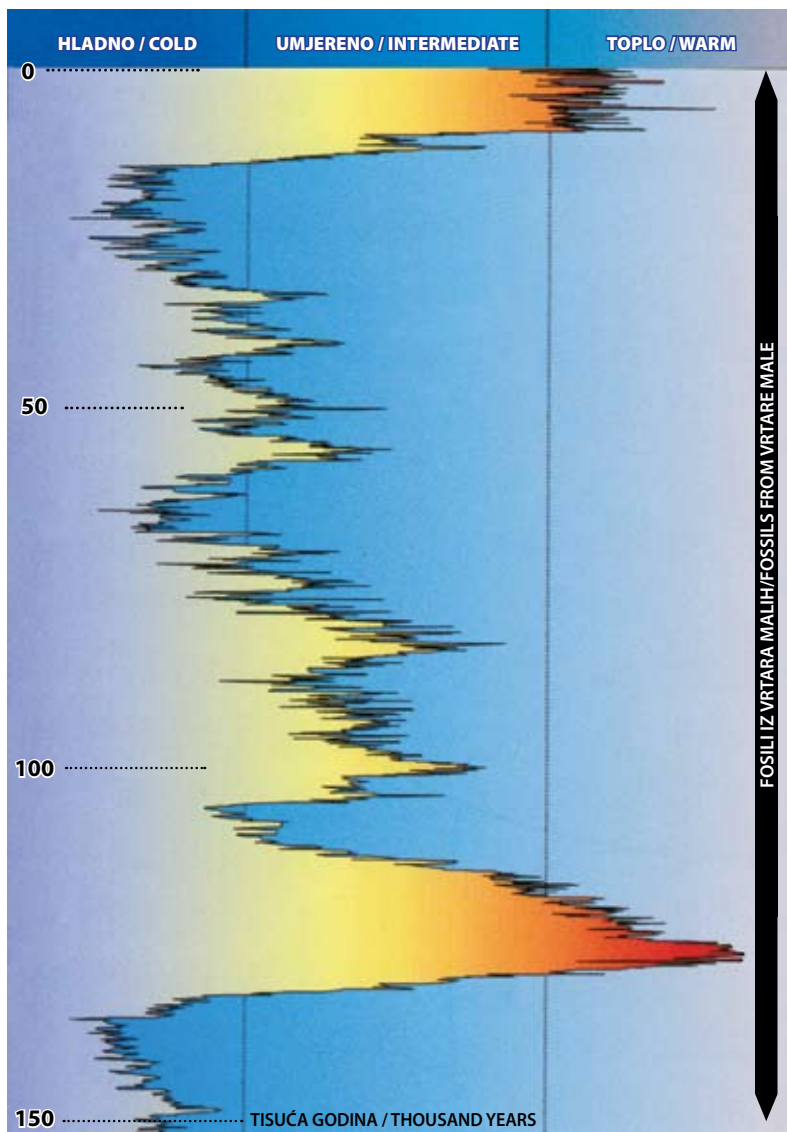
Throughout this last section of the geological past, to humans and human ancestors a relatively long period, long cold periods - *glacials* (known as ice ages) repeatedly alternated with warm periods - *interglacials*. Science has proved that the first major glaciation began about 800,000 years ago and lasted for about a hundred thousand years. The next ice age followed 550,000 years ago, and then another one 350,000 years ago. The last ice age began a hundred thousands of years ago and lasted until 10,000 years before present. The last *great warm period between two glaciations* or *great interglacial* to which the Lion's pit fauna could partly be attributed lasted from 126,000 to 117,000 years before present.

The scientists have tried to explain the causes of these global changes, of the withdrawal and advances of ice, in various ways. Some of them associated these processes with the changing position of the Earth's axis, others with periodic changes in solar radiation, or with changes in the Earth's ecliptic plane. For example, a famous Croatian geologist Gjuro Pilar thought that causes of glaciation should be sought in periodic perturbations of Earth's orbit and still

today it is widely thought that cosmological, as well as geological reasons, have brought about climate changes on Earth.

In periods of glacial stages much of the northern Earth's hemisphere was bounded by ice, which extended far to the south at the peak of glaciation. In the warm stages the ice melted and retreated to the north and higher altitudes, while the climate was changing. This was repeated several times over. The alternation of climatic periods brought radical changes of wildlife that tried to adapt as much as possible, or else migrated to a more suitable climate. The advances and withdrawals of the ice sheets narrowed or expanded the living spaces, and even entire life communities had to migrate, enriching or impoverishing themselves by new species.

At the beginning of the Pleistocene climatic and palaeogeographic conditions in the coastal area were very similar to those in the Pannonian part of Croatia, but later they differed greatly. The reason for this may be the more pronounced elevation of the mountain ranges, but also the possibility of the mountain peaks icing over during the Pleistocene glaciations' maxima. Both the Adriatic Sea level and the global sea level fluctuated in line with changes in climate and the influence of neotectonic movements. It is assumed that during the peak of the glaciation the lowest sea level in the Adriatic was a hundred meters lower than today. It is in this light that we should see the whole region of the former Crikvenica landscape together with the broader area and coastal islands which at that time were part of a comprehensive land connected with the Apennine Peninsula. During warmer interglacials, when the sea level rose again, the area of Hrvatsko primorje (the northern Croatian coast) was repeatedly exposed to strong erosion and denudation, and so the older Quaternary sediments are preserved very rarely today, only in karst poljes or in other depressions as well as in the caves and pits. Continuous development of Quaternary deposits from the Lower Pleistocene to the Holocene, has hitherto not been known at the surface outcrops. However, at some localities deposits from one or more Quaternary periods have been developed, and thus the palaeogeographic and stratigraphic relations, climate and conditions of sedimentation may be approximately reconstructed.





Fossil bones from Vrtare Male pit certainly belong to the *Upper Pleistocene* period, a time from 125 to 25 thousand years before present, but there is still no clear scientific evidence to determine a more accurate time frame for the fossil remains of some findings. Based on the diversity of collected and determined fossil material, diverse life communities could be attributed to different biotopes or indented environments of mountain, lowland, forest and grassy areas in dry and humid ecosystems. Reconstructing the palaeogeographic relations from the Middle till the end of the Upper Pleistocene, the knowledge of landscape changes in the wider area of Kvarner and its mountain hinterland reveals us dynamic and diverse landscapes of constant change. Without further research and radiometric determination of the absolute age of palaeontological material it is difficult for us to determine the more precise age of the findings. But it could be assumed that over a longer period of the Upper Pleistocene the accumulation of various animal bones often occurred in the area of Vrtare pits. The real reason for the extraordinary accumulation of animal bones in the dark, karst underground in the vicinity of Crikvenica still remains a mystery to science. Taphonomic considerations of this important locality along with many unresolved issues certainly may indicate a direction for future investigations. ??????????????????????

The past environment and its animal world

At first glance there is an intriguing impression that Vrtare pit is very rich in Pleistocene faunal content when the small amount of sediments surrounding the accumulation of bones is considered. The five locations of this cavern yielded parts of skeletons, bones and teeth of various fossil and possibly subfossil species. Only a single underground passage reveals the bones of Pleistocene fauna, providing an insight into the animal world of the distant past. During the Pleistocene, different animals must have fallen into the pit and, trapped there, unable to find any way out, there they died, their skeletons thus being preserved down to our days. Although the entrance to the cave is very small today, the picture obtained from the underground chambers investigated suggests that the entrance was larger in the past, one that is probably completely blocked with sediments and thus unrecognizable today. An important feature of the site is the discovery of the fossil remains of the vertebrae, ribs, parts of a foot and a tusk fragment of big elephant of a previously unidentified species. Any discovery of the elephant remains in the caves and in the underground caverns is very unusual. Also, teeth and parts of the long bones of the forest rhino have been found here. Besides these exotic species the fossil remains of the wolf, bear, cow, horse, deer, boar and goat have also been identified here as well as many remains of small mammals and birds, with a particularly rich fauna of small rodents.



The most significant part and the most numerous element of the palaeontological content of the underground cavern consists of several skeletons of the cave lion. Many animals from the faunal spectrum preserved in the *Lion Cave* became extinct in the recent period, some of them being still present in the surrounding environments, while some species have migrated to a different landscape. But the most interesting aspect of the cave taphonomic association must be the remains of the large, attractive, and powerful mammals whose existence in the past environments of Dramalj and Crikvenica is recorded in the sediments of the almost vertical underground cavity and the darkness of the karst.



The steppe bison (*Bison priscus*) was a frequent animal in the environments of the steppe grasslands of northern and central Europe. The Pleistocene migration of that species across the ice cover of the Bering Strait into North America resulted in the evolution and appearance of *Bison bison*. The Euro-Asian species of bison became extinct in the Late Pleistocene and it was replaced by *B. bison* on the northern American continent and by *B. bonasus* in Europe and Asia.

The cave bear (*Ursus spelaeus*) represent the most frequent large mammal in the cave deposits of Europe from the last Pleistocene glacial period. As in the case of the cave lion, the population of this species shrank drastically at the end of Pleistocene, and, at the end of the last phase of glacial maximum it became extinct. Its distribution zone consisted of temperate and relatively humid environments. The animal was much larger than recent bears, and when stood upright could attain a height of 3 meters. This extinct species appeared in the Middle Pleistocene of the karstic regions of Central Europe and the Mediterranean, and the remains of it are the most frequent fossil bones in many underground cavities of the Croatian mountains.

The forest rhinoceros (*Stephanorhinus kirchbergensis*) is also animal which can be attributed to the warm periods the Pleistocene. It belongs to the largest species of typical rhinos. The rhino species were widely distributed animals



throughout the Pleistocene while today we can witness only four genera in the warm regions of Africa and Asia. At the end of Middle Pleistocene in the region southeast of the Alps and in the areas of the northern Adriatic plain and the Dinaric range they migrated, and came to inhabit open forests and the margins of the forested environments. The remains of fossil rhinos are well known from the numerous Upper Pleistocene sites in Croatia, and we can distinguish woolly rhinos (*Coelodonta antiquitatis*) typical of the cold periods of Upper Pleistocene from the warm climate, forest rhinos characteristic of the interglacial periods.

The proboscidean fossil remains from the *Lion Cave* are unique in Croatia, but, unfortunately, they do not allow specific determination. However, they are certain proof that the past environments of this region were completely different from our recent landscapes. The discovered bones could be attributed to the steppe or forest elephant or possibly even to the woolly mammoth. If the future investigation of this site reveals additional bones or teeth we might be able to solve the species enigma for the representation of proboscideans at this site and more bones will certainly further explain palaeoecological information concerning the former environments. Elephants are very good indicators for paleoclimate and environment reconstructions.

As pointed out earlier, the most intriguing find in the underground world of this region is the remains of the cave lion, or *large cave cat*. The cave lion (*Panthera leo spelaea*) was a frequent animal and faunal element in the Late Pleistocene glacial era of Europe, northern Asia. There is an opinion that this large cat was represented in North America as a species of *Panthera leo atrox*. Populations of these animals decreased significantly and the animal became completely extinct at the last phase of Pleistocene glacial maximum.

Two almost complete skulls with dentition have been excavated, as well as numerous paw bones, long fore-limb bones, vertebrae and rib parts. The size values of the preserved bones indicate the discovery of the largest yet known cave lion in the wider region of Croatia. The remains of cave lions have been excavated and are known from many sites such as the Upper Pleistocene sediments of the Veternica Cave near Zagreb, Cerovačke Caves near Gračac in Lika, Vindija Cave near Voća, Velika Pećina near Ivanec, Romuladovo Cave in the Limski kanal in Istria as well as in the caves of Šandalja and Kanger in Istria. However, the Vrtare site reveals the most abundant and in number of skeletons and individuals represented the most complete site yet discovered in the wider region of this part of Europe.

Panthera leo spelaea or the European cave lion appeared in Europe half a million years ago and was in existence until 10 thousand years ago. The species' distribution range was northern Eurasia and the animal was adapted to the temperate environments as well. The cave lion was the largest animal of the cat family of carnivores. This massive predator is sometimes described as a hybrid between lion and tiger with many robust characteristics: ears pointing forward, with weak shaggy or absent mane or no hair, a tufted tail and slight body stripes similar to the tiger. The remains of these animals are quite frequent in the Upper Pleistocene, Palaeolithic sites throughout Europe. The Palaeolithic is the Early Stone Age culture and it is related to the ancient humans, early humans, Neanderthals, and early representatives of our own species. At the sites of the Mousterien culture this animal is a rather frequent discovery, it is quite frequent in the layers containing Aurignacien culture, while in Magdalenian the bones of the cave lion are very rare. In cultures at the end of the Palaeolithic, the Old Stone Age, when art and the use of symbols came into being, cave art frequently exhibited paintings of the cave lion. The cave lion is less frequently found in the sediments deposited in the transition from the Pleistocene to the Holo-



cene. Prehistoric hunters and gatherers shared their habitats and environments with cave lions. They were bound to hold the animal in great respect, and the cave lion was pictured in the oldest paintings on cave walls (Chauvet and La Marche in France, etc.). Not only are there beautiful cave paintings, but artistic representation of this animal appears in the form of clay figurines or artifacts made in ivory (Vogelherd in Germany). One of the oldest ivory carvings, showing a combination of human and animal attributes, is the sculpture of Lion-man, discovered in 1939, in the Stadel-Höhle cave in Germany, but, due to World War II, unrecognized until the late 1970s, and finally in 1997 and 1998 the sculpture was reconstructed from thousands of tiny fragments. The sculpture is exhibited in the Ulmer Stadt Museum in Ulm in Germany. The sculpture is 29.6 cm high, 5.6 cm wide, 5.9 thick and it represents a human body with a lion head. It is carved out of mammoth tusk and has been dated to 31,000 BP. Interpretation of this sculpture is still a matter of dispute and there are various opinions whether the image represents a male or a female figure. The sculpture is known as **Lowenmensch** or **lion-man**.

The motif of the lion is frequently represented symbolic presentations and in the histories of various cultures, from the Palaeolithic to modern times. Usually it represents power, and the strength of someone who owns and controls the world around us. All the presentations in the various cultures have similar meanings: they exhibit the wisdom and dignity of a divine creature, male or female. Whether we might be able to associate findings of the cave lion in the *Lion Cave* with the Palaeolithic hunters and gatherers who were wandering around this cave more than a hundred thousand to ten thousand years ago we do not know, for there is no scientific evidence on which to base any such claim.

More questions for the future?

The Pleistocene period of our distant past, as understood from the bones of the cave lion from Dramalj, reveal that these creatures, larger and more dangerous than the animals of today, roamed this Croatian landscape as well. Yet the Lion Cave reveals only a few of the many secrets of the dark underground. A future and more extensive scientific inquiry into this cave may offer some new clues in unknown world of our past landscape. We might well discover some new animals which lived here in the Pleistocene and we will have better information concerning space and time in this region. We might have some inkling of an environment similar to the grasslands of Africa in which lions lurk and watch the elephants. Or, we might discover evidence to reconstruct a frozen steppe environment disclosing a wandering woolly mammoth? Or, we might discover something not mentioned in this article at all. We always have to bear on our minds that all our clues to the past are derived from two components, understanding the mechanism of change in space and time. The resulting component is the curve of life lying in multidimensional space. It is important to remember that we are technically still in the Pleistocene and that our world could well represent an interglacial, warm period of the punctuated history of the Quaternary era, where we belong with all our human achievements and habits and with everything that happened before us. Therefore, if you are an *astonished tourist*, respect the world surrounding you now, because it is a prize for all of us, for those people from Dramalj who made their *Lion from Dramalj* seen at the Museum entrance as well as a prize for the ancient Paleolithic humans who, carving the Lionmensch in ivory, did honor to both lion and man.



