Cytological Studies in Charophyta, II.
Morphology of the spermatozoid in Chara and Nitella
with special reference to the structure of the motile apparatus

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(With two figures)

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In the first paper of this series (1935), the spermatoteleosis in Nitella sp. was reported with special reference to the morphogenesis of the blepharoplast. Since then an attempt has been made to compare the motile spermatozoids of Charophyta with those of Bryophyta and Pteridophyta. In the present paper mainly the structure of the motile apparatus is described and discussed.

Concerning the insertion point of the cilia of the spermatozoid two different observations have been reported on this family. Belajeff (1894), Strasburger (1900), Mottier (1904), and Meves (1918) are of the opinion that the cilia are not attached at the end of the blepharoplast, but at a point some distance back of the anterior end of it. Mühldorf (1930), on the other hand, reported that the cilia spring from the extremity of the blepharoplast, and go directly forwards. She insisted that the results of the observations of the investigators mentioned above were erroneous and said: "Bei der Einwirkung der Osmiumsäuredämpfe macht das Spermium in den Todeszuckungen eigenartige Bewegungen, wobei die vordere Hälfte des Halsteiles sich nach rückwärts umlegt und mit der zweiten Hälfte zusammenklebt, und zwar meistens so genau, daß man nur ein einfaches einheitliches Organ zu sehen vermeint."

In order to reexamine this, spermatozoids of two species of Chara and one species of Nitella were subjected to investigation. Both the living and fixed materials were observed.

In order to get motile spermatozoids in abundance, the writer pinched the ripened antheridia off the plant body, opened them carefully with the aid of pointed needles, transferred a considerable amount of the antheridial filaments in a drop of water onto the slide glass, and kept it for several hours in the damp-chamber. When the spermatozoids in the antheridial filaments are at their full maturity, we can get motile spermatozoids in abundance, at a period two or three hours after the operation mentioned above. The investigations of motile spermatozoids were

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carried on throughout their whole life cycle. For the fixation of the motile spermatozoids, the vapour of 2% osmic acid was employed and the preparations were stained with either gentian-violet or carbol-fuchsin.

The writer agrees with Mühldorf’s observations as regards the point she made that the blepharoplast (her “Halsteil”) is far longer and thinner than was reported by other investigators, and that the cilia spring from the end of the blepharoplast. She reported that the “Halsteil” has always two bending points and that the distal part of the blepharoplast bends backwards with a sudden turn at the X-point (cf. Fig. 1), when we employ the vapour of osmic acid for fixation. In the present

Fig. 1. Spermatozoid of Chara fragilis (Schematic). MP = motile portion, CP = connecting portion, A = ends of nuclear spiral, BB = basal body, CE = cytoplasmic posterior extension, EP = end piece of cilium, V = spherical vacuole, X = junction between motile and connecting portion. The blepharoplast coalesces with the tapering end of the nuclear spiral, the latter becoming more and more narrow at both ends, with a gradual elimination of its width. The nuclear part shows a 4–4.5 right-handed spiral. The blepharoplast shows a rough spiral structure consisting of two elements (motile portion and connecting portion). At the end of the cilia we can recognize the end pieces. Basal bodies are also recognizable at the insertion point of the cilia. The posterior cytoplasmic extension stains heterogeneously both with gentian-violet and carbol-fuchsin and is characterized by its striped patterns. Most of the spermatozoids have a spherical vacuole, enveloping the cytoplasmic extension. Fig. 2. a, Spermatozoid of Nitella sp. x100. b, Spermatozoid of Chara fragilis ×1000.
case under observation, however, many spermatozoids, even in the living state, were formed, of which the blepharoplasts bend backwards with a sudden turn at the X-point. And so we can not always say that the bending of the blepharoplast at the X-point is provoked by the effect of the vapour of osmic acid.

Judging from the fact that the "Halsteil" bends always at the X-point even in the living spermatozoids, this point seems to be not merely a bending point but rather a junction having important significance for the motility of the spermatozoid.

In the preparations fixed with the vapour of osmic acid, two parts (distal and proximal) stain in a different degree, both with gentian violet and carbol-fuchsin—the distal half stains homogeneously and the proximal half heterogeneously—which seems to indicate for sure that the blepharoplast consists of two different elements. This conclusion seems justified also by the fact that the proximal half of the blepharoplast degenerated at first, whereas the distal half remains always attached to the cilia.

It may thus be concluded that the upper part of the blepharoplast represents the motile apparatus (Fig. 1, MP) and the lower part the connecting portion (CP) between the former and the nuclear spiral.

The motile apparatus has a distinct basal body (BB) at the point of the cilia attachment.

When the blepharoplast bends at the point X and the two halves of the blepharoplast become attached side by side, the blepharoplast of Charophyta comes to bear some resemblance to that of Pteridophyta, the distal part having the nature of the cilia-bearing band and the proximal part having the nature of the border-brim reported in Pteridophyta by Yuasa.

In Nitella the distal part of the blepharoplast becomes far shorter than that of Chara. It will be not unreasonable to consider that the spermatozoid of Nitella comes to bear a great resemblance to that of Bryophyta, if the distal half of the blepharoplast in Nitella is extremely reduced.

For these reasons, it will be very important and interesting to consider whether Charophyta has any phylogenetical relation to both Bryophyta and Pteridophyta in the light of the morphological investigation of their spermatozoids.

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References


