LASER SCANS, CT SCANS AND CONVENTIONAL PHOTOGRAPHY SCANS, AS A POWERFUL TOOL FOR COMPARATIVE PALAEONTOLOGICAL STUDIES

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Abstract

THALIS MIS380135 project, aims to build up and present to public a complete three dimensional life size skeleton of *E. tiliensis*, using Rapid Prototyping Technologies. In order to construct 3D models of bones *that have not been collected during the excavations* or were very fragmentary we used material from parental species (*Palaeoloxodon antiquus*) excavated in other localities (Megalopolis) or even recent african or asian elephants. For the purposes of the THALIS project 3D digital models are being transformed after considering biometrical information, ontogeny, allometry and evolutionary trends. The direct comparison of overlapped 3D models used initially to check the accuracy of the applied methods revealed their capability and importance for answering questions of classical palaeontology for describing morphological differences of species belonging to a single genus. Efforts have been made also to apply the same methodology two species belonging to a different genus or different family.

Keywords: Keywords: *Elephas tiliensis*, CT scans, laser scans, CAD, 3D modelling, rapid prototyping

Introduction

Rapid Prototyping Technologies of fossil bones can be easily used to reconstruct reliable 3D replicas.

Our aim was to use CT scans, laser scans, conventional photography scans and their CAD models for palaeontological studies on comparative anatomy of different animal species eliminating bias from possible subjective traditional palaeontological comparisons based on personal observations and descriptions of bones.
The methods that are used in this study for 3D modelling can be used as an extremely powerful tool for studies on vertebrate comparative anatomy.

Materials

Elephas tiliensis bones have been excavated from Charkadio Cave on Tilos Island Dodecanese Greece, since 1971, bringing to light more than 15.000 complete or fragmented skeletal remains. This species represents the last Mediterranean endemic elephant that migrated on Tilos island (Dodecanese, Greece) 45.000 years ago after crossing swimming the sea corridors of the past. Tilos endemic elephants became extinct about 4.000 - 3.500 years ago. It belongs to the Mediterranean endemic elephants of middle size with an average height of less than 2 meters. Its parental species, *Palaeoloxodon antiques* belongs to the large continental Quaternary elephants that roamed Greece and Asia Minor with a height close to 4,5 – 5 meters. The morphology of the remains of these elephants excavated in Megalopolis since 1902 is compared with the morphology of the endemic elephants from Charkadio cave.

Methodology

An interdisciplinary team has been put together under the auspices of THALIS MIS380135 project, in order to build up and present to public a complete three dimensional life size skeleton of *E. tiliensis*, using Rapid Prototyping Technologies. In order to construct 3D models of bones *that have not been collected during the excavations* we use material from parental species excavated in other localities. This material is transformed after considering allometry, ontogeny and evolutionary trends. The use of these models and our trials to check the accuracy of the applied methods that we used brought to light the importance and the capability of all these methodologies for answering questions on classical palaeontology and describing morphological differences of species belonging to a single genus.

Methods used include:

- CT scans of *E. tiliensis* carpal and tarsal bones.
- Laser scans of selected *E. tiliensis* carpal and tarsal bones.
- CT and Laser scans of tarsal and carpal bones of the continental parental species *Palaeoloxodon antiquus* and *extant elephants (Loxodonta Africana - Elephas maximus).*
- Conventional photography scans of *E. tiliensis* carpal and tarsal bones.
- 3D modeling, scaling and mirroring.
- Comparison of overlapping 3D models and evaluation of the differences. Different degrees of grey tones (or color) correspond to morphological differences.
- Conventional descriptive palaeontological and biometrical methods for comparison reasons and evaluation of the digital results.

In this way the aforementioned methodologies have been used to compare the morphology of bones belonging to different taxa, bones excavated at different stratigraphic horizons or localities. By the way these methods have been applied to bones stored in different museums eliminating or minimizing the need for travelling at different cities or transporting large fossils or replicas from one city to the other for direct comparisons.

Results-Discussion

This is the first time that these methods are used to compare the morphology of eastern Mediterranean endemic animals with its parental continental forms. The 3D scans of selected carpal bones and tarsal bones have been used for the creation of the 3D models for *Elephas tiliensis*, *Palaeoloxodon antiquus* and recent species. The different degrees of grey (or color) at the overlapping 3D models correspond to the morphological differences of the selected bones.

Drawbacks include the cost of the equipment and software, the necessity of qualified personnel at the paleontological museums and the necessary man hours. Future plans aim to combine these methodologies with classical biometrical methods, allometrical studies, ontogeny and other paleontological techniques in order compare species belonging to different genus or even families.

A new very powerful tool is available for vertebrate and invertebrate palaeontologists all over the world making morphological comparisons more accurate and easy than the past eliminating bias of classical descriptive palaeontological methods.

References

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2. Figures and Tables

Figure 1. Tilos island at eastern Mediterranean sea. The arrow represents the position of Charkadio Cave.

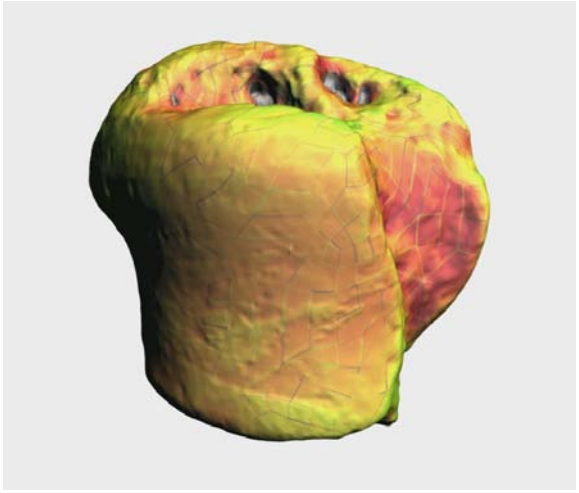

Figure 2. Comparison of data extracted from Computed Tomographies and 3D Laser Scanning technologies. The different tones correspond to the differences of the two methods used. The same principle is used for the morphological comparison of bones of different taxa. This method opens new horizons for vertebrate palaeontology.