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Possibilities of 3-D modelling and quantitative morphometric analysis of decimeter-sized Echinoids using photogrammetric approach

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Echinoids (sea urchins) are useful fossils in palaeoenvironmental reconstruction for e.g. palaeobiogeography, palaeoclimatology or sedimentatological researches. In the Hungarian Badenian stage (Langhian, Middle Miocene) the species *Parascutella gibbercula* (DE SERRES 1829) is a common taxon and indicate shallow marine environment. The specimens of this extinct species show high morphological variability within relatively small geographical areas, even within one given strata. These differences can have a relevant palaeontological and/or palaeoenvironmental information. It is necessary for the interpretation of the value of the morphological parameters to quantify them in properties.

Among the possible quantification methods 3D photogrammetric reconstruction is found to be suitable; recent years have seen its increasing palaeontological application both on invertebrates and vertebrates. In order to generate proper 3D models of the specimens with the required details a great number of digital images have to be shot. In case of proper data acquisition and precise model generation it is possible to outperform the traditional 2D morphometric studies of the echinoids that are often inaccurate when the spatial characters as well as ambulacral system and the conical shaped apex (top of the test) are measured.

An average $P.$ *gibbercula* specimen is about 10 cm diameter. Therefore, desktop image acquisition is possible if appropriate lighting conditions are provided. For better results we have designed an elaborate target background pattern that enhances the chances to find homologous points in the imagery. Agisoft Photoscan software has been used for the model generation. The generated models typically show high-resolution details and reproduce original colours. However, various problems may occur: improper focusing and/or poor lighting conditions may cause hardly patchable aboral and oral side, and/or shallow surface undulations cannot be modelled appropriately.

Another issue is the proper georefering the specimen: the definition of the specimen-related inherent coordinate systems should be transformed to a common one in order to get comparable results. The resulting point clouds are exported to other rendering systems for further processing.

In these systems the operation of the palaeontologically relevant morphometric characters is possible, like generation of profiles, measurement of various parameters, volume calculations, and surface analysis. These results can be interpreted in palaeontological context. Potentially taxonomical, palaeopathological (e.g. parasite-affected), palaeoenvironmental conclusions can be drawn. Furthermore detection of intraspecific variability is of great importance.

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