Recovering Fossils From Underwater Caves

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Abstract

In this report we describe an airlift equipment used for collecting fossil material from an underwater cave in Central Brazil. The airlift system is composed of a gas fueled engine connected to a hard plastic pipe that brings the sediment up to the surface and to a thinner hose that pumps compressed air into the pipe. The pipe and the hose are 200 meters long and have a copper opening. The hose opening penetrates the pipe opening and has dozens of small holes. The compressed air is blown through these holes provoke a turbulence resulting in a pressure differentiation that brings to the surface water plus sediment. This system has proved to be very effective bringing the material undamaged from up to 40 meters depth.

Background

The research program "Quaternary Mammals from Brazil" (SALLES *et al.*, 1999) is developed under a broad perspective on the geo-biological history of the South American continent. The main goal of this program is to reveal mammalian micro and megafauna fluctuations during the last 2,5 Myrs. Thus, we expect to contribute to paleontological and geo-climatic reconstructions of Brazilian Quaternary scenarios (BROOKS & MCLENNAN, 1991).

Our research focus has been the fossil material deposited in limestone caves presently distributed along the Brazilian savannas. Caves are considered areas of special paleontological interest since they may accumulate fossil-rich sediments carried by water. They also represent natural traps for larger mammals (PAYNE, 1983.) or may serve as a shelter for animals such as owls, that regurgitate therein pellets rich in non-digested osteological material (ANDREWS, 1990). However, paleontological studies on Brazilian caves are still scarce (LUND, 1838; VOSS & MYERS, 1991). This is specially true for microvertebrates, that are considered to be the best indicators of climatic changes due to their diverse and refined ecological association with the environment (AVERY, 1982; KORTH, 1979). One of the reasons for this lack of studies are the difficulties regarding the logistics for paleontological exploration inside caves.

This report concerns paleontological exploration specifically in underwater caves. Due to their extreme conditions, human impact in these caves is nearly absent, what makes them even more appealing for paleontological studies. On the other hand, highly sophisticated techniques are required to recover the fossil material and interpret the associated taphonomy and stratigraphy (KORTH, 1979).

In fact, underwater paleontological and archeological explorations are limited to open waters, so far no methods have been reported for use in overhead diving conditions. We report here an experiment using an airlift system to be used in paleontological studies under such conditions. The purpose of the system is two-fold: 1) to recover small-sized fossil material brought up by the "lifted" water; 2) to remove deposited sediments in order to expose bigger-sized fossil material, that can be then hand-picked. In this study we describe the airlift technique as a means to promote undewater paleontological exploration.

Technical Procedures and Results

In January 2001, the airlift technique was implemented for the first time on the paleontological exploration of the underwater cave Buraco do Japonês. This limestone cave is part of the Serra da Bodoquena complex (http://www.unb.br/ig/sigep/), located in Mato Grosso do Sul (Brazil; CECAV/IBAMA, license number 006/00, process number and register in IBAMA 02001.002336/00-32). The dive is technically classified as a full cave dive, due to a very narrow restriction that occur on the first eight meters from the entrance. In addition, the dive is particularly difficult given the great amount of fine sediments encountered on the cave floor that brings visibility to level zero with nearly any contact.

A team of eight professional cave divers, leaded by Antonio Libertino, in collaboration with paleontological researchers, has carried out the first airlift experiment to recover fossils. The divers have used special cave diving equipment (including dry suits) and various respiratory gas mixtures, such as Nitrox, Trimix and pure oxygen (used for decompression). The exploration of the Buraco do Japonês cave has reached a linear distance of 330 meters from the entrance and a maximal depth 56 meters. However, the paleontological sites were confined to the first 210 meters with a maximal depth of 43 meters.

The airlift promotes a pressure differential in order to lift water columns, guzzling material with different densities up to the surface. This equipment is specially useful for paleontological exploration because it does not use rotors or palettes that cause damage to the lifted material. After a series of tests, we have constructed a special airlift with the following technical description. A 15 cubic feet (or 425 liters) per minute compressor operates on a 170 PSI/pound labor pressure and has a gasoline fueled engine of 4 HP with a 200 liter reservoir. The compressor is connected to two tubes. The first tube is a highly resistant annealed plastic pipe (2 inches of internal diameter and 200 meters long) that goes underwater and brings the sediment to the surface. The second tube is a thinner rubber hose (¼ inch of diameter and is also 200 meters long) that blows compressed air into the underwater system. The collecting pipe has a copper reinforced opening 60 cm long and 45^o angulation with a sphere valve that allows the operator to control the sediment flow. A 5kg ballot is attached to this end of the main pipe, stabilizing it. The total weight of the operating opening is about 7.5 kg. The rubber hose is tied to the main pipe along their 200 meters. To the final end of this hose is attached a copper tube (30 cm long) that penetrates into the main pipe. This tube has a large number of tiny holes that blow compressed air into the main pipe provoking a large scale turbulence (i.e, *venturi* system). The turbullence results in a pressure differential that causes the water (plus sediment) to be lifted to the surface. The collected sediment went through a screenwashing system of three sieves.

Our first airlift experiment produced an average of 16 liters of water plus sediment per minute. 47 hours were needed of deep diving in order to airlift for just 9 hours that yielded 8640 liters of water plus sediments removed from the cave. The airlift technique has been successful under depths of 13, 16, 19, 23, 27, 30, and 40 meters.

Conclusions

Approximately 550 vertebrate fragments were recovered from the screenwashing process. Most fragments showed signals of having been extensively rolled. No signs of fractures, possible due to the airlift system, were found. Therefore, the airlift system proved to be extremely useful in recovering intact small fossil fragments. Due to the limited time available for this experiment we were not able to demonstrate exposed larger fossil bones previously covered sediments..

The fragments collected through the airlift comprised mainly of teeth, maxilae, vertebrae, long bones and osteoderms of mammals. The identification of this material is still undergoing but it has already revealed a very diverse fauna including mammals amphibians, crocodilians, lizards, snakes and invertebrates. Among mammals members of different orders were identified such as Xenarthra (armadillos), Carnivora, Artiodactyla (deers), Rodentia (agoutis and capibaras), Primates (howler monkeys) and Notoungulata (Toxodontidae), a representant of the extinct Pleistocene megafauna of South American Mammals. It is worth mentioning that a large number of other vertebrate fossils were hand picked. Given the preliminary status of the taxa identification and the fauna diversity encountered, the perspectives of underwater paleontological exploration in Brazil are very good.

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