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NOTES ON *ARCHIMEDES*[1]

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Within the fauna of the Glen Dean formation of Crane, Martin County, Indiana, bryozoans are by far the dominant group; among them the genus *Archimedes*[2] is probably the most common and certainly the most spectacular, although Condra and Elias (1944, p. 99) list the Glen Dean limestone among the Chester formations in which this genus is not abundant. Ten different forms of *Archimedes* are recognizable in the present material. They will be enumerated in an annotated faunal list of that locality now in preparation. In these notes it is not intended to describe all the forms of *Archimedes* found at Crane, less so since two comprehensive papers dealing explicitly with this genus (McFarlan, 1942; Condra and Elias, 1944) appeared quite recently. Therefore, only a few remarkable specimens are here described. In addition, Condra and Elias' recent bryozoan-algal hypothesis is briefly discussed.

THE FROND OF *ARCHIMEDES TEREBRIFORMIS* ULRICH

McFarlan (1942, p. 443) states the nature of the frond of this species of Ulrich's (1890, p. 575, pl. 63, fig. 5–5c), distinguished by the corkscrew shape of its shaft, to be unknown. Condra and Elias (1944, p. 135, pl. 3, fig. 5, pl. 26, figs. 17–24) were able to study its meshwork in the flange only; these authors also point out that the frond is "usually broken off completely." The material from Crane, however, includes among many specimens of this species four (A.M.N.H. Nos. 26103/3, 26110, 26122, and 26169) in which the frond is more or less well preserved; one of them, A.M.N.H. No. 26122, shown in figure 1, is selected as the hypotype.

In this specimen the frond is seen to attain a diameter of about 35 mm. transversely; where not distorted by crushing, it appears to depart from the axial line at

Fig. 1. *Archimedes terebriformis* Ulrich, hypotype, with frond preserved, on specimen A.M.N.H. No. 26122. Glen Dean limestone. Quarry "IIc," Crane, Martin County, Indiana. Natural size. Note frond radiating from screw and portions of meshwork clearly recognizable below screw and at about half the height of the picture to its left and right. The focus having been concentrated on these portions of meshwork, the screw itself is slightly out of focus.

[1] Second report on the results of the writer's collecting trip to Crane, Indiana, in October, 1944; for the first report see American Museum Novitates no. 1289.

[2] Easton (1943, pp. 142–143; 1944, pp. 406–407) proposes, for nomenclatorial reasons, to replace the generic name *Archimedes* by *Archimedipora*. Condra and Elias (1944, pp. 15–16), however, reject his arguments. Since the solution of this thorny taxonomic problem cannot be attempted in this short article, the universally accepted generic name *Archimedes* is retained here as well as in the forthcoming faunal list. It might, however, be suggested that, should Easton's proposal prove to be supported by the Rules of Nomenclature, the International Commission on Zoological Nomenclature be requested to consider the suspension of the Rules in favor of the retention of the generic name *Archimedes*.

Fig. 2. *Archimedes invaginatus* Ulrich, hypotype, on slab A.M.N.H. No. 26161. Glen Dean limestone. Locality "III," Crane, Martin County, Indiana. × 2/3.

an angle of 65° (60°–65° given by Ulrich, 1890, p. 575). From five to six branches can be counted on a width of 2.5 mm., and four fenestrules on a length of 2.5 mm.

On the obverse side the fenestrules appear to be only half as wide as the branches and narrow-elliptical in shape; the dissepiments seem, on this side of the frond, only a little narrower than the branches. However, it must be taken into account that these observations were made at a rather short distance from the flange, where the fenestrules are narrowed, and the skeletal elements widened accordingly, by encrustation. The branches are rounded; their middle line is marked by a fine but distinct carina which carries, here and there, equally fine nodes. Their number seems to be inferior to that of the zooecia, from 11 to 12 of which can be counted to a length of 2.5 mm. The latter occupy alternating positions on either side of the keel and are circular or subcircular in shape and provided with slightly raised, thin peristomes.

The reverse side of the frond was studied at a distance of from 4 to 10 mm. from the flange. Here the fenestrules about equal the branches in width and exhibit a subelliptic to oblong shape. The dissepiments are about half as wide as the branches and straight or slightly concave upward. The branches show the fine longitudinal striation frequently observed on the reverse surfaces of *Archimedes* fronds.

Similar observations were made in the study of the frond of the last of the abovementioned specimens of *Archimedes terebriformis*, except that here an unencrusted portion of the obverse side also is accessible to examination, with fenestrules almost as wide as branches, and that there are up to seven branches on a width, and up to five fenestrules and up to 14 zooecia on a length, of 2.5 mm.

But for the facts that the median keel of the branches is fine rather than wide and that its nodes are not very prominent and less rather than more numerous than the zooecia, the microstructural characters described above agree fairly well with those observed by Condra and Elias (1944, pp. 136–137) within the flange only. If the number of nodes is left out of account, the "meshwork formula" of the hypotype from Crane is found to be 20–24/16–20/22–28, as compared to 20–23/15.5–20/20–26 according to Condra and Elias.

HYPOTYPE OF *ARCHIMEDES INVAGINATUS* ULRICH

An unusually large, bent screw of *Archimedes invaginatus* Ulrich (A.M.N.H. No. 26161), selected as the hypotype and illustrated in figure 2, attains, though incomplete, a length, measured along its axis, of approximately 24 cm. and has 46 volutions preserved. It is certainly the largest specimen of this species on record. Of screws referred to other species of *Archimedes*, the largest one of *Archimedes welleri* Condra and Elias, reproduced by these authors (1944, pl. 18, fig. 4a, 4b) from a figure of Keyes' and attaining, according to them (1944, p. 86), 28.5 cm., seems to be the only one which exceeds it in length.

The specimen under discussion is remarkable not only for its extraordinary size but also for its peculiar curvature which, by the way, agrees almost perfectly with that seen in the screw of *Archimedes communis* Ulrich, figured by that author (1890) in plate 63, figure 1. Condra and Elias (1944, p. 38) believe in a "rise [of *Archimedes* helicoids] from a prostrate fenestellid zoarium to an upright position," which caused gradual erection of the screw, as seen in their illustrations, plate 14, figure 3, plate 15, figure 4, and plate 32, figure 6. Curvatures like those observed in the specimen under discussion and in Ulrich's type of *Archimedes communis* mentioned above seem, however, to be essentially different from the initial one discussed and illustrated by Condra and Elias. The former are believed to be smaller or greater deviations of the screw from the vertical direction caused in a later ontogenetic stage by its tendency to compensate for overweight of the frond on one side or the other. Thus the first, only slight deflection of the screw, visible in both Ulrich's type and the specimen from Crane, might be due to a minor disturbance of the equilibrium which was soon overcome, whereas the second, much more decisive and persistent deflection might in both specimens be considered as an attempt toward restoration of equilibrium in the face of a continuous overweight of the frond on one side, or else as a consequence of such overweight on the other which pulled the upper part of the screw down from the upright position. It is believed that despite the buoyancy of the frond in the sea water even slight differences in its development on one side, as compared to the other, which might have been caused by better living and food conditions due to currents, light, etc., must have made themselves felt in the equilibrium of the whole structure which was supported by the comparatively tender screw.

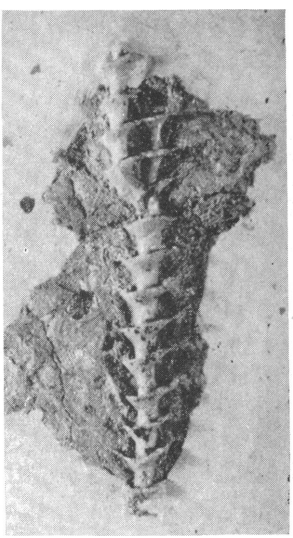

Fig. 3. *Archimedes invaginatus* Ulrich, bifurcating screw, A.M.N.H. No. 26096. Glen Dean limestone. Locality "III," Crane, Martin County, Indiana. Natural size.

BIFURCATING *ARCHIMEDES* SCREWS

Condra and Elias (1944, pp. 34, 65) distinguish, among the *Archimedes* individuals exhibiting more screws than one, adventitious, paired, and twin screws, the first branching off a main screw, the second coiled in opposite directions, the last in the same direction. Many illustrations of all three of these types can be found in their plates. Two examples of paired screws may be found in Ulrich's (1890) plate 63

also (figs. 9b, 14, both specimens refigured by Condra and Elias, 1944, pl. 8, figs. 5, 7).

The present material includes a particularly well-preserved example of "twin screws" of *Archimedes invaginatus* Ulrich, (A.M.N.H. No. 26096), shown in figure 3. Here a screw branches off the main screw at an angle of slightly more than 45°, but soon assumes an upright direction parallel to the main screw which, immediately after bifurcation, deviates slightly in the opposite direction, but soon afterwards resumes its former, upright course. Two features, apparently not yet reported elsewhere, are remarkable. After bifurcation the side screw appears to be in every respect stronger than the "main screw," and the flanges of both neighboring screws remain merged with each other and continuous, as far as preservation permits their study, i.e., for three volutions after bifurcation.

Both these features are observable in another twin screw of *Archimedes invaginatus* Ulrich from Crane (A.M.N.H. No. 26096/5:2), but here only one amalgamated flange is preserved after bifurcation. Here the angle at which the side screw branches off is greater than in specimen No. 26096, attaining about 60°.

CONDRA AND ELIAS' BRYOZOAN-ALGAL CONSORTIUM HYPOTHESIS

Hardly any student dealing nowadays with the genus *Archimedes* is likely to escape taking some position toward the above hypothesis (Condra and Elias, 1944, pp. 1, 25–50). Some observations made in the present material, especially on the structure of the fibrous tissue building up shafts, flanges, and pillars of the screws, on the fibers visible on their surfaces and on the course of these fibers, which sometimes appears indeed to be independent of the main directions prevailing in the meshwork, confirm Condra and Elias' observations. Still, those authors' (1944, p. 25) conclusion "that *Archimedes* is made of *Fenestella* and that the encrusting tissue about it belongs to a different organism in a symbiotic relationship" does not seem to be sufficiently founded on its premises. It is difficult to see why all these structures—in *Archimedes* as well as in other bryozoan genera (see Condra and Elias, 1944, pp. 48–49; 1945)—should not have been built up by the bryozoan colony itself, without any interference from an algal symbiont. This opinion would conform with Ulrich's, who, in a paragraph quoted by Condra and Elias themselves (1944, p. 25), pointed out the essential structural identity of "all the dense portions of the zoarium" in various bryozoa (Ulrich, 1890, p. 353[1]).

Since McFarlan's (1942) and Condra and Elias' (1944) recent papers it can no longer be doubted that bryozoan meshworks, conspecific with each other, are found one time as foliate expansions, without any visible connection with *Archimedes* screws, in which case they have to be called *Fenestrellina*,[2] another time as the fronds of definite *Archimedes* species. This is certainly a most unsatisfactory situation, both biologically and taxonomically, which calls emphatically for some solution of the problem involved. It may, however, still be doubted whether the one suggested by Condra and Elias but questioned by Easton (1944, pp. 407–408) is the correct one.

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[1] Erroneously quoted "53" by Condra and Elias (*loc. cit.*).

[2] Condra and Elias as well as Easton use the generic name *Fenestella*.

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