

Cave inhabitants

Caves: an inhabited area

Cave environment, dark and mysterious, has always stimulated man's fantasy, provoking a mixture of curiosity and fear. Man has envisioned cave inhabitants as being arcane and fantastic, often related to the netherworld and worship of the dead: in western cultures they were seen as evil and devilish, but for many others such as the oriental ones, they were (and in many cases still are) positive supernatural beings that gave protection and brought good luck. Further studies and knowledge on this particular environment made us understand that caves are not home to devils or dragons, but to a micro fauna of tiny and shy beings, difficult to observe but interesting for studies on evolution and management of the environment.

Special biologists

Biospeleology is a zoology branch that studies animals, big and small, that live in caves, their life cycle and how they have adapted to life in environments with particular characteristics.

Man's interest in cave inhabitants dates back to a very long time ago: in a cave on the Pyrenees (France) a bison bone was found on which 15.000 years ago an ancestor of ours had drawn an insect that is easy to find in our caves nowadays: a grasshopper which belongs to the *Troglophilus* species (trogo means cave and philo means friend). Anyway the first scientific descriptions of cave animals date around 1500, and only in 1700 researchers started to be interested systematically in this kind of environment. Biospeleology was born in 1907 thanks to the work done by a Rumanian naturalist called Racovitza, that started off modern day-type studies. Initially biospeleology focused on animals that lived in caves, but as they progressed in their studies, researchers have realized that for smaller animals (such as insects, spiders and other Arthropods) small cracks or tiny shaded valleys have the same environmental characteristics as caves. This way the term biospeleology has broadened to include the study of all types of organisms that live in environments similar to caves.

Temporary and permanent guests

Biospeleologists divide cave inhabitants into 3 big categories: **troglossens**, **troglophiles**, and **troglobes**. These are difficult sounding names that classify animals that live by chance in a cave (troglossens) or by necessity (troglophiles), or animals that live out their entire lifecycle in a cave (troglobes). The latter have adapted so well to cave life that they could not survive on the outside.

Unwilling visitors

Troglossens are animals that end up living in a cave by chance, possibly because they fell inside a well or in a crack or were dragged into a cave by an overflowing creek or water infiltration. They are animals that generally live on the surface and that have never adapted to actual cave life. They are doomed to a quick death in this strange environment, and if in some cases they survive it is because they receive food from external sources, and usually they settle near the entrance where there is some daylight. In any case they are unable to reproduce themselves and merely try to survive as they can. Caves often contain fossils remains of troglossen animals, that entered by chance, and man happens to be among those (such as, for instance, the famous Altamura man, in Puglia)...

Comfortable shelters

Troglophiles are "cave friends", animals that live generally in the daylight, but occasionally will seek shelter in caves where they look for protection from the cold, storms and excessive heat, or to hide from predators. It is the case of bats, foxes, opossums, raccoons, porcupines, small rodents, snakes and many kinds of other animals that look for shelter and a safe place to bear their young as well as storage space for their food reserves (as many rodents do) or to hide their prey from other predators (as, for instance, hyenas and leopards do).

Bats and bears live out the winter in caves and give birth to their young who will then get to know the outside world only in spring because caves offer a warm shelter to spend the wintertime.

Near the entrance speleologists often find traces left by cave guests: excretions, food leftovers, prints, nests and

burrows. Occasionally speleologists become involuntary sources of food and shelter to cave guests: during an exploration it isn't unlikely that one might find a whole dormouse family peacefully wrapped up around the ropes of a rucksack left at the bottom of a 90-meter deep well!

Cave animals are not always large and visible: many insects and other arthropods (such as spiders and centipedes) or amphibians (such as frogs and salamanders) find shelter in caves and in cracks during the colder months: during the winter time near the entrance of a cave it is easy to see butterflies, spiders, and other small "refugees" that take advantage of the warmth within.

Troglophiles are animals that live on the surface, that need daylight to move about and eat food that cannot be found in caves. These guests are "opportunists" that use them as dens, for resting or as shelter for their young, but that cannot live permanently in a cave: in fact they must go out to search for food or a partner. Some of them, however, have the ability to move well in the dark such as bears and rodents. Others, in spite of needing their eyesight to move about, have developed specific systems to move in the dark, such as bats or other types of birds that make their nests in caves: the salangane (a kind of dove that comes from South-East Asia that make nests that are considered to be very refined delicatessen food in Oriental cuisines) or the guacharo (a very strange South American bird). These animals have an "echolocation" radar-like system: they are able to emit high frequency sounds that, bouncing on obstacles or preys are then perceived by a sophisticated hearing system which allows them to put together a surprisingly precise map of their surroundings even in total darkness.

Permanent residents

Troglobes are animals that spend their entire life cycle in a cave, where they are born, live, reproduce and eat. Spanning over thousands and millions of years, they have evolved so as to adapt to life in this particular environment. They have no need to go on the outside and in many cases will live their entire lifecycle without ever leaving the cave. Not all animal phyla are represented in this category: mammals and birds are missing. Instead we find many belonging to the Arthropods (spiders, scorpions, and pseudo scorpions, centipedes and millipedes, crustaceans, such as shrimps, and especially insects), fish and amphibians.

A particular environment

Cave environment has certain physical and morphological characteristics that make it very particular and different from any other environment on earth. These characteristics don't allow for all animals to survive, but only those that have developed particular evolutionary modifications. The hypogeous ambient can be divided into different under-ambients:

- surface ambient
- endogenous ambient (soil)
- superficial subsurface (rock cracks and holes)
- deep subsurface

The deeper the more animals have changed to adapt to it. Of all the aspects that characterize the subsurface the most important is the dark, which increases as one moves further from the entrance. This means that animals had to undergo major evolutionary changes in order to be able to move, to defend themselves or run away from predators, to hunt for food and to look for a partner and reproduce in permanent total darkness.

Another significant consequence of the absence of light is the gradual disappearance of vegetable organisms that live thanks to the chlorophyll photosynthesis. The superior plants are the first to disappear, while other plants were able to adapt to living in low light conditions. Plants that likely to live deep in caves are ferns (cryptogams) and the last vegetables that disappear are mosses and green- blue algae, that can live in conditions that our eyes perceive as almost total darkness. Therefore without vegetable organisms a very important food source is missing, which is typical of an oligotrophic environment, which means very short on food. In this way the food chain is upset and animals that live there must adapt to this.

Temperature is a very important parameter too, because it controls all living beings' metabolisms. Caves have a very particular characteristic: the temperature inside is very stable and remains constant throughout the year at the average outside temperature for the year. This means that most cave animals cannot manage thermal differences and even very minor temperature variations can kill them.

Another important parameter is humidity, which is usually very high in caves and around cracks and fractures. Most cave animals need very high humidity levels, close to saturation: some are sthenhydros and need constant humidity. This is the reason why, if we want to go and look for animals in caves we must remember that dry areas are practically uninhabited.

Evolution

Cave environment is hard and selective and a very few organisms have adapted by undergoing specific morphologic and metabolic modifications. Changes aren't immediate, but come as the result of an evolution that can take up to millions of years, starting from species that lived outside and that for many reasons ended up trapped and isolated in underground cavities. Species that have been used to living longer in underground conditions are the ones that show more specific modifications.

In the absence of light, eyes are a useless instrument: species that have lived in caves the longest can be recognized by the fact that they are eyeless, while a species that is in the process of adapting to this type of environment still has eyes but they are very small or underdeveloped. Others have eyes at the time of birth but then they disappear as the animal reaches adulthood. To move in the dark, to feel the presence of predators or other animals of their same kind, they develop other senses: cave organisms generally have long legs, long antennas, hairs and bristles that function as tactile organs as well as a highly developed olfactory sense.

In total darkness, even the ability to fly is useless: cave animals that descend from species that were originally able to fly (such as insects) have all lost this capacity, with the subsequent atrophy and loss of their wings.

In the dark colours disappear too: cave fauna shows a depigmentation phenomenon, animals are scarcely coloured and have mostly light colours such as beige and yellow tones (the colour of chitin), as is the case of many insects, or are completely pale or transparent, such as shrimp or certain fish. It is interesting to notice that species that have adapted only recently, when exposed to the light they tend to regain their colour, while species that have totally adapted to cave life no longer have this capacity and often are killed by the intensity of solar radiation.

The lack of light has an influence also on chitin production (the substance that makes up insects' and crustaceous' exoskeleton), so in general these have a lighter and finer exoskeleton which makes them more vulnerable to predators and dehydration. Some beetles have evolved by developing a particular elytra welding, that creates a cavity inside the abdomen that can contain a small quantity of "reserve" liquids: this is why many cave insects have a large spherical abdomen.

Miniature tigers

Because of the lack of vegetables, in the hypogeous environment the food pyramid is structured differently: the alimentary base is represented by autotrophic bacteria, which are organisms that are able to produce organic substance not from light but directly from mineral substances, such as **nitrobacteria** (that use nitrogen), sulphur bacteria (that use sulphur) and many others. There is a bacteriophage fauna too, that lives in mud and feeds on bacteria. Bacteriophages are in turn hunted and eaten by the limivous fauna (earthworms, crustaceans, insect larvae), that eats by sifting mud and becomes in turn prey to chilopodas (centipedes), arachnids (spiders), and insects that in caves are at the apex of the food pyramid.

The "large carnivores" are represented by chilopodas and coleopterans, that, in spite of being small, have the same ecological role of lions and tigers in surface environments. Coleopterans are, of all cave animals, the ones with the most sophisticated techniques: they are efficient and terrible predators, provided with a very fine sense of smell, with a great ability to spot their prey and go great distances for food. The mouth and trophus apparatus, which is very sophisticated, leaves no escape to the prey, and makes them into the real "tigers" of the insect world.

Other very efficient hunters are chilopodas and crustaceans, such as shrimp. Fish are troglome organisms which can be larger (a few tens of centimetres), which is a sign of their position at the apex of the food pyramid in the submerged underground world.

Lifestyles

The cave environment offers very little in the way of food. The trick in underground life is energy saving, so the best adapted organisms are those that need less energy to reproduce and live. For this reason, most of the cave inhabitants have very slow metabolisms: slow growth, small dimensions, a long life cycle, they are slow and don't move very much, sexual maturation occurs very slowly and very often they maintain the typical characteristics from their youth, they reproduce very little, they are satisfied with minimum quantities of food and normally they use very little oxygen. Since there is no night and day, their life rhythms aren't based on the usual 24-hour cycle such as other organisms that live under the sun. Because of the scarce food sources, that depend on autotrophic bacteria and the rare supplies coming from the outside, the hypogeous environment can give hospitality only to a very reduced number of species each made up by few individuals: so caves aren't very crowded and have a few predators, which means it is a safe and protected place.

Small devils that need protection

The typical cave animal is the bat. In many caves in tropical areas, bats form colonies made up by thousands or millions of individuals. The show offered by these animals is one of the most fascinating in nature: at dusk they move about the sky, "drawing" a black snake in search of insects.

This animal has very particular characteristics: it is the only mammal able to fly, with real wings and muscles unlike other "flying" mammals, such as some squirrel species that simply have skin membranes. But their most particular characteristic is the echolocation system: no other animal has such a precise and sophisticated "radar" system, that allows it fly far from the cave entrance and to hunt even very small prey such as insects. When going through small and narrow paths speleologists are used to feeling a light air current and the butterfly like flapping of wings of a bat that flies through the very narrow spaces between their heads and the cave walls without ever grazing either one!

Their sophisticated hearing system has given them enormous ears (as opposed to the eyes, which are small and underdeveloped even though bats are not completely blind) and the nose is often very strange looking, since it has been modified to emit certain ultrasounds necessary for orientation purposes. This makes them not particularly nice looking which together with the membranous wings and their dark colour, gives them that "devil like" look. In fact man has put out many stupid and unfair theories about bats being evil and dangerous that in the past (and often at present too) has led to real persecutions towards them. Many people nowadays are still convinced that these animals will get tangled in one's hair, which is almost impossible, given the highly sophisticated system by which these "little devils" fly and it is more likely that all the noise that we make is going to make them escape faster and a lot more scared than we are! There is another silly belief that bats suck blood: there is only one kind called "vampire", that belongs to the *Desmodus genus*, that lives in South America, that generally bites his preys without hurting because his saliva contains anticoagulants as well as a kind of anaesthetic. Contrary to what most people believe, it is a tiny animal just a few centimetres long, that can such a very small amount of blood (unable to kill a person!) and generally attacks quadrupeds, that don't have hands that can fight it off. The vampire bat has a social behaviour that makes it easier to forgive its feeding habits: since they aren't able to resist without food for more than a few hours, they help their babies and wounded or sick ones that can't seek food for themselves, by regurgitating food into their mouths.

Leaving behind legends and popular traditions, bats are in fact very useful animals: in fact they are great insect hunters, which they eat by tons every night. If they are adequately protected, they are very efficient "natural insecticides", that don't cost at all, don't pollute and make our summer nights more interesting with their oscillating flight. Their guano is also a very fine and rich fertilizer. Unfortunately, they are becoming rare animals in industrialized countries because of the large amount of pesticides used, which, by killing their usual preys, end up poisoning our little friend too.

Dragon tales

The animal man's fantasy located in caves, as a guardian of huge treasures or kidnapped princesses, is the dragon. But are they only legends? Very often are exaggerations of reality and legends on dragons aren't an exception. Dragons are generally provided of wings, just like bats (and devils too in the end): maybe these small cave inhabitants scared them so much, that in some way, they seemed to be bigger than what they actually are.

Many palaeontology findings (such as the dinosaur ones) have contributed surely on making up legends on dragons and on the fact that often many big bones have been found in caves (such as for example, the cavern bears, the big *Ursus spelaeus*) and this made people think that these places were homes of these fantastic animals. For instance, in the southern part of Italy, the findings of elephant fossils, which skull has a big hole for the nasal cavity where the proboscis starts, gave life to Cyclops legends, gigantic beings that have one big eye in the middle of their forehead. But legends on dragons had an extraordinary confirmation in 1689. A naturalist called Valvassor, one of the first cave scientists, found in a fount near by a cave of the Carso a small curious animal: long and pinkish, that has 4 paws, a long tail and two strange red whorls on the sides of the muzzle without eyes, this animal seemed like a small dragon in miniature...surely a cub of some kind of gigantic and monstrous being, taken out of the waters! In 1768 the mystery was revealed: it wasn't a dragon's cub, but an adult specimen of *Proteus anguinus*, one of the most strange cave inhabitants.

Proteus

It's an **amphibious**, a distant salamander relative, that represents one of the most surprising adaptations of life in caves. It lives in caves in the Oriental Mediterranean area, in Dalmazia, Slovenia and in the Carso triestino and goriziano part. It is 20-30 centimetres long, pinkish colour and extended form, with a long tail and 4 small paws (that have 3 anterior fingers and 2 posterior), that aren't though able to sustain it, so the proteus can't walk but can swim. When it is born it has developed eyes, but these, during the growth, regress completely. Their particularity are the red whorls of the gills on the sides of the muzzle, that remain in the adult stage too. The proteus doesn't complete his metamorphosis and remains at the larva status, which is young, all life long: it is practically an eternal baby... Many underground biospeleology labs that rear them so they can study them better, but it is difficult for them to reproduce in captivity. In 1832, Alberto Parolini who is a naturalist introduced a few specimen in the Oliero caves, near by Vicenza, where the specie was absent. There weren't any news on the introduced proteus and they thought these species didn't survive, but in 1965 a few speleolosubs in the Cogol fount of Veci had an extraordinary meeting with different specimen that, evidently, adapted and reproduced, and now it frequent for the speleologists that immerse into the Olieri fount to see these funny small animals. This demonstrates the big adaptability these animals have and they hope it is possible to reinsert it in zones originally presented, but where they disappeared later on, often because of the water pollution.

A vulnerable environment

A cave environment, for it's nature and for the modalities superficial waters enters and moves, is a delicate ambient and very vulnerable to pollution. Their inhabitants, so sensible to small variations around them, are then in big danger. Only a serious and a focusing environment political can maintain intact this particular ambient and fauna, that for a million years they adapt slowly to very tough life conditions in the world underground. Do we want to help out the mysterious, strange, curious and useful inhabitants of the caves too?