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Radial skeletal dissolution to promote vegetative reproduction in a solitary coral *Diaseris distorta*

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Abstract. The solitary, free-living coral *Diaseris distorta* (Michelin) (Fungiidae, Scleractinia) reproduces asexually by fragmentation along radially oriented slits. Localized skeletal dissolution, which can be recognized as white, opaque and chalky lines along the thecal wall between segments, ultimately results in autotomy. We suggest that the skeletal dissolution which dissolves the weakest part of the corallum for easy breakage, is a species-specific character.
Key words. Coral; *Diaseris*; asexual reproduction; dissolution.

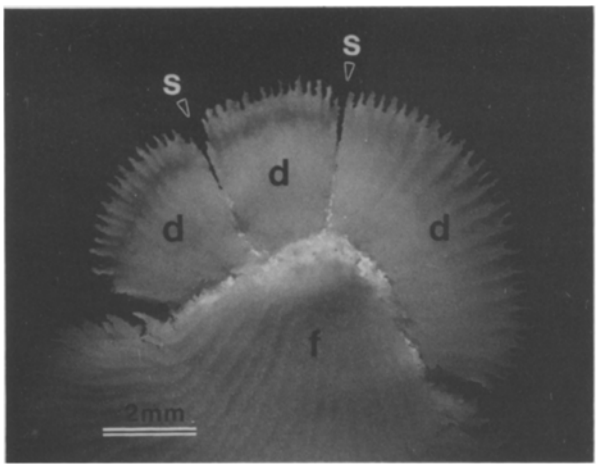
The soft sea-bottom near coral reefs is the habitat of free-living corals such as *Heteropsammia cochlea* (Spengler), *Heterocyathus aequicotatus* (Edwards and Haime), *Diaseris distorta* (Michelin) and *D. fragilis* (Alcock). These solitary corals aggregate and form dense populations[1–3]. If a coral is to remain solitary, vegetative reproduction must be accompanied by a fragmentaion of the solid skeleton. Two coral species of *Diaseris* form radially oriented slits that promote fragmentation. On a soft sea-bottom, such accidental fragmentation may be rather rare. It might therefore be adaptive for a solitary coral if the fragmentation of the skeleton is actively promoted by partial skeletal dissolution.
Skeletal dissolution has been reported for some mushroom-shaped fungiid corals, which undergo a transverse division when the disc is detached from the stalk[4]. Skeletal dissolution decreases the mechanical strength of the corallum[5]. The presence of substances that dissolve the calcium carbonate skeleton in these corals has been proposed, but they have not been identified[6]. In *Diaseris distorta* we have found that skeletal dissolution takes place in the thecal wall between segments. This is the first report on radial skeletal dissolution in scleractinian corals. We describe here the morphological changes in the skeleton of *D. distorta*, especially radial skeletal dissolution, which ultimately result in autotomy and asexual reproduction.

Materials and methods

Specimens of two fungiid corals, *Diaseris distorta* and *D. fragilis*, were collected from a soft bottom (10 to 15 m depth) at Khang Khao Island (13°09′N, 100°48′E) in the Gulf of Thailand, and prepared as dried specimens. Live specimens of *D. distorta* were collected from a soft bottom (18 m depth) in Kin Bay (26°38′N, 127°52′E), Okinawa, Japan. The corals were broken into segments by hand, the resultant fragments were reared in the aquarium, and the regeneration process was observed.

Results

Some of the Okinawan specimens had chalky skeletons, and radial autotomy occurred within 2 years in laboratory culture in 16 of 18 corals (Yamashiro and Nishihira, unpubl. data). Out of 100 dried specimens of Thai *Diaseris distorta* (maximum diameter 13.2 ± 2.5 mm, mean $\pm$ S.D.), 94 showed either powdering of the skeleton, or signs of it, between segments. On the other hand, 100 specimens of *D. fragilis* (24.5 ± 5.9 mm) showed no sign of powdery areas.
In *Diaseris distorta*, skeletal dissolution appears first on the underside of the corallum as white, opaque spots between the segments. Then a chalky line elongates betwen the segments. The surface of the pulverized area of the skeleton is composed of poorly organized, loose crystals with round peripheries and voids between them, which indicates skeletal dissolution. In contrast, the artificially fractured surface of an ordinary skeleton shows densely packed crystals without any voids.
In addition to its capability of decalcification the skeleton of *Diaseris distorta* is so constructed that it is fragile between the segments which are to be dissolved later. Fragile skeletal structures form slits on thin walls between segments. During regeneration and growth, slits (fig.) appear in the outermost region of the thecal wall about 1 to 2 months after fragmentation. Segments are connected to each other only by the thecal wall, because other skeletal elements such as septa and synapticulae (bars connecting adjacent septa) do not develop. The thecal wall is thin between the segments (50 μm thick) and forms within a month after fragmentation, but does not increase in thickness. In contrast, the ordinary



Under-surface of a corallum of *Diaseris distorta* composed of 4 segments. This specimen originated as a regenerate. Note skeletal dissolution indicated by white, opaque lines between segments. Radial autotomy occurs through such areas of localized skeletal dissolution. f, founder segment; d, daughter segment; s, slit.

thecal wall of the rest of the corallum gradually increases in thickness with corallum growth (up to 500 μm by 2 years after fragmentation).

Discussion

These observations show that radial autotomy in *Diaseris distorta* can occur by localized skeletal dissolution even without mechanical disturbance. In the field, various forces increase the likelihood of breakage of the corallum, which becomes very fragile owing to its structural characteristics, including skeletal dissolution. Skeletal dissolution seems to be a species-specific characteristic, because a chalky skeleton between segments was observed in *D. distorta* but not in its congener *D. fragilis*, which is a larger species[3,7]. To colonize sediment bottoms that lack a stable substratum for larval settlement, these two corals seem to have developed different strategies for asexual reproduction by skeletal breakage. One is passive skeletal breakage by means of slits, as observed in *D. fragilis*. This may be related to that species' relatively large size. Another strategy is active skeletal dissolution, as observed in *D. distorta*, which enhances the likelihood of breakage compared to a purely passive mechanism. Skeletal dissolution results in an efficient fragmentation process, by which small-sized fragments are made which may escape biological or physical distrubances more effectively than small corals originating from settled larvae.

Skeletal dissolution or decalcification has been known until now only in the transverse division of some fungiid corals. The present study shows that skeletal dissolution may also be involved in radial fragmentation. However, this process is probably more widespread than was previously thought, because the shapes and modes of asexual reproduction of some solitary corals belonging to other families suggest that they also undergo skeletal dissolution[8,9] An understanding of skeletal dissolution could also give insights into the mechanisms of calcification. In conclusion, the skeleton of the coral *Diaseris distorta* is designed for easy breakage since it not only has skeletal structures such as slits and a thinner thecal wall between segments, but for rapid asexual reproduction, the structurally weakest part of the corallum can be dissolved.

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