

Some Late Glacial Charophytes Compared to Modern Species

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Abstract

Some Late Glacial Charophytes Compared to Modern Species. Fay Kenoyer Daily, Butler University.—Fossil fructifications from New York provided by Norton G. Miller were referred to the modern taxa, *Chara sejuncta* and *Tolypella glomerata*. This *Tolypella* displayed a triply-segmented basal plate on the oospore while a *Tolypella* (undoubtedly *T. prolifera*) reported in an earlier study had an undivided basal plate. In view of these findings and the conflicting literature on this subject, some selected modern specimens were studied. It was found that *Tolypellas* of the Section Conoideae to which *T. prolifera* belongs had an undivided basal plate similar to that in the Chareae. Members of the Section Allantoideae represented by *T. glomerata* had doubly or triply-segmented basal plates as in *Nitella*. For the first time in a *Tolypella*, some well-developed, hard limeshells were discovered in a collection of *Tolypella prolifera* from Indiana. Calcium deposits inside the spiral cells were also found in oogonia of other members of the Conoideae. No similar deposits were found in the Allantoideae or in *Nitella*. Descriptions and illustrations as well as a consideration of the evolutionary significance of these findings are given.

Introduction

In 1961, some fossil charophytes were reported from New York (5). Among them were charophytes referred to the recent species, *Chara sejuncta* and *Tolypella* (probably *T. prolifera*).

The *Tolypella* oospore (Text-figure 1) was damaged, but its unmistakable characteristics caused no hesitation about referral to that genus. However, it was perplexing that the specimen had an undivided

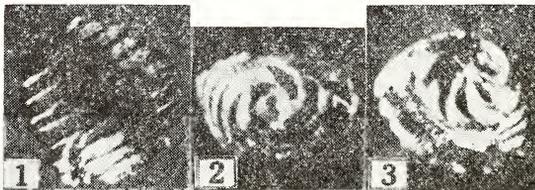


Figure 1. Oospore of *Tolypella prolifera*, fossil from Erie Co., New York (Table 1, No. 13): 1. lateral view; 2. basal view; 3. apical view, ca. 80 X.

basal plate (Text-figure 1, no. 2). Grambast (6) described the basal plate of a fossil *Tolypella* from the Tertiary of the Paris Basin as having three segments similar to that in *Nitella*. Horn af Rantzien (7) in 1959 questioned the persistence of sterile oogonial cells in *Nitella* and *Tolypella* to produce the three-parted plate. He reported not having seen any although some of his photographs suggest their presence. In 1962, Grambast (9) again discussed the triply-segmented basal plate of

¹The abundant charophytic remains provided for this study by Norton G. Miller, Michigan State University, East Lansing, Mich., made this contribution possible.

charophyte fructifications from the Tertiary of the Paris basin. He explained that Horn of Rantzien had examined them and "has seen that there is considerable similarity between the triply-segmented basal plate of these fructifications and the three oogonial cells demonstrated to occur in *Nitella*." Since both genera belong to the Nitelloideae, they were expected to be similar in this respect.

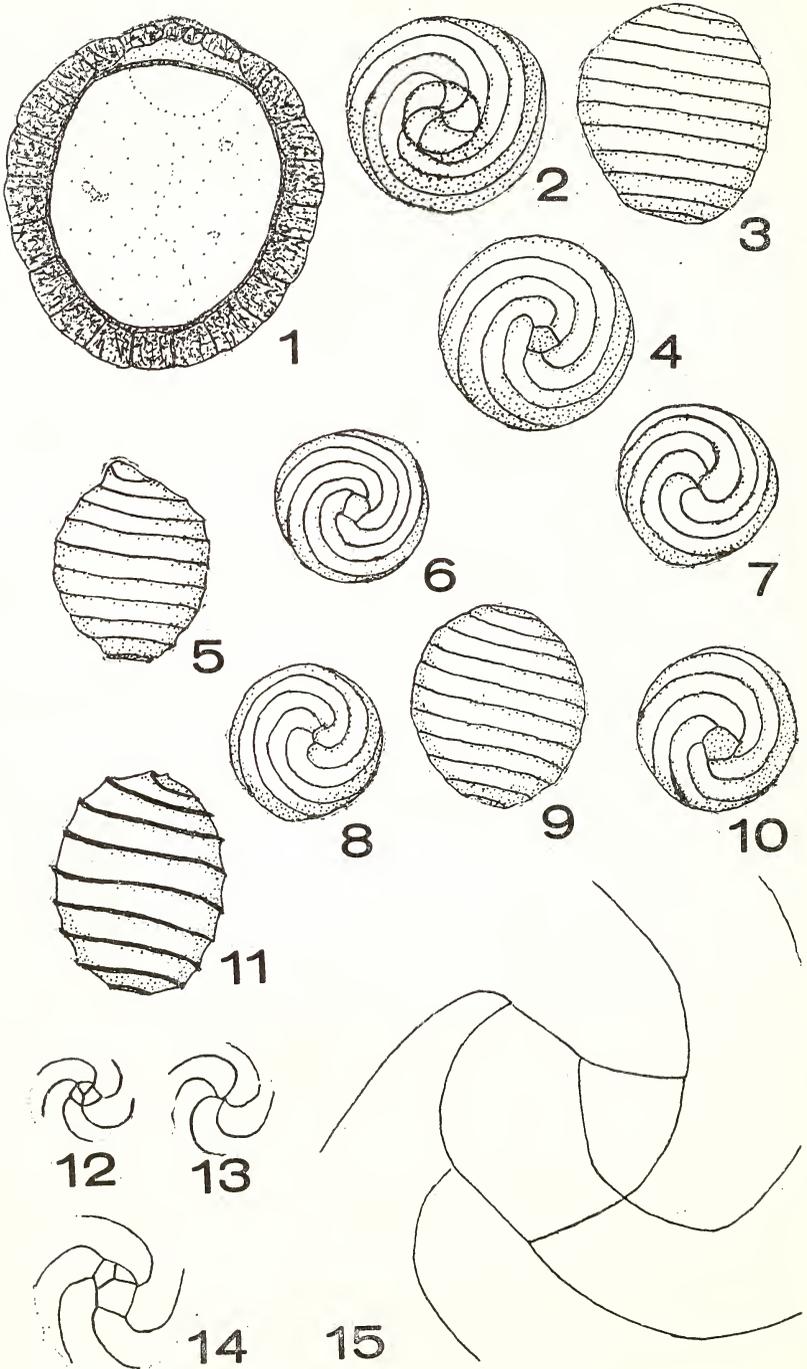
Recently, more fossil charophyte specimens collected in New York were made available for study. Mr. Norton G. Miller¹ sent four vials which contained oospores from the basal marl at Houghton Bog, several miles north of Springville, Erie Co., New York. It is $11,880 \pm 730$ years B. P. (Norton G. Miller communication). The oospores had been treated with hydrochloric acid. Some untreated material from this site was also obtained. This had been collected with a piston sampler. Oospores and lime-shells of *Chara sejuncta* A. Br. were obtained from that site. (For a description and illustration of this species see Daily, 5)

Another vial contained oospores picked from untreated organic debris collected ca. ten feet beneath a gravel deposit near Lockport, N. Y. This material was deposited near the shore of Lake Iroquois and has been dated at $12,000 \pm 400$ years B. P. (1). *Chara sejuncta* A. Br. and *Tolypella glomerata* Desv. in Lois. were found in that deposit. (A description and illustrations can be found in the Systematic Section for *T. glomerata*). Pollen found in the sediments imply that a spruce forest was dominant during the time the charophytes were being deposited. (Norton G. Miller communication).

One of the interesting things about the *T. glomerata* oospores was that the basal plates were triply-segmented instead of undivided as in the *T. prolifera* oospores from the New York deposits. (See also Plate 1, figs. 8-10, *T. intricata*, for an undivided basal plate.) It was then recognized that these two species represented the two sections of *Tolypella*. *T. prolifera* belongs to the Section Conoideae with short, conical and acute ultimate cells of the branchlet rays, spiral cells not swelling at the apex and persistent coronula. *T. glomerata* belongs to the Allantoideae with ultimate cells of the branchlet rays elongate, spiral cells swelling at the apex and coronula deciduous.

Therefore, it was decided to examine some herbarium specimens of extant species representing the two sections of *Tolypella* to see if the basal plate in the Allantoideae was consistently segmented and in the Conoideae undivided. The basal plates were best demonstrated by transmitted light and high power. The integuments were removed from the basal portion of the oospore which had been hand sectioned and flattened on the slide.

Results obtained with selected specimens are given in Table 1. They show that species of *Tolypella* belonging to the Conoideae do have oospores with a consistently undivided basal plate (Plate 1, Fig. 10). Members of the Allantoideae may have oospores with a two- or three-segmented basal plate (Plate 1, Figs. 12, 14, 15). Furthermore, hard lime-shells were found in *Tolypella prolifera* (Plate 1, Figs. 1-4), *T.*



intricata (Plate 1, Figs. 5-7), and *T. fimbriata* (Table 1, nos. 12, 9, & 11 respectively), which belong to the Conoideae. However, none of the specimens examined belonging to the Allantoideae produced lime-shells. Hard lime-shells in the Conoideae have apparently gone unnoticed before. Various authors have described the accretion of crystals on the exterior of *Tolypella* oogonia or internal discrete crystals on the oospores beneath the integuments in damaged specimens, but hard lime-shells in undamaged specimens were thought not to exist.

A description and illustration of the lime-shell of *T. prolifera* from Indiana is included in the systematic part of this paper. Calcification develops inside undamaged spiral cells of the oogonium beginning as discrete crystals on the adaxial wall, but finally consolidating and filling the slightly convex spirals producing an opaque, smooth, hard lime-shell without concentric lamination. A suggestion of the original discrete crystalline consistency remains even after the crystals consolidate because of a difference in opacity between the crystals and their juncture.

Discussion

While studying morphological development in extant Characeae, Sawa (10) found two- and three-parted basal plates in *Nitella*, but observed only undivided basal plates in *Tolypella*. However, he stated, "there is a separate group of *Tolypella*-like plants with *Nitella*-like oogonia and oospores some of which might have been identified as various species of *Tolypella* in the past." That these were stated to be laterally compressed is a misprint (personal communication). They were not laterally compressed or in other words, they were terete. They also had oospores with a three-parted base similar to the Paris Basin *Tolypella* reported by Grambast. They are undoubtedly allied to the Allantoideae. The suggestion by Sawa to remove *Tolypellas* with an undivided basal plate of the oospore from the Nitelleae seems unwarranted. Many other morphological characteristics in common between the genera *Nitella* and *Tolypella* seem sufficient to place them in the same category. The possession of an undivided basal plate in the Conoideae, however, indicated that this Section of *Tolypella* is intermediate in this respect between the Allantoideae and the Chareae and evolutionarily nearer. As far as lime-shells are concerned, none have been found in the genus *Nitella*, none in the Allantoideae, developed in the Conoideae, may or may not be developed in the Chareae.

With the finding of lime-shells in *Tolypella*, a basis is provided for returning several fossil species of charophytes to that genus. The

Figs. 1-4. *Tolypella prolifera* (Table 1, no. 12). Limeshell: 1. axial section, X 100; 3-4. apical, lateral and basal views respectively, X 62. Figs. 5-7. *T. intricata* (Table 1, no. 9). Limeshell in lateral, basal and apical views respectively, X 62. Figs. 8-10. *T. intricata* (Table 1, no. 10). Oospore in apical, lateral, and basal views respectively, X 85. Figs. 11-13. *T. glomerata* (Table 1, no. 8). Oospore in lateral, basal and apical views respectively, X 100. Fig. 14. *T. glomerata* (Table 1, no. 6). Basal plate of the oospore X 100. Fig. 15. *T. nidifica* (Table 1, no. 1). Basal plate of the oospore, X 270.

lime-shells of extant *Tolypella* and the fossil genus *Sphaerochara* (illustrated by Horn af Rantzien, 7, Plate X) are similar. Horn af Rantzien's excellent photographs of *Sphaerochara* (*Maedlerisphaera*) *ulmensis* could very well be used to illustrate the lime-shell of *Tolypella prolifera* which differs chiefly in size. It is similar in shape, number of convolutions of the spiral cells, apical configuration with a groove, base, texture of limeshell and basal plug. The apex in lime-shells of *T. intricata* (Table 1, no. 9) was more like that of the fossil *Sphaerochara headonensis* without the apical groove. Horn af Rantzien (8) removed several species formerly assigned to *Tolypella* to *Sphaerochara* because: "*Tolypella* fructifications do not develop lime-shells (Horn af Rantzien, 8, p. 210) and gyrogonites cannot accordingly be lime-shells of fossil *Tolypella* species." However, with the finding of lime-shells in *Tolypella*, that genus is undoubtedly synonymous with *Sphaerochara*.

Summary and Conclusions

The presence of an undivided basal plate of the oospore and production of lime-shells were found to be consistent characteristics in the Section Conoideae of the genus *Tolypella* while divided basal plates and lack of lime-shells are consistent in the Allantoideae. In these respects, evolutionary development apparently followed a trend from segmented basal plates and lack of lime-shells in the genus *Nitella* and the Allantoideae of the genus *Tolypella* to unsegmented basal plates and presence of lime-shells found in the Conoideae of the genus *Tolypella* and unsegmented basal plates associated with or without lime-shells in the Chareae. The Conoideae are thus an intermediate group with reference to these characteristics. However, the two sections of *Tolypella* form a natural group based upon many other characteristics held in common and show the greatest affinity to each other.

The finding of firm lime-shells without lamination in *Tolypella* removes the objection to placing fossil specimens assigned to *Sphaerochara* in this genus.

Systematic Section

Tolypella glomerata (Desv. in Lois.) Leonh. 1863 Lotus 13:129.

The following is a description of fossil oospores found at the Lockport, N. Y. site. (For full citation see Table 1, no. 8. Illustrated in Plate 1, Figs. 11-13).

Oospore ca 0.312 mm. long and 0.260 mm. wide with 7-9 ridges in lateral view. Spirals slightly narrower at apical periphery than at equator, then widen slightly and again narrow meeting at a point at the apex, narrower at the base meeting around a triply or doubly segmented basal plate. Outer colored membrane light brown, decorated with granules in linear arrangement with the bases of the granules forming an indistinct reticulate pattern.

Tolypella prolifera (Ziz ex A. Br.) Leonh. 1863. Lotus 13:57.

Description of lime-shells from extant specimens collected in Pokagon State Park, Indiana. (Full citation given in Table 1, no. 12. Illustrated in Plate 1, Figs. 1-4).

TABLE 1¹

Observations on the basal plate of some fossil and extant charophyte oospores.

| Section of <i>Tolypella</i> | No. | Species | Fossil Extant | Basal Plate | Collection Data | Remarks |
|-----------------------------|-----|---|---------------|-------------|--|-------------------------|
| Allantoideae | 1 | <i>Tolypella nidifica</i> | X | 2-3 parted | In mari Baltico ad Valje Blekingiae Sweden, L. J. Wahlstedt, Aug. 17, 1886. | Neotype locality (11) |
| " | 2 | " | X | " | Westerplatte, Danzig, Poland, C. Baenitz, July 7, 1874. | Cited in (7) and (11) |
| " | 3 | <i>T. hispanica</i> | X | " | Keratea, Attica, Greece, Th. de Heldreich, Apr. 18, 1886. | Cited in (7) |
| " | 4 | <i>T. hispanica</i> var. <i>Porteri</i> | X | " | Small lake, 7 mi. S. W. of Laramie, Albany Co., Wyo., C. L. Porter 6191. | Cited in (4) |
| " | 5 | <i>T. comosa</i> | X | " | Seneca Lake, N. Y., T. F. Allen, Amer. Exs. no. 35, Aug., 1882. | Dupl. of lectotype (11) |
| " | 6 | <i>T. glomerata</i> | X | " | Okanagon Lake near Pentiction, B. C. Canada, Francis Hueber 2, July 29, 1956. | |
| " | 7 | " | X | " | In piscina horti bot. Lundensis, Skåne Sweden, O. Nordstedt, Exs. 395. | Cited in (11) |
| " | 8 | " | X | " | Organic deposit near Lockport, N. Y., (ca. 12,000 yrs. old), Norton G. Miller. | |
| Conoideae | 9 | <i>T. intricata</i> | X | undivided | Sweden, Skåne, Lund, L. J. Wahlstedt, 1864. | Cited in (7) |
| " | 10 | " | X | " | Cartier Lake, Douglas Co., Neb., Walter Kiener 20011, Apr. 26, 1946. | Cited in (2) |
| " | 11 | <i>T. fumbriata</i> | X | " | Lake Memphremagog, Vt., T. F. Allen, Aug. 19, 189. | Cited in (11) |
| " | 12 | <i>T. prolifera</i> | X | " | Pond, Pokagon St. Pk., Steuben Co., Ind. W. A. & F. K. Daily 155, Sept. 10, 1947. | Cited in (3) |
| " | 13 | " | X | " | From 2.1-2.9 ft. level of core (ca. 12,000 yrs. old) along Nichols Crk., Erie Co., N. Y., W. J. Wayne. | Cited in (5) |

¹All specimens are in the herbarium of Fay Kenoyer Daily to be lodged in the Ray C. Friesner Herbarium at Butler University.

Lime-shell without utricle and formed by 5 spirals, 0.465 mm. long, 0.417 mm. broad, spherical to ellipsoid with rounded to protruding apex and rounded base, with 11 striae. Spirals flat to convex, ca. 0.062 mm. thick and wide at equator, thinner forming a groove around the apical periphery, then the cell ends slightly protruding and distinct at the apex, at the base meeting around a pentagonal pore completely filled with the basal plug. Plug 0.052 mm. broad and about as thick at maturity. Texture of limeshell crystalline, with occasional fractures and without lamination or zonation.

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