A 3D photogrammetric reconstruction attempt of specimens of Badenian echinoids

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The rich echinoid fauna of the Badenian (Middle Miocene) from Budapest (Hungary) is well known for more than one hundred years. Along the road cuts and due to the construction of large buildings from 1960 to 2011, new Badenian outcrops with rich and well preserved echinoids were found in the city. Thus the main aim of this study was to revise historically collected echinoids (in the collection of Geological and Geophysical Institute of Hungary) from different parts of the city (Örs Vezér Square, Gyakorló Street, Rákos and District of Budafok-Tétény) and to classify the newly collected fossils, moreover to carry out the palaeoenvironmental reconstruction of the different localities. The specimens studied are from the Upper Badenian Leithakalk Formation Rákos Member, which consists of sandy limestone, calcareous loose sandstone with volcanic clast and/or calcarenite without terrigenous or volcanic clast.

One of the most common echinoidea in the Badenian, the Parascutella gibbercula DE SERRES, 1829 is well known and researched in both morphological and taxonomic aspects. However there are some intraspecific morphological features that show sharp differences across the specimens: the adapical conical convexity is considerably different between several forms. The petalodium's length/width ratio is also different between many specimens. Other morphological characters for example peristomal and periproctal aperture and the food groove can also be different. These differences within this relatively small area could be determined by ecological conditions (such as substrate, palaeodepth), or can be related to taxonomical or pathological changes. For an appropriate comparison, quantification of these features is necessary.

Photogrammetry is in general a useful and well-developed tool to reconstruct 3D surfaces of artefacts (e.g., in archaeology, cultural heritage, and also in palaeontology). In order to evaluate the differences found in P. gibbercula specimens various photogrammetric technologies have been used as our initial experiments showed that it could be a good tool to get three dimensional information about the collected fossils.

This contribution discusses which photogrammetric techniques are adequate to study and compare the studied echinoid specimens. Our goal is to review modern techniques and current software solutions to model the fossils and also to study the resulting 3D point cloud. Different methods are evaluated and compared from taking the pictures (with different camera types and different target tables) through data processing, analyzing potential errors, resolution and accuracy for each one of them. Time- and cost-effectiveness of the software packages were also taken into account in order to render the images into 3D model effectively.

Preliminary results show that 3D analysis using photogrammetrical method is a good tool to study the collected echinoid specimens showing more information than the classical morphometry studies, especially in the convex part of the studied fossils. Furthermore, the resulting 3D point clouds of different fossils make it possible to compare and maybe even quantify the differences across the specimens.