In situ growth evaluation of scleractinian corals using underwater photography and 3D modeling applications

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Introduction

In order to gain accurate information on coral growth increments, the buoyant weight technique (BWT) is a commonly employed technique. However, this method is not readily applicable for *in situ* studies, as individual coral fragments need to be retrieved regularly to be measured in the lab. The use of 3D photogrammetry on the basis of underwater photography eliminates both of these issues. The pictures as a source for the data can be directly taken from the *in situ* setup with underwater photography. Consequentially, no transfer of specimen to the lab is required, stress is limited for the coral specimen. This new digital tool further enables data acquisition in remote places without laboratory access. This non-invasive method is beneficial not only for coral reef research but also applicable for projects with other sessile animals. Aims of the Project are:

- Develop and refine a Method to evaluate the growth of Scleractians *in situ*
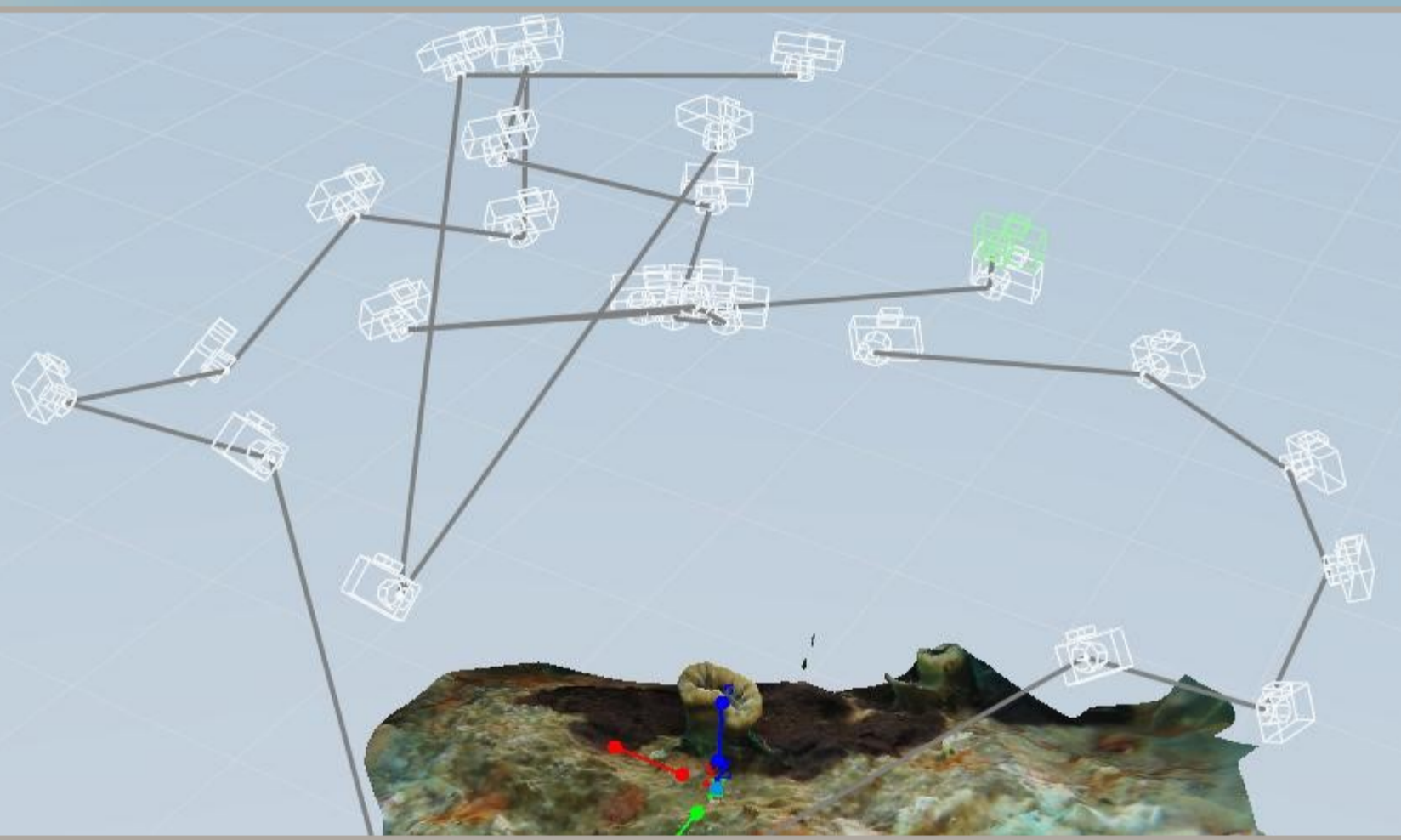- Evaluate the feasibility of the Method in the field

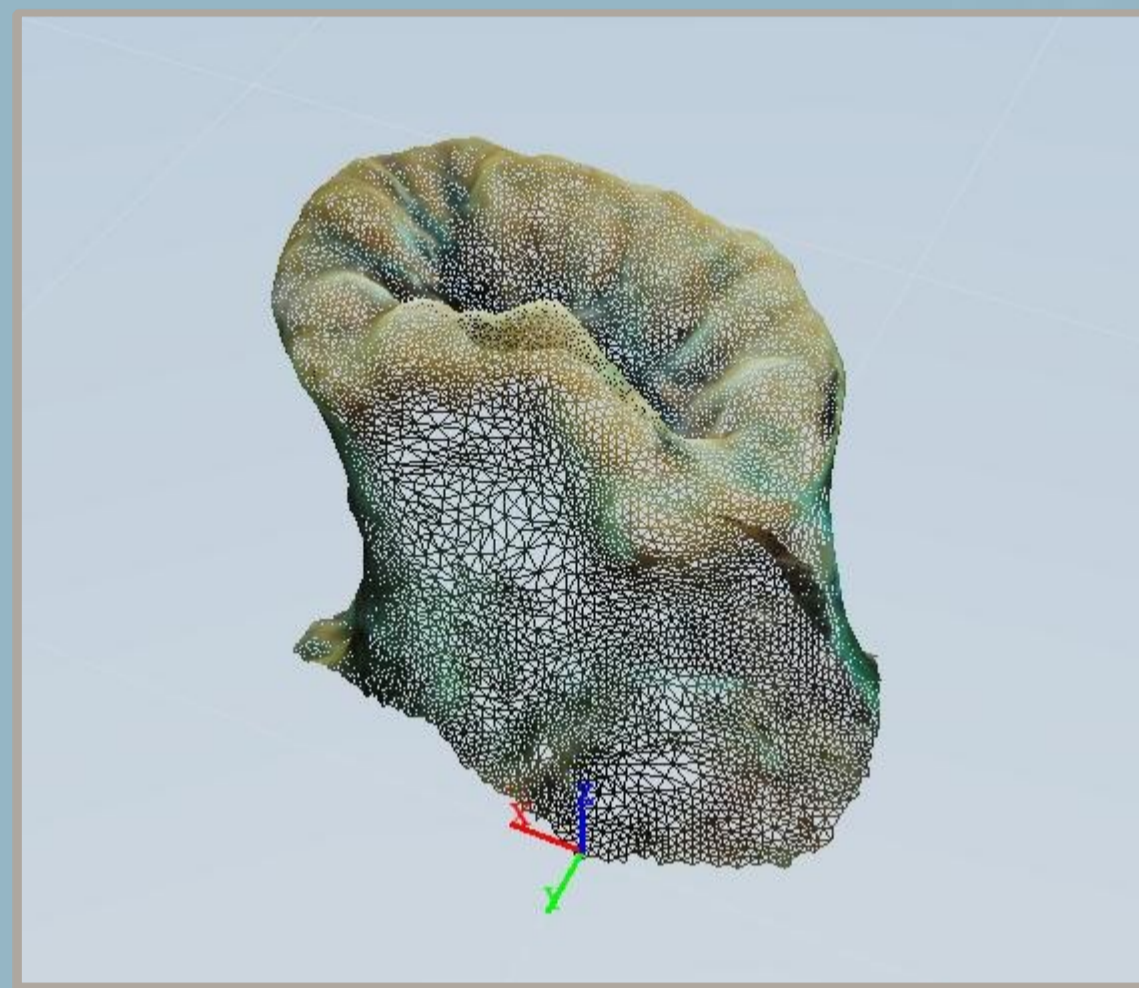Fig. 1: 3D Model and pathway of Camera positions around the Object

Fig. 2: Open mesh model of a single coral polyp

Method: Underwater Photography & Photogrammetry

To get best results a minimum of 20 - 30 pictures is needed, taken every 15 – 25 degrees around the coral (Fig. 1). Vital for the later calculations is a well structured Background and good focusing of the pictures. Also important is a size reference for the Volume calculation. In this study several individuals of *Balanophyllia europea* have been photographed in the Mediterranean sea around Giglio, Italy.

To gain Volume Information the pictures where processed in 3 steps:

1. Stitching of the pictures to create a polygonal 3D mesh model (Fig. 2) and defining a reference distance (Fig. 3) (done with Autodesk 123D catch)
2. closing the Mesh Model at the bottom (done with Autodesk Meshmixer)
3. Calculating the volume of the polygonal body (done with Blender)

Beside the fieldwork also several calculations have been carried out to gain more information about the accuracy of the Method. Therefor 3 skeletons of *Caryophyllia smithii* Fig. 3) have been weighed in the lab and modeled as described above.
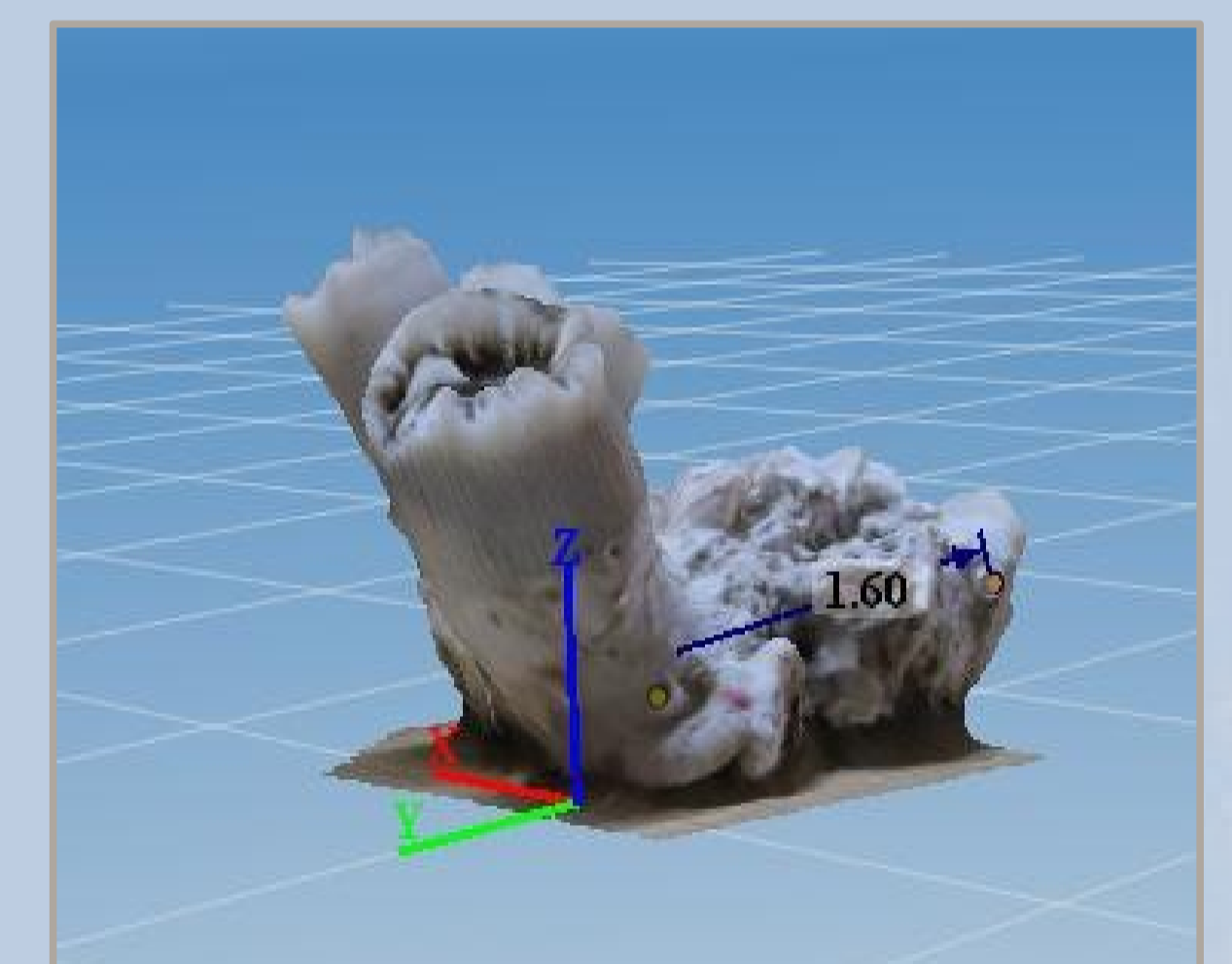

Fig. 3: 3D model with reference distance

Results: volume calculated from polygonal models

The variation of calculated volume from different photo sets (Fig. 4) varies about ± 5,3 – 9,0% while the variation among calculations from the same photo set are lower (± 1,3 – 4,6%).

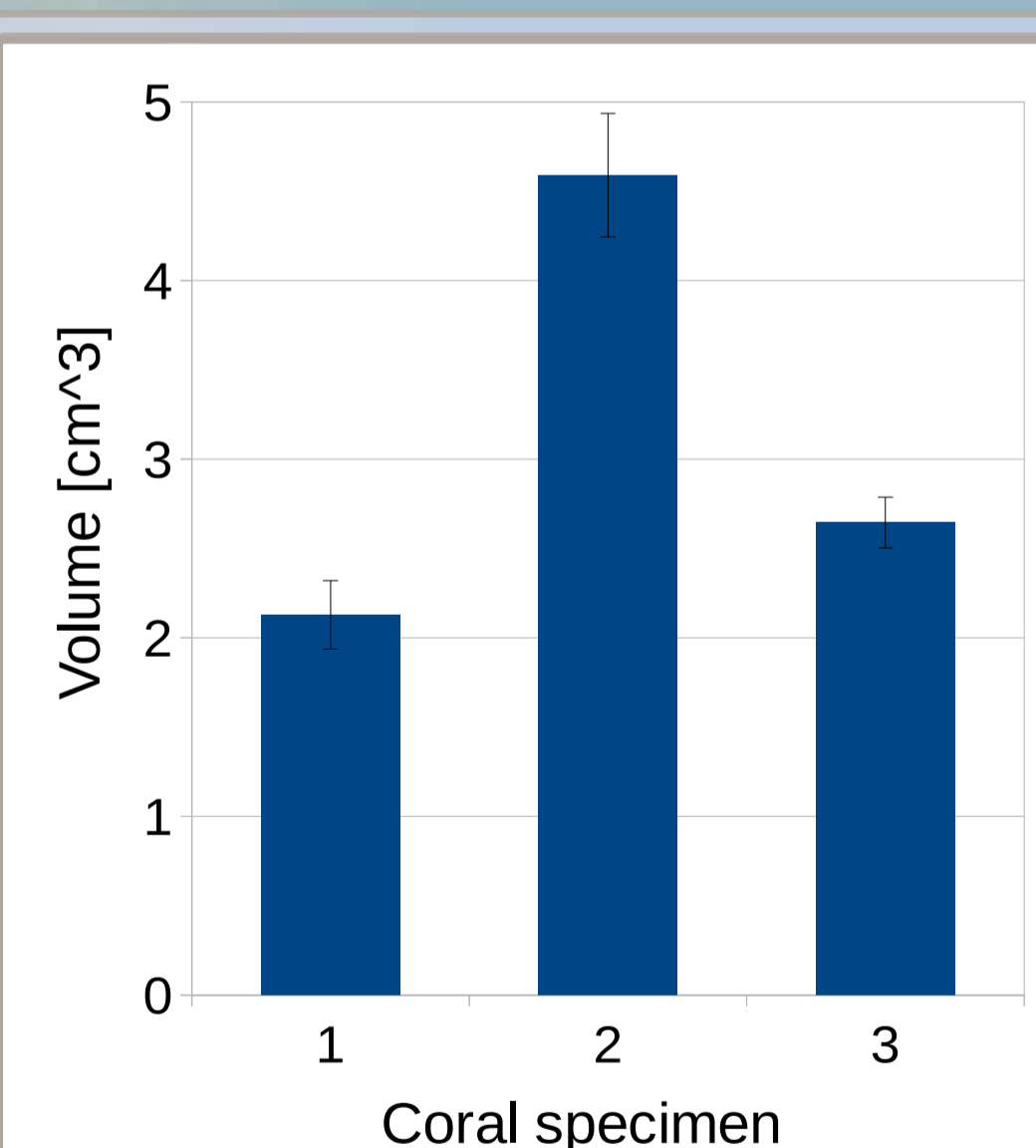The calculation of total mass (g) using the density of aragonite (2,93 g/cm³) did not lead to satisfying results.

Fig. 4: Calculated volume (cm³) from 3 different sets of photos per coral (*C. smithii*)

Fig. 5: Racks to move the camera in controlled angles and keep distance to the object

Conclusion and outlook:

The method is applicable for a well trained diver and underwater photographer but needs to be refined to gain more accuracy for the volume calculation.

Main pitfalls / limiting factors are:
- a too homogeneous background behind the coral
- the quality of the pictures / the camera equipment
- Substrate needs to be plane in order to close the polygon accurately
- capacity / RAM of the computer used for the calculations

Also a way to calculate total mass from the calculated volume needs to found. The skeletal structure of the scleractinians in this study seem to be too porous to estimate the mass using the density of aragonite.

In the future accuracy can be increased by using more sophisticated hard and software. The use of a DSLR or Bridge Camera in combination with flashes will increase the quality of the pictures and thus generate better models. More computing capacity will allow the use of more sophisticated programs (like Agisoft Photoscan) and more photos to create more detailed models and gain accuracy.

Holding the camera in hands makes it difficult to take pictures from defined angles (Fig. 1), especially when the corals grow on steep slopes or overhangs. Mounting the camera on a revolvable rack (Fig. 5) will solve this problem.
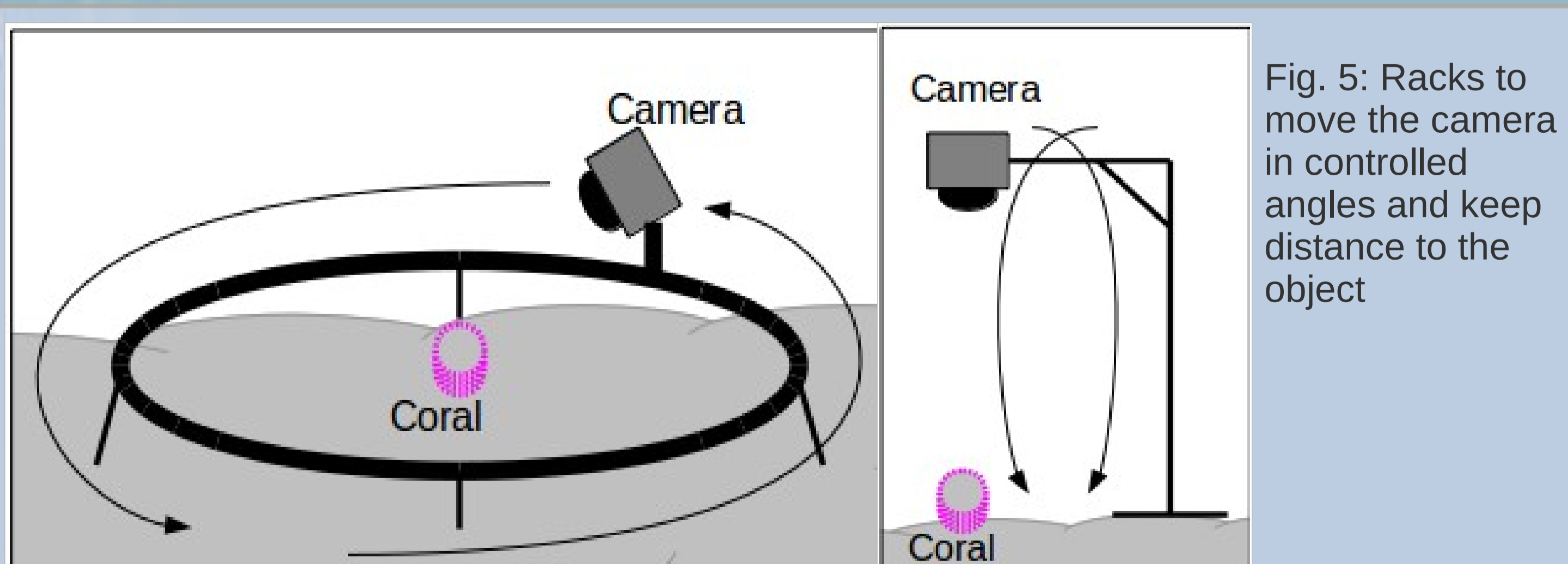
Literature: The ultrastructure of the skeleton and skeletogenic tissues of the temperate coral Caryophyllia smithi, Martin D'A.A. Le Tissier Journal of the Marine Biological Association of the UK 04/1990; 70(02):295 – 310

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