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Human fossils and paleoanthropologists: a complex relation

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The discovery of a human fossil remain is a special event, not only from a scientific point of view but also from the point of view of the impact it has on all human beings. The dreams of lifelong research become a reality through the discovery of a small piece of bone, whose significance goes far beyond its physical reality. The first notification of the discovery in newspapers and/or scientific journals propels the team of researchers to the front of the scientific stage and to the center of attention in the media. They bask in their recognition within the scientific community, which gives weight to their work after many years of unsuccessful efforts, while other scientists remain in the shadows throughout their lives.

A discovery seldom occurs at random, except when it is the result of roadworks or speleological explorations. The standard method of finding human fossils is through the classical but difficult process: of obtaining funds, and carrying out unfruitful prospectings and layer excavations for weeks, or even years, before reaping the rewards.

After its discovery, the fossil begins a new life with several "parents", i.e., the digger, the scientific community, the authorities of the country in which it was discovered, and finally, the entire human population. The duration for which these different "parents" are recognized is not exactly the same: "fossil hunters" are recognized as long as they can take part in the scientific movement. The scientific family lasts longer, because it comprises not only the scientists alives at the time of the discovery, but also all the paleoanthropologists who will join them in the future.

The first implication of this complex genesis of discoveries is the recognition and legitimacy of "scientific property." Only the field prehistorian has the capacity to direct multi-field studies integrating the human fossil in its archeostratigraphical context. He has to face the great expectations of the scientific community, who awaits the results of the paleoanthropological study to integrate the fossil into the hominid phyletic trees.

In a preliminary paper, the paleoanthropologist and his team describe the main characteristics of the fossil and propose a phyletic interpretation.

This first publication does not present all the detailed studies, which are now required by the modern complex paleoanthropology and science evolution, carried out by specialists of various disciplines and methods.

Consequently, the discoverer and his team have to face multiple requests for access to the original fossil. Access is generally refused, except in the framework of a planned collaboration with another team or paleoanthropologist. This refusal is often criticized by some members of the scientific community, but it is normal, provided the discoverer and his team continue studying the fossil remains and publishing their results. These limitations can be misinterpreted and regarded as deliberated acts to prevent other scientists from studying these remains, although, sadly, this can also occur in the event of a conflict of interest.

In countries where national paleoanthropologists are still few in number, such as Africa, access to a fossil is often granted only after a discussion between the team of archeologists and the authority in charge of the country's national

heritage. Access to fossils can be is granted after acceptance of a scientific proposal, which often includes the participation of national scientists or students.

In Western Countries, where prehistory is considered an "old" science that appeared in the nineteenth century, fossils are generally kept in museums.

These fossils were first studied a long time ago, but there are still iterative requests for access to them today. These requests may come from scientists and/or teams who wish to propose an original methodological approach.; however, some of them are made by students whose scientific level has yet to be validated. Museum curators have to be especially careful when they grant fossil access to people claiming that they need them for methods that require fossil sampling, even if the request is for a very small quantity. For all the above mentioned reasons, namely, the fossils being the scientific property of the discoverer, the rights of countries to the fossils, and the requirements pertaining to the preservation of collections by museums, access to fossils is obviously limited. However, in this day and age, it is much easier to access copies of fossils. Casts made with modern resins have a high resolution and can be used for the external measurements of fossils in most studies and especially by students.

Unfortunately, the methods applied to paleoanthropological remains evolve slowly. Let us take the example of new medical imaging methods, such as use of the three-dimensional X-ray- computer or laser- scan data and virtual image processing (Mafart et al., 2002, 2004; Bruner & Manzi, 2006). Recent images obtained by means of medical X-ray computer data represent a major step in the study and diffusion of human fossils. The best images are obtained with the use of industrial scanners. These methods are currently used to analyze previously invisible structures like the sinuses, the inner ear, or the endocranial structures. Several new research fields have opened up as a result of the recent applications of X-ray synchrotron microtomography to paleoanthropology,. Thanks to these new applications, the internal dental structure as well as the enamel thickness and enamel-dentin junction can now be studied. With this rapid prototyping, it is now possible to obtain reproductions of fossils similar to casts. Three-dimensional imaging and the virtual digitization of modern and fossil skulls provide the opportunity for new statistical studies based on computer-graphic visualizations and have also opened up the broad field of 3D morphometric analysis.

Almost all hominid fossils have undergone taphonomic degradation and have become decayed, fractured, and deformed in the archeological soil environment. One of the crucial problems is the validity of the reassembly of fragmented fossils before moulding. Until now, reconstruction has been done manually using various materials, such as (adhesives, plaster, and plastic putty) to fill in missing areas. Such reconstructions are questionable, especially when fossils are fragmented or deformed, with numerous missing parts. Currently, the virtual reconstruction of scanned fragments not only allows for the testing of every possible configuration but also the assembly of pieces from different contemporary fossils to evaluate morphological compatibility. Virtual reconstruction with the correction of defects is also feasible. Rapid prototyping can be used to generate replicas of the various virtual configurations.

These new techniques and requests are sources of difficulty for countries, teams, and museums that are not equipped with or do not have access to digital methods. Good examples are the techniques of high resolution micro-CT and 3D medical CT, which are not available in most African countries. As a consequence, fossils have to be brought to Western laboratories to get 3D images.

Fossils that were discovered years ago are re-studied using these methods.

Consequently, the paleoanthropologists using these new techniques request the scannographic data of the fossils. The teams who have discovered them want to control the diffusion and scientific use of the scannographical data. The concept of scientific property is then broadened to the digital data of the fossils.

A convention of partnership should define the rules for using these data, which can be diffused without the control of the scientific owner and for which there is the correlative risk of unauthorized utilization.

Obviously, strict vigilance has to be maintained by the curators in charge of hominid fossils conservation, which explains some reservations that have occasionally been misinterpreted as limited access (Weber, 2001).

The diffusion of 3D scanning data of several fossils discovered in past decades has begun through an international network. Several hominid skulls have been scanned and these 3D data are available at a low price, part of the money being sent back to the organizations in charge of their conservation (see *Digital Archive of Fossil Hominoids*). It was our choice to sign a convention with a museum preserving a human fossil cranium. We carried out the scanning of an Upper Paleolithic skull found at the end of the nineteenth century, maintaining scientific exclusivity for two years in order to have enough time to publish its study. After this two-years period, the museum curator will be responsible for data diffusion. In our opinion, this type of convention is well adapted for the study of European fossil remains dispersed across different museums.

Various other types of relationships between "fossil hunters" paleoanthropologists, and museum or institutions authorities can be established. It is essential to take into account both the scientific property of the scientists and the duties of others in order to secure preservation of these rare and fragile witnesses of the past for future generations.

The use of 3D imaging for the study of human evolution is only the beginning. Further progress will result as technology in medical imaging and 3D image processing advances. With the continued development of high definition scanners, allowing the analysis of large fossil specimens such as skulls, no difference between virtual and original specimens will be perceptible to the naked eye, and digital images will be a standard tool for storage and analysis. In the near future, the advent of 3D processing, allowing volume analysis, and computer-assisted morphometric analysis, will become the backbone of paleoanthropological study and provide the foundation for the derived applications mentioned above.

Paleoanthropologists will continue to give growing importance to 3D imaging; however, it will not take the place of the visual study of fossils. The morphological study of fossils, i.e., the study of muscle insertions, surface of the bones, and details of the teeth, are still quite relevant and cannot be considered obsolete. The study of original fossils will always be necessary, but the sharing of 3D data between paleoanthropologists is clearly necessary and on the rise.

Three-dimensional imaging opens the door to a large diffusion of virtual fossils. A strict respect for correct scientific practices gives the best opportunities to everyone in these new fields of research. The digital world has opened the door for a worldwide paleoanthropological database, the "International Digital Library of Fossil Hominids." All paleoanthropologists have the duty to participate in its development; however, the scientific property of the discoverers, institutions, scientists, museums, and national heritages must be strictly respected.

Info on the web

http://www.virtual-anthropology.com/3d_data/3d-archive
Digital Archive of Fossil Hominoids

http://www.ifi.unizh.ch/staff/zolli/CAP/Main.htm
Computer-assisted Paleoanthropology

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