

ART. XXXVIII.—*Synopsis of the Mode of Growth and Development of the Graptolitic Genus Diplograptus* ;\* by R. RUEDEMANN.

THE main results of the observations made upon a large collection of specimens of the genus *Diplograptus* found near Dolgeville, N. Y., are the following :

(1) *Diplograptus pristis* Hall (= *D. foliaceus* Murch. sp.) and *Diplograptus pristiniiformis* Hall (= *D. dentatus* Brgt. sp.), two typical graptolites of the Utica shale, which were hitherto known to grow only in single stipes, have been found growing in compound colonial stocks which appear in the fossil state as stellate groups. The compound fronds of *D. pristis* Hall reach a diameter of four inches and are composed in some specimens of as many as forty stipes, those of *D. pristiniiformis* Hall are only an inch in diameter and have about a dozen of stipes.

(2) The virgulæ are joined to a central connecting stem, the "funicle" of Hall, which is mostly extended to a vesicle of quadrangular shape. The funicle is inclosed in a thick chitinous capsule, which is identical with the "central disc" of the compound fronds of numerous *Monograptidæ*. The central disc, too, is drawn out at the four corners where most of the virgulæ leave, so as to appear subquadrangular in the compressed state.

(3) The central disc is surrounded by a verticil of oval capsules, which number from four to eight and probably still more. The latter appear mostly as oval impressions ; in a few specimens a thin chitinous film is discernible ; in some fossils, however, the oval appendage is made up of distinct siculæ which radiate from an axial club-shaped protuberance within the vesicle, to which they are joined by the filiform prolongation of their pointed ends. The mature siculæ are found near the base, the younger ones toward the top of the vesicle. The section of the test of the vesicle appears sometimes as a chitinous ring.

The enclosed siculæ give evidence that the vesicles were organs of reproduction which are to be compared with the "gonangia" of recent hydrozoa. In some specimens the compound frond is surrounded by a dense crowd of siculæ, most of which are pointing with the broad ends outwards, so as to make it obvious that they took their origin in the center of the frond. In this case the gonangia were apparently opened shortly before the covering of the fossil.

\* Abstract of a paper on the genus *Diplograptus* to be published in the Report of the State Geologist of New York for the year 1894.

(4) The majority of the fossils present a large subquadratic impression which overlaps the gonangia, and sometimes even the proximal ends of the stipes. Some specimens of *D. pristiniformis* Hall, found in a limestone-layer which is interpolated in the shale, reveal the fact that this impression belongs to an organ which was made up of a large spherical segment on the upper side and a smaller one on the under side of a quadrangular plate. The latter has a system of furrows parallel to the margin. The author compares the whole organ with the air-bladder or pneumatocyst of the *Discoideæ*, a family of the *Siphonophoræ*, on account of its size, its being the topmost organ, and on account of the apparent absence of any structure—besides the furrowing in the plate which reminds much of the system of canals in the float of the *Discoideæ*.

We may infer from the preceding observations that the colonial stock was carried by a large air-bladder, to the under-side of which was attached the funicle. The latter was enclosed in the central disc and this was surrounded by a verticil of vesicles, the gonangia, which produced the siculæ. Below the verticil of gonangia and suspended from the funicle was the tuft of stipes.

(5) A close observation of the siculæ, which are found so numerously on the slabs, detected the fact that the siculæ, at the time of developing the first two hydrothecæ, possessed a quadrangular plate, joined by a small node in the center to the end of the filiform proximal process. On young stipes with seven hydrothecæ on one side and six on the other, can be already discerned four oval, distinctly furrowed impressions around the central node.

The first appearing quadrangular plate—or probably vesicle—develops into the pneumatocyst, the central node into the funicle and central disc; and in the small oval impressions we most probably see the budding gonangia. The sicula, therefore, which grows out to the primary stipe develops first the floating organ and then the central organs.

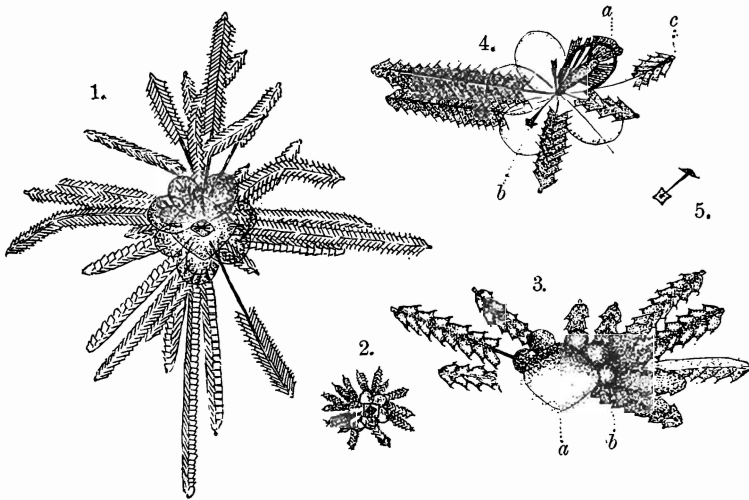
It deserves to be noted that the new hydrothecæ of the primary stipe sprout in the direction towards the central organs while the sicula remains in all stages of development at the opposite end of the central organs, i. e., at the distal end.

Whether the primary stipe produces first new siculæ, some of which remain in connection with the center, forming new stipes and by these the compound frond, or whether other detached siculæ gain connection with the new center of the first stipe, could not be decided. The fact, however, is that fronds with one full-grown stipe, the primary one, and several young ones are a rather common occurrence, further that fronds have been found to the center of which siculæ without

any hydrothecæ and stipes in all stages of development were joined.

(6) A most astonishing feature of the compound fronds is the position of the siculæ at the remote end of the stipes, so that the so-called "proximal" sicula-bearing end of the single stipes appears in the compound colonial stock as the distal one. This is accounted for by the observation that the first hydrothecæ of each stipe sprout at the distal, broad end of the sicula and that all following hydrothecæ make their appearance more proximally. The stipe, therefore, is growing backward, towards the center, or like a leaf at the base, and the sicula is carried to the distal end.

(7) By the possession of a pneumatocyst and the arrangement of the reproductive organs at the bases of the stipes, the colonial stocks of *Diplograptus* had a general similarity to those of certain *Siphonophoræ*, while the chitinous structure of the hydrothecæ and gonangia can be only referred to the Sertularians. It thus becomes evident that the genus *Diplograptus*, like so many palæozoic fossils, has the combined properties of different groups, thus giving valuable hints in regard to the common ancestors of these groups.



#### EXPLANATION OF FIGURES.

- FIG. 1.—*Diplograptus pristis* Hall. Natural size.  
 FIG. 2.—*Diplograptus pristiniiformis* Hall. Natural size.  
 FIG. 3.—*Diplograptus pristiniiformis* Hall. Enlarged six times. Specimen from the limestone. *a*. Pneumatocyst. *b*. Gonangium.  
 FIG. 4.—*Diplograptus pristis* Hall. Enlarged four times.  
*a*. Gonangium filled with siculæ.  
*b*. Sicula developing into a stipe.  
*c*. Young stipe with distinct sicula at the distal end.  
 FIG. 5.—Detached sicula of *D. pristis* Hall with pneumatocyst.