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Methodology

A new technique for making serial sections of solitary rugose corals

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Abstract

Taxonomic identification of Paleozoic solitary rugose corals relies heavily on serial sections to determine the ontogenetic development of skeletal structures. Previously, small rugose corals have been difficult to study because their size and curvature make it difficult to serially section them at a right angle to the longitudinal growth axis. In this paper, we describe a newly designed apparatus, with a rotatable clamp to hold the fossil coral. This guarantees easy adjustment of the cutting angle so that serial sections can be made at changing angles that are always at a right angle to the curved longitudinal axis of a rugose coral. In addition, the apparatus allows the distance between consecutive sections to be controlled precisely to mm scales.
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1. Introduction

High-precision serial sections are very important for the study of ontogenetic development of skeletal structures in rugose corals, especially the insertion pattern of new septa at early growth stages. The configuration of septal development is a key character for taxonomic and phylogenetic studies of Paleozoic rugose corals. Serial sections made using parallel grinders have been widely used for the study of Paleozoic rugose corals (e.g., Minato, 1961; Neuman, 1969, 1986, 2003; Elias et al., 2008; Fedorowski, 2009; Fedorowski and Vassilyuk, 2011). However, this method has some disadvantages, and the destruction of the specimen during grinding is perhaps the most serious problem. Despite the serial peel (usually acetate) sections taken at many intervals while the specimen is ground down, it is impossible for a researcher to check back the original mineralogy of the coral. As a result, original microstructures recorded in minerals are lost and archived only as the superficial imprints of acetate peels.

In the past few decades, the precision of rock cutting has improved drastically by the development and use of increasingly thinner saw blade. In addition, improved saw designs have been made by paleontologists and technicians. For example, Joysey and Breimer (1963) used a new inner-rim annular saw to make thin sections of fossil blastoids. Sutherland and Forbes (1981) used the same type of saw to study the septal development of a heterocoral species. However, its high cost has hindered its extensive use.

Another problem in previous procedures of serial sectioning is the lack of proper holding mechanisms for small corals with a significant curvature. Some coral workers relied on holding the fossil by hand while grinding it with changing angles, which works reasonably well for relatively large corals. For small coral specimens, however, this technique often results in poor control on the cutting angle and distance between slices, and sometimes even causes hand injury. These problems can be solved partly by embedding a small coral in bioplastic, plaster, dental stone or other sandable material to create a larger piece to hold. With an embedded sample, however, it becomes difficult to adjust the angle of the specimen during grinding operation, which is particularly necessary for the serial sections of small and strongly curved solitary rugose corals.

To solve the problems discussed above, we designed a new apparatus to meet the needs of holding a small, curved coral at adjustable angles and cutting very thin slices of the coral to make consecutive, conventional thin sections to preserve the original

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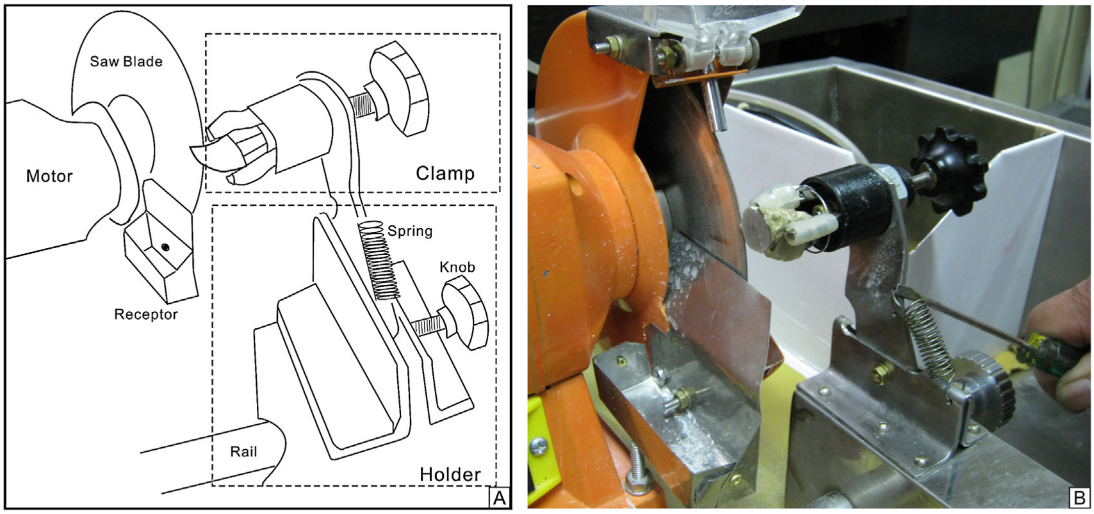

Fig. 1. Simplified diagram (A) and photo (B) of the cutting assembly, showing operational scheme of serial sectioning for rugose corals.

mineral composition. Such serial thin sections can be made at millimeter intervals, at a right angle to the longitudinal axis of a curved coral.

2. Description of the apparatus and procedures of operation

What is described here is an adjustable clamp complex to be operated in conjunction with a thin-bladed saw (blade thickness 0.13 mm or thinner and stainless steel or diamond in nature). This apparatus consists of two major parts: a clamp and a holder for mounting and adjusting the clamp (Fig. 1). The first part comprises three curved fingers, swiveling radially, with the swivels attached to a cylindrical base which is mounted inside a sleeve (see details in Fig. 2). The base can be advanced and retracted inside the sleeve, by a screw mechanism operated by an adjustment knob. When the knob turns anticlockwise, three curved fingers retract towards the sleeve, causing them to approach one another because of their outer sloping angle and thus to clamp down a specimen. Conversely, a clockwise rotation of the adjustment knob will release the specimen. Because there are constantly three fixed points for clamping the specimen, this apparatus can easily adjust the fossil at a desirable angle through repeatedly clamping and releasing the specimen manually.

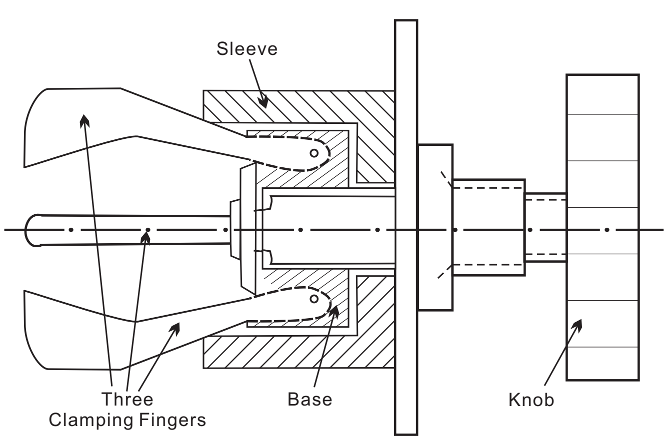

Fig. 2. Design of the clamp (vertical median section).

The other part of the apparatus is a holder for the clamp (Fig. 1). The clamp is attached to a rectangle base partly by using a spring parallel to the saw blade, which allows a rotation of the clamp parallel across the saw blade. That base is mounted on a cylindrical rail parallel to the saw axis, and the rail connected with an adjustment knob. When the knob turns in a clockwise direction, both clamp and its base are pushed forward along that cylindrical rail. Specific forwarding distance depends on the extent of knob's rotation under manual control.

The material losses are mainly from the vibration of the outer-rim diamond saw and the thickness of the saw blade itself. In addition, when in operation, a certain thickness is necessary for a slice which prevents the slice from being shattered and also allows its further grinding to a desirable thickness. For these reasons, the minimum cutting interval for this apparatus is approximately 1 mm.

Serial thin sections can be obtained by combining the sliding and rotatable clamp with a stationary saw blade (Fig. 1). A ceratoid corallum (from the Kuanyinchiao Bed, Shiqian County, northeastern Guizhou Province) is used as an example to illustrate how serial sections can be made using this apparatus (see Fig. 3) in the following procedures.

1. Photograph the specimen from different views for future reference.
2. Mark a longitudinal line along the convex side with a permanent marker.
3. Put the specimen in a position, which ensures the coming cut perpendicular to the growth direction of coral, and fasten it by rotating the knob of clamp. It is highly recommended to cut the specimen from the apex because the calice of the coral has a large diameter and is thus easily clamped. After the first cut, one piece of fossil slice is collected in the receptor. Then mark slice on its apical side.
4. Move the clamp by clockwise rotation of adjustment knob in holder part, and the clamped coral specimen forward for

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