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ON THE SCALES OF SOME SYNURA SPECIES

BY

JOHS. BOYE PETERSEN and J. BENTH HANSEN

København 1956
i kommission hos Ejnar Munksgaard

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Synopsis.

The scales of a number of Synura species were examined by means of electron microscopy and thoroughly described and figured. Two main groups of species could be distinguished. One group includes S. Petersenii and S. glabra, the other S. uvella, S. echinulata, and S. spinosa. The last-named species occurred in different forms, which may represent a corresponding number of species, viz. f. spinosa, f. mollispina, f. longispina and f. Nygaardii, all of them new forms.

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In 1918 Boye Petersen called attention to the fact that the covering of the Synura cell is built up of scales which in a screw position make up a tight armour. Boye Petersen gave the name of *Synura uvella* to the species he had examined, the only species which up to then had been fairly well defined. Several authors (Lemmermann 1903, Pascher 1914) had attempted to establish new species of the genus on the basis of the length of the spines, as well as from a certain mesh pattern on the surface, and from the shape of the cell. No doubt the first two criteria may indicate differences of species, but the shape of the cell is of no value whatever as a criterion, as already pointed out by Boye Petersen in 1918, owing to the great variability of the cell shape. It will probably for ever remain an unsolved problem with what species the authors have been confronted, as there is no possibility of finding the original material from which electron microscopy of the scales can be made. On the other hand, *S. Adamsii* G. M. Smith (1924) and *S. australiensis* Playfair (1915) seem to be so adequately characterized that they are easily recognized. Other species have been established by Kisselew (1931); these, however, are not provided with any information about the scales and, therefore, can hardly be recognized without careful examination of the original material.

Korshikov (1929) made a thorough examination of the scales of a number of Synura specimens, which led him to the discovery that the scales have so many different patterns that he was able to establish a number of new species from the appearance of the scales. Above all he made it clear that Boye Petersen's Synura could hardly be identical with *Synura uvella* Ehrb. The latter species, especially in Stein's well-known picture (1878) is remarkable for strongly developed spines on the anterior portion of the cell. Besides, however, he found a Synura species the scales of which were in complete accordance with those of Boye Petersen's species, for which reason he termed it *S. Petersenii*. Apart from that he found several other species with very characteristic scales. Bioret (1933) worked on the same lines without knowing about Korshikov's work. Like the latter, he found several types of scales; however, he did not establish any new species, assuming that the scales of *S. uvella* were just highly variable. Quite obviously he has not seen *S. Petersenii*. Finally, Conrad, in a posthumous paper (1946), tried to carry on Korshikov's work; but he did not arrive at a satisfactory grouping of the species before his death. Huber-Pestalozzi (1941) collected all essential facts known about Synura species and their scales. He carefully gathered biological information about *S. uvella*; as this information, however, is based on the statements of the different authors, and as, moreover, these authors beyond doubt used the term *S. uvella* about all the species they observed, it is fair to believe that the biological data may apply equally to *S. uvella* and to other species. Consequently, along with investigations into the biological relations of the species, it will be necessary to start afresh for a correct definition of the existing species. It should be noted that Korshikov (1941) described a most characteristic species, *S. splendida*. Schiller (1929) mentions two Synura-like organisms by the genus name of *Synuropsis*. As for these two species, there are no indications to show whether they have a covering built up of scales. About one of the species, *S. globosa*, it is stated that there are short bristles on the surface of the cell, whereas the other species (*S. danubiensis*) is mentioned as being completely smooth. Especially in the case of *S. globosa* it will be natural to ascertain whether the bristles in question are not in fact fixed on a scale armour. Kisselew (1931) mentions some Synura species, one of which is identified as *Synura uvella*, the other as *S. reticulata* Lemm. As for the latter, it seems likely to believe that the species is *S. spinosa* Korsh.; and the former, which is figured and mentioned as having a completely smooth cell surface, can at least not be *S. uvella*. These species, accordingly, should be more closely examined.

It may be useful to realize fully which of the characters hitherto used to distinguish the different species are in fact reliable as specific characters. As a main criterion, Korshikov (1929, p. 287) among other things mentions the arrangement of scales, according as they are lying longitudinally or obliquely. To this may be objected that these relations are very difficult to determine, even in the exsiccated material, because the scales are, as a rule, more or less displaced in the exsiccation process. Besides, it is a fact that even if the scales are placed in a screw position, as may be seen in spruce cones, it is still possible to distinguish longitudinal rows; and at least it will be possible to observe oblique rows, even if the scales are arranged in circles. This last arrangement never seems to occur. Wherever we have been able to distinguish the arrangement of the scales, oblique lines have been discernible in all species. The cellular shape is used by several authors as a systematic criterion; as it has already been emphasized, this is highly objectionable because all Synura species are characterized by the great variability of the cellular shape. Within the same species, there are few-celled colonies with nearly spherical cells and large, many-celled colonies with long-stalked cells (see also Korshikov 1929, p. 285; I. Manton 1955, p. 310, and Conrad 1946, p. 2). What makes all these variations possible, is among other things the very fact that the covering is built up of imbricated scales of a certain mutual movability. This, in the end, leads to the conclusion that the best specific characters are obtained from the structure of the scales. For this reason we have, by electron microscopy, examined the scales of the different Synura forms available. We have adopted the simple method of drying up the Synura cells direct on the formvar film. By this the covering of most cells will decompose more or less into its single scales, which, however, often retain part of their original arrangement. If the material is preserved in formalin, it pays to dry up a drop on a cover slip, and after that to heat it on a platinum or iron sheet. In this process the formalin evaporates completely, and superfluous organic parts are eliminated. After this the material may be transferred in the usual way with collodion to the formvar film. However, it seems as if this treatment makes the scales so brittle that they are easily crushed. As a rule the preparations have been shadowcast with palladium and then electron micrographed at different magnifications. These micrographs show a very different and highly characteristic structure in the single species. By shadowcasting the preparations a clear impression is obtained of the spatial relations in connection with the structure of the scales. For further confirmation of the structures observed we have prepared stereoscopic pictures with the electron microscope, and the structural relations thus observed have proved to be quite in agreement with those previously assumed.

Most of the species examined were identified, with comparative certainty, with Korshikov's species. Some species, however, presented difficulties. On the other hand, as original material will hardly ever be available, it is fair to regard our determinations and descriptions as emendatory descriptions of these species, and in future it will be necessary to make use of e. m. micrographs of the scales in order to determine the species with adequate correctness.

The genus Synura may be divided, according to the structure of the scales, into two sections:

I. Peterseniananae, the scales of which have a hollow ridge in the middle, and no spine or, if any, a very short one.

II. Spinosae, without a hollow ridge in the middle, and the scales of which have a more or less strongly developed, hollow spine attached near the tip of the scale.

Section I Peterseniananae.

Synura Petersenii Korsh.

Korshikov 1929, p. 283, pl. 11, figs. 54—58.
Synura uvella Boye Petersen 1918, p. 345, pl. V, figs. 1—9.
Synura caroliniana Whitford 1943, p. 159, figs. 6, 7.
Plate I, figs. a—c. Text, figs. 1, 2, 3.

The species was first mentioned by Boye Petersen (1918) by the name of *S. uvella*, which was natural as it was the only one fairly well-defined at the time. Later on, Korshikov (l. c.) succeeded in ascertaining that it could not be identified with *S. uvella*, as he found a different species far more in accordance with Stein's description and figure of this species. Whitford

(1943) has described *S. caroliniana*, an American species characterized above all by very long-stalked cells, and by very short thorns on the apical part of the cell. The scales of this species were presented by MANTON (1955) in e. m. photos from specimens selected from a culture made by WHITFORD. These scales are in perfect accordance with the scales of *S. Petersenii*; and as the other details of the description reveal a corresponding identity with the latter species, we do not hesitate to merge the two species into one. In consequence, the species must bear the older name, that of *S. Petersenii*. The scales of *S. Petersenii* are imbricated, and lie in a screw position like the scales of a spruce cone. The dimensions of the scales may vary a little. By measurings with the light microscope, KORSHIKOV (1929) found length ca. 4 μ, breadth ca. 2 μ. In *S. caroliniana* — in e. m. photos by MANTON (1955, pl. V) — was found l. 3.2—3.8 μ, br. 1.9 μ. In our own pictures, in apical scales, we have found l. 4.7 μ, br. 2.3 μ. On the whole, the different values observed agree fairly well; and as the variation within the same individual is far from being negligible, and it cannot be decided with absolute certainty to what part of the covering the measured scales belong, the degree of accordance must seem satisfactory.

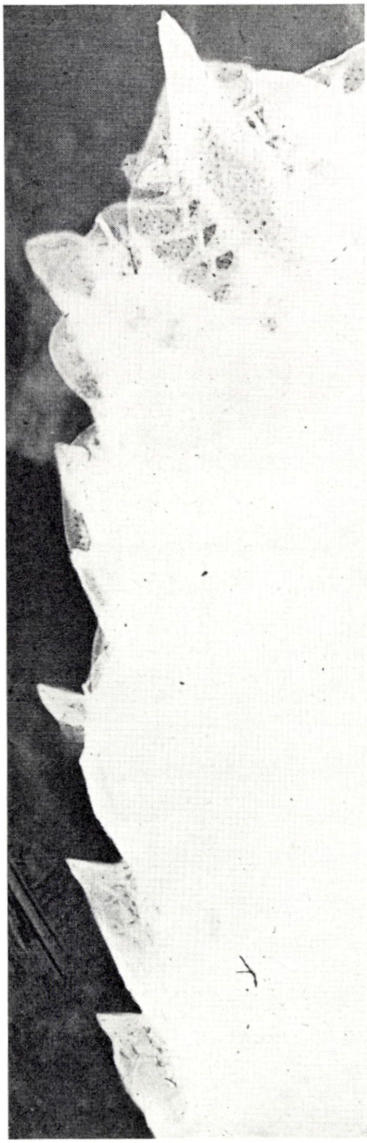

Fig. 1. *Synura Petersenii* Korsh. Border of cell showing the serrate outline. ×14.400.

In a live cell of *S. Petersenii*, along the edge, is seen a fairly distinct serrulation (fig. 1). In his paper of 1918, BOYE PETERSEN

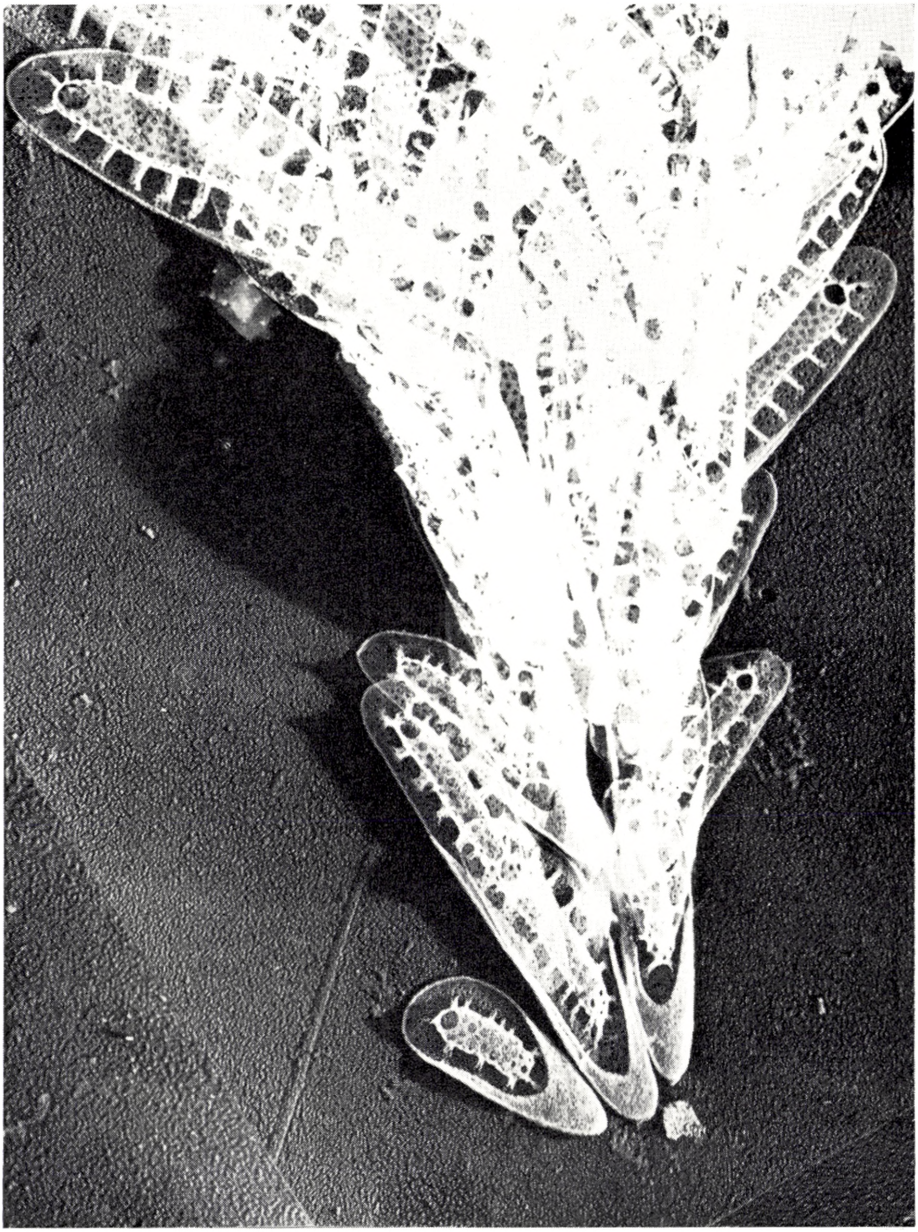

Fig. 2. *Synura Petersenii* Korsh. The stalk. ×14.400.

assumed these points to be due to the edges of the slightly projecting scales. We know now that they are caused by the short thorns to which the apical scales are tapered off. On the lower portion of the covering (the stipe), the scales have no spines; consequently the covering appears smooth (fig. 2). The description of the scales of this species in Korshikov (1929) is very much to the point; equally, his figures are so carefully made that identification of the species with the light microscope is feasible.

In the neighbourhood of Copenhagen, *S. Petersenii* is the commonest species. It has been found in the pond of the Botanical Gardens; in the pond Bondedammen of Teglstrup Hegn; in the lake Bøgholm Sø, and in several minor ponds in northern Zealand. From the e. m. micrographs it is possible to give the following description of the scales:

Apical scales elliptical or oval, l. 3.6—4.7 μ, br. 2.2—2.5 μ. Along the lower two-thirds of the scale is an upturned edge (0.3—0.4 μ broad). The upturned portion is transparent enough for ribs and holes to be seen through it, and, accordingly, it is very thin. In the middle of the surface of the scale is a hollow, longish region, which at the front end tapers into a short, pointed thorn. The cavity is 2.7—3.3 μ long, 0.6—0.9 μ broad in front, narrowing gently towards the rear end. The thorn is ca. 1 μ long, conical. Inside the spine base is an opening inwards towards the cell (0.2—0.35 μ in diameter). The ceiling as well as the floor of the cavity is provided with little holes (ca. 0.1 μ in diameter). Evidently the outside wall is very thin, which implies that in many of the e. m. pictures it is impossible to discern its structure above the hole on the inside, and often it has been crushed during the preparation. The spine itself, on the contrary, has a rather thick wall. The surface of the scale round the hollow rim has numerous little holes (0.05 μ in diameter, ca. 12 in 1 μ), and from the cavity a number of strong ribs extend towards the edge. Most often they are not forked, occasionally they are bifurcate, and sometimes they are interconnected by transverse ribs (fig. 3). These ribs are of rather considerable height, as may be seen from the shadowcast e. m. pictures and, still more conspicuously, in the stereoscopic pictures. In some pictures they are seen in a somewhat oblique position, in which cases the vertical planes are seen to contain small holes, which leaves the impression that they are folds originating from the inner surface of the scales, projecting from the middle cavity as a sort of buttresses.

Down the lower part of the cell the scales grow narrower and smaller. At the same time the spine disappears; the cavity,

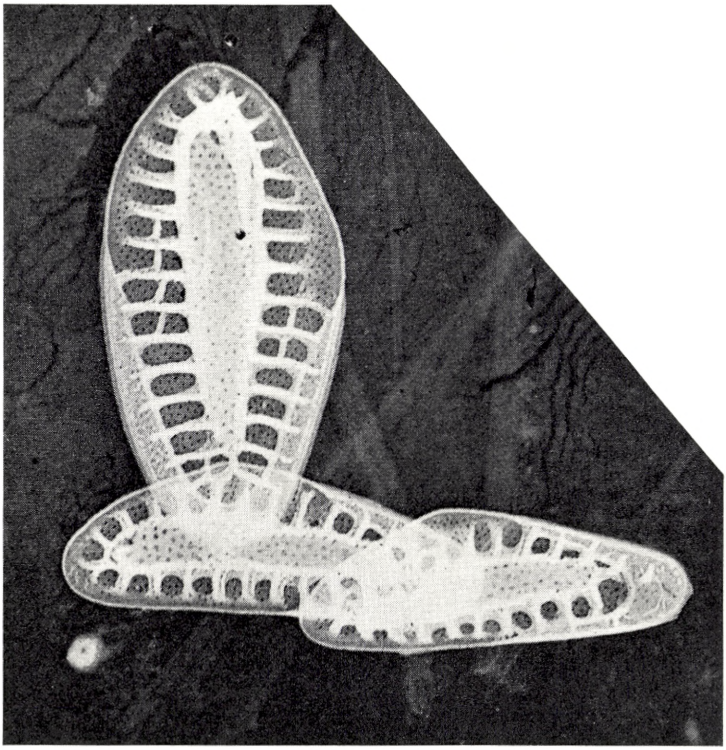

Fig. 3. *Synura Petersenii* Korsh. Three median scales. ×14.400.

however, remains right down to the very lowest scales. This is inconsistent with Korshikov's observations, because he was not able to see any "median ridge" on the basal scales (l. c., p. 284, table 11, figs. 57, 58). However, the objects in question are so extremely small that it is no wonder he was not able to see all the details revealed in the e. m. pictures.

The basal scales are shaped like slippers, elongate obovoid, the smallest and very lowest l. 2 μ, br. 0.6 μ. The lower point is covered by the upturned edge, the upper part has a narrow cavity and extremely small holes (ca. 0.01 μ). The upturned edge is broad at the bottom (0.8 μ), narrowing upwards and reaching nearly halfway up the scale. Ribs are short, do not reach the edge. Cavity of the central part (l. 1.9 μ, br. 0.4 μ) narrow and short.

Synura glabra Korsh.

Korshikov 1929, p. 285, pl. 11, figs. 59—65.
Plate I, figs. d, e. Text, figs. 4, 5.

The species was established by Korshikov after some hesitation, because he suspected that it might be regarded as a variety of *S. Petersenii.* However, it has proved possible to distinguish the two species, even by means of the light microscope, and the e. m. pictures show such a marked difference, that the species must be considered without doubt different from *S. Petersenii.* Its main characteristic is a less silicified scale, the shape of which is more oval (at times nearly circular and slightly oblique in

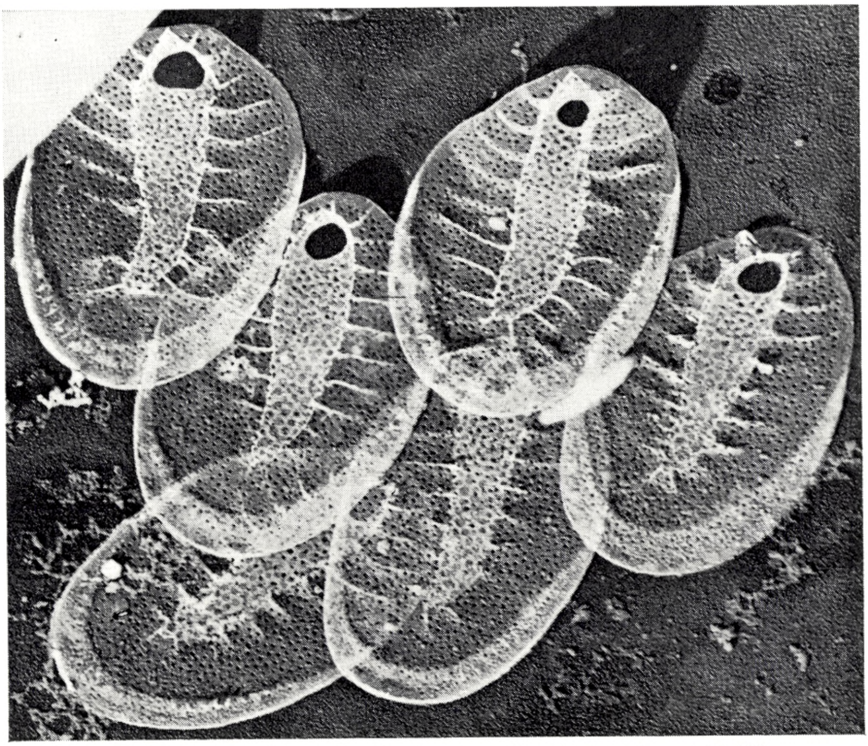

Fig. 4. *Synura glabra* Korsh. A group of apical scales. ×14.400.

front), a less developed middle cavity, which in front is only provided with a very short point, hardly discernible in the light microscope.

As already emphasized by KORSHIKOV (1929, p. 286), *S. Petersenii* and *S. glabra* make up a group within the genus which is

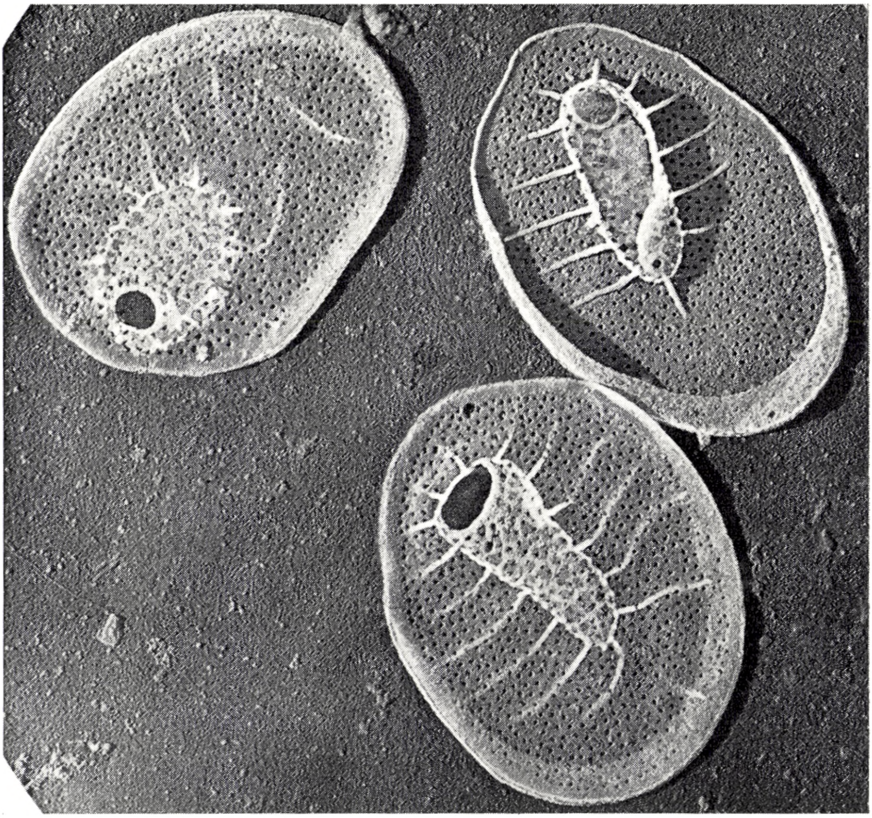

Fig. 5. *Synura glabra* Korsh. Three median scales. ×20.000.

quite different from the other species through the structure of the scales. KORSHIKOV has even considered the possibility of referring the two species to a special genus; he gave up this thought, however. We have joined him on this point, dividing the genus into two sections.

Apical scales oval, often cut off obliquely at the top, l. 3.4—3.6 μ, br. 2.3—2.6 μ. On the basal part of the scale an upturned thin edge 0.5 μ broad, reaching upwards ca. two-thirds of the scale. The scale surface is very broad, with weak radial, hardly bifurcate ribs which do not reach the edge of the scale. Between, and on, the ribs are seen small holes (0.025 μ in diameter, ca. 14 in 1 μ). As in *S. Petersenii*, the central part is covered by a hollow ridge, tapering off, in front, in a very short thorn. The cavity is 2.6 μ long, 0.6—0.7 μ broad in front, gently narrowed at the back. At the very back it is often turned a little sidewards. The inside as well as the outside wall are provided with holes at small intervals (ca. 0.05 μ in diameter). Through a pore (diam. 0.4 μ) the cavity is connected with the surroundings.

Downwards on the narrow part of the cell, the scales grow smaller and more elongated. The smallest scales: l. 2.1 μ, br. 1.1 μ still contain the middle cavity with a hole on the inside, but the ribs are very weak, or there are none at all. The shape of the scale is rather oblong, with parallel sides, not elliptical as in Korshikov's drawings (1929, table 11, figs. 63, 65).

Found in Bøgholm Sø.

Section II. Uvellae.

Synura uvella Stein

Stein 1878, p. 15, table 13, fig. 24.
Korshikov 1929, p. 279, pl. 11, figs. 31—37.
Plate II, figs. a, b. Text, fig. 6.

Korshikov realized that what previous authors understand by *S. uvella*, evidently represents several species. Consequently he decided to accept the specimen depicted by Stein (l. c.) as the type species. This form is characterized by scales provided with strong spines which are discernible even through imperfect optical instruments. By this it is clearly distinguished from all the other species described. Korshikov (l. c.), gave excellent figures of the scales of this species, having made surprisingly good observations of the structure of these scales with the light microscope. The e. m. pictures testify in nearly all details to the correctness of his observations. It should be noted, too, that this particular species has larger scales, and these a coarser structure, than all the other species. Bioret (1933) in fig. 5 a—e depicted a number of scales evidently belonging to this species; this

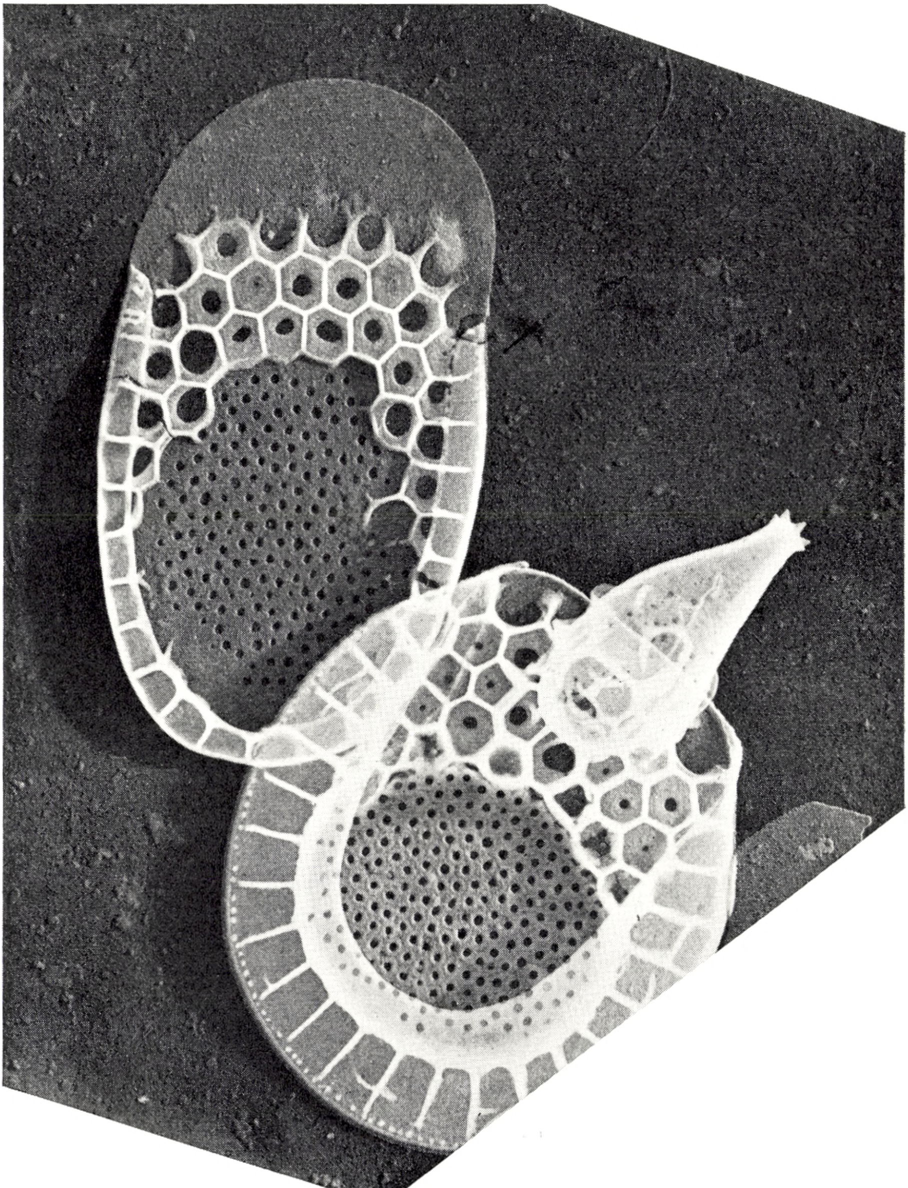

Fig. 6. *Synura uvella* Stein. An apical and a basal scale. ×15.400.

presumably also applies to fig. 7 f—i. As for Bioret's other figures of Synura scales, it will no doubt for some time to come be impossible to decide to what species these scales belong. CONRAD (1946) tried to base the establishment of new species on some of Bioret's drawings; however, it seems difficult to classify any more of his figures among Korshikov's species. No doubt some of his original figures belong to *S. uvella,* e. g. figs. 37—39.

The scales of *Synura uvella* may be described as follows:

The apical scales are almost circular, cut off rather abruptly in front; l. 4.9 μ—5.0 μ, br. 4.3 μ—4.5 μ. An upturned edge (1.2 μ broad) reaches upwards nearly as far as to the cut-off portion of the edge. Here the edge of the scale is very thin, supported by strong ribs. Below the upturned edge, too, are seen strong ribs at right angles to the edge (ca. 25 in 10 μ), and along the edge itself are a number of very small grains (0.05 μ in diameter, ca. 6 between every two ribs). Inside this portion of the edge, the surface of the scale falls into two sections of completely different structures. The front part to which the spine is attached has strong ribs connected as a mesh pattern forming hexagonal meshes, each of which is covered at the top by a thin membrane with a hole in it. The meshes are 0.5 μ in diameter, the holes 0.1—0.3 μ in diameter. At times, however, the membrane seems to be quite missing, or perhaps to have burst during the preparation. The posterior section is a continuous plane with round, evenly distributed holes (0.1 μ in diameter) which often appear surrounded by a fine thickened border. The spine issues from the front part of the scale, slightly inside the edge. It is thick, conical, and hollow, and ends in 3—5 teeth; l. 2.7 μ—3.0 μ, th. 1.2 μ—1.3 μ. At the bottom the inside of the spine is connected with the cell through a hole (ca. 0.2 μ in diameter). The spine appears to be rather thick-walled; however, the thickness of the wall is not easily measured in the pictures.

The basal scales are oblong oval, without thorns (l. 5.8 μ—6.0 μ, br. 3.2 μ—4.5 μ). The upturned edge along the basal part of the scale is narrow (0.3 μ) and only stretches ca. three-fourths upwards towards the upper end. The surface of the scale falls into three sections:

1) the upper part of the surface is thin, devoid of structure;
2) after this follows a section with strong ribs connected as a

mesh pattern, and forming hexagonal meshes (0.4 μ in diameter). In these, a thin membrane is sometimes stretched out, with a hole in the centre (0.05 μ in diameter); on the basal scales, however, this membrane is often missing;

3) from this section stretches a zone of radial ribs surrounding the rear part of the scale as a continuation of the middle section. It should be noted that the floor of this third section has a smooth surface with holes in it (0.1 μ in diameter).

Found in Hulsø (leg. J. Kristiansen), and other places.

Synura echinulata Korsh.

Korshikov 1929, p. 282, figs. 42—53.
Table I, figs. f, g, h. Text, figs. 7, 8.

In Korshikov (l. c.) this species is characterized particularly by the blunt-edged shape of the apical scales, the short stiff spine forming an angle to the surface of the scale, and by the small size of the scale. In reality the scale is best desribed as elliptical or ovoid, and the reason why Korshikov describes it as being blunt-edged in front, is no doubt that he was not able to discern the thin edge of the front part.

Erroneously he considered the front plane as a thickened portion of the edge. The scales are characterized particularly by the short stiff spine ending in one point, and by the front plane provided with linear thickenings making an area of broken lines. Apart from that, the scales are essentially built like those of *S. uvella*. The shape of the middle scales is more elongated, the spine completely or almost missing. On the basal scales the front plane with the broken lines is also completely missing.

The scales may be thus described:

Apical scales ovoid, l. 3.0—3.4 μ, br. 2.4—2.5 μ.

At the base is an upturned edge, which stretches upwards to slightly above the middle of the scale. Under it no structure is discernible. Its breadth is ca. 0.35—0.5 μ. It extends in front into a narrow thin edge with ribs at right angles to the edge (5 in 1 μ). Between each of the ribs is seen a small hole (ca. 0.03 μ). The front part of the scale surface, to which the spine is attached, is highly silicified and provided with small linear, sinuate thickenings (ca. 0.03 μ thick, 0.15—0.5 μ long). From here issues the

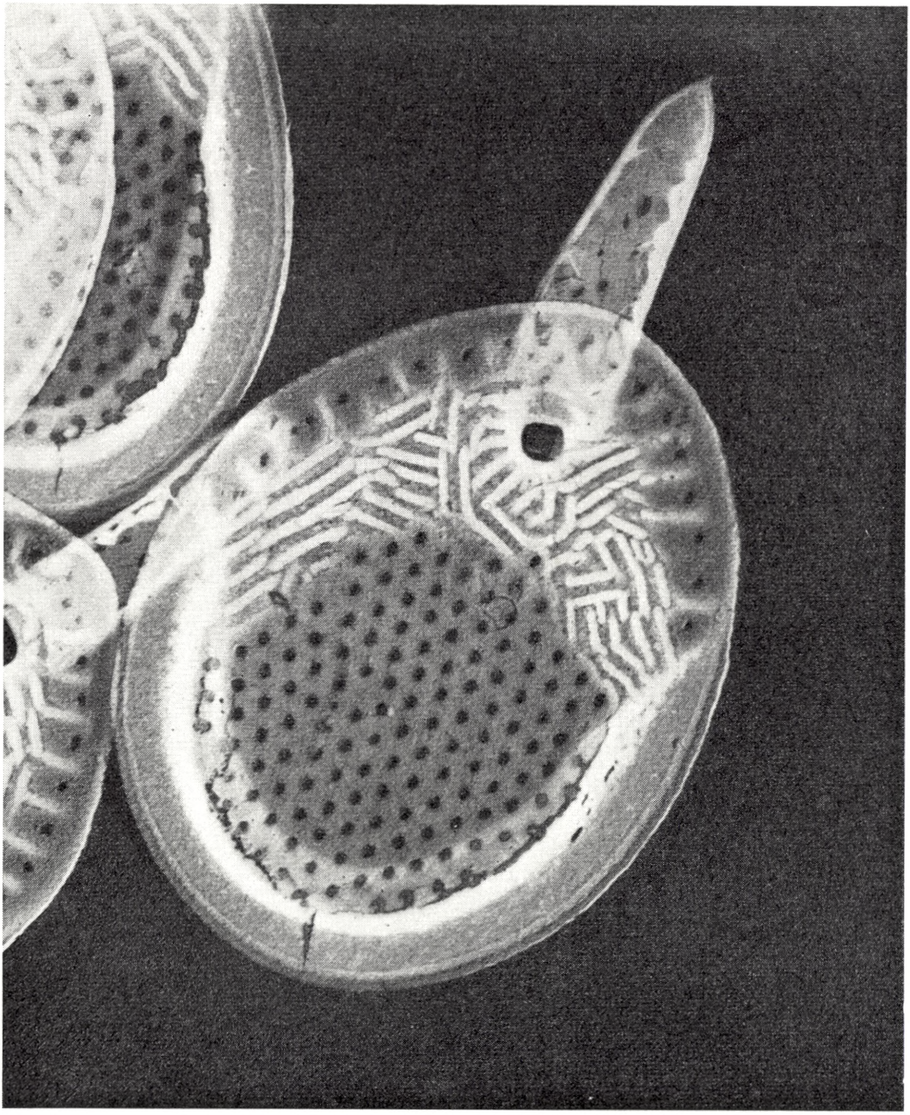

Fig. 7. *Synura echinulata* Korsh. Apical scale, seen from the inner side. ×32.400.

spine, forming an angle to the surface of the scale (l. 1.4—2.0 μ, thickness at the base 0.5 μ), narrowing gently upwards, and ending in one point. The spine wall seems to be provided with occasional holes, and it rests above a hole in the surface of the scale (0.2 μ in diameter). The posterior part of the scale surface

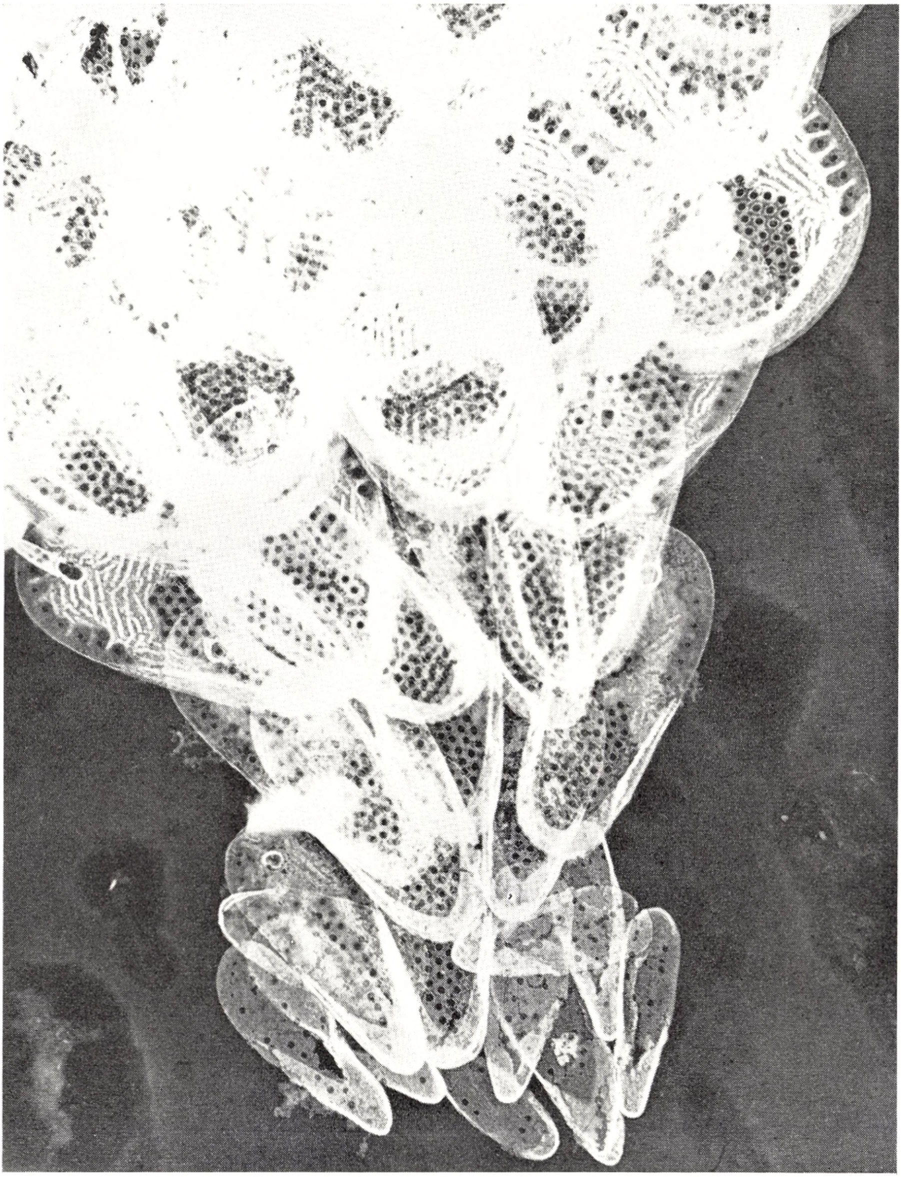

Fig. 8. *Synura echinulata* Korsh. The stalk. ×14.400.

is smooth, with holes (0.05 μ in diameter; ca. 8 in 1 μ), regularly arranged in rows following three directions.

In a downward direction on the cells the scales adopt a more oblong obovoid shape, and the spine becomes shorter. A scale of this kind (corresponding to Korshikov 1929, table 11, fig. 49) showed the following dimensions: l. 3.5 μ, br. 1.7 μ. The basal upturned edge stretched as far as two-thirds of the length. The front edge had no ribs, but a row of small holes (ca. 0.05 μ in diameter), ca. 5 in 1 μ. The front part of the scale surface had linear thickenings arranged in slightly sinuate lines. The spine was quite short, pointed (ca. 0.5 μ long). The rear part of the scale surface had round holes (0.06 μ in diameter) arranged in rows following three directions (ca. 6 in 1 μ). The basal scales were still more simplified, shaped like slippers, broadest upwards (l. 2.3 μ, br. 0.7 μ); at the base they had an upturned edge reaching upwards ca. half the length. The surface had small holes (ca. 0.04 μ in diameter) lying irregularly.

Found in the Fuglsangsø (leg. J. Kristiansen), and in other places.

Synura spinosa Korsh.

Korshikov 1929, p. 281, pl. 11, figs. 38—41.
Bioret 1931, p. 5, 6, figs. 2, 4a—e.
Conrad 1946, p. 4, 8, fig. 20.

This species seems to be rather variable, or it may in fact include a group of closely related species. We have selected, as the type species, the form found in the pond Bondedammen and the lake Bøgholm Sø, the apical scales of which have spines of medium length, with two or three teeth at the points. Other forms have very long spines, which are blunt-edged at the points; besides these, there are short-spined forms the spines of which are truncated abruptly at the points, and are provided with up to seven teeth. Besides, the structure of the scales seems to be essentially identical within the different forms.

In the opinion of Korshikov and later authors the spines of the apical scales of this species are attached to the edges of the scales, and are projecting at the same level as the surface of the scales. This is not so. The spine is always attached slightly within the uppermost edge of the scale and, in life, always forms an angle to the scale surface. Probably this angle is always acute.

In dried preparations the spine is sometimes lying on the glass or the formvar film, owing to the fact that the degree of silicification is not very high.

In this species KORSHIKOV has only observed the apical scales, whereas he has not been able to find the basal scales, on account of the sparsity of the material at his disposal. He describes the apical scales with great correctness, and gives these measurements: l. 3—5 μ, br. 2.5—3 μ; spine 2—3 μ long. These measurements agree fairly well with ours, as will appear from the figures given below.

Survey of the forms found within the species in question:

1. The whole scale covered by ribs forming a hexagonal mesh, spine slender and soft.................. f. *mollispina*
   Only front part of scale covered by ribs in mesh pattern, spine coarser and rigid.......................... 2
2. Spine ending in blunt point, 3.5—4.3 μ long.. f. *longispina*
   Spine ending in teeth, shorter..................... 3
3. Spine 2.8—3.5 μ long, with 2—3 teeth.......... f. *spinosa*
   Spine shorter.................................. 4
4. Spine 2.7 μ long, having up to 7 teeth....... f. *Nygaardii*
   Spine 1.9—2.4 μ long, having 3—4 teeth...... f. *curtispina*

S. spinosa f. *mollispina* n. f. Plate IV, fig. a.

Apical scales ovate, l. 4.9 μ, br. 3.3 μ, upturned edge at base 0.5 μ broad reaching upwards about halfway. The whole of the plane covered with mesh-pattern ribs, mesh hexagonal (0.3 μ in diameter); in the middle of each a little hole (0.05 μ in diameter). Spine hollow, 2.8 μ long, 0.3 μ thick, only a little silicified, ending in two teeth. Spine attached slightly within the upper edge of the scale.

Found September 14, 1954 (leg. Berit Asmund) in the pond Bondedammen. Few apical scales observed, and none basal.

S. spinosa f. *spinosa* n. f. Plate II, figs. c, d, Text, fig. 9.

Apical scales with oval or slightly elliptical outlines, l. 4.2—4.8 μ, br. 2.9—3.0 μ. Upturned edge at base 0.5 μ broad, reaching upwards two-thirds of scale. Front plane provided with mesh-

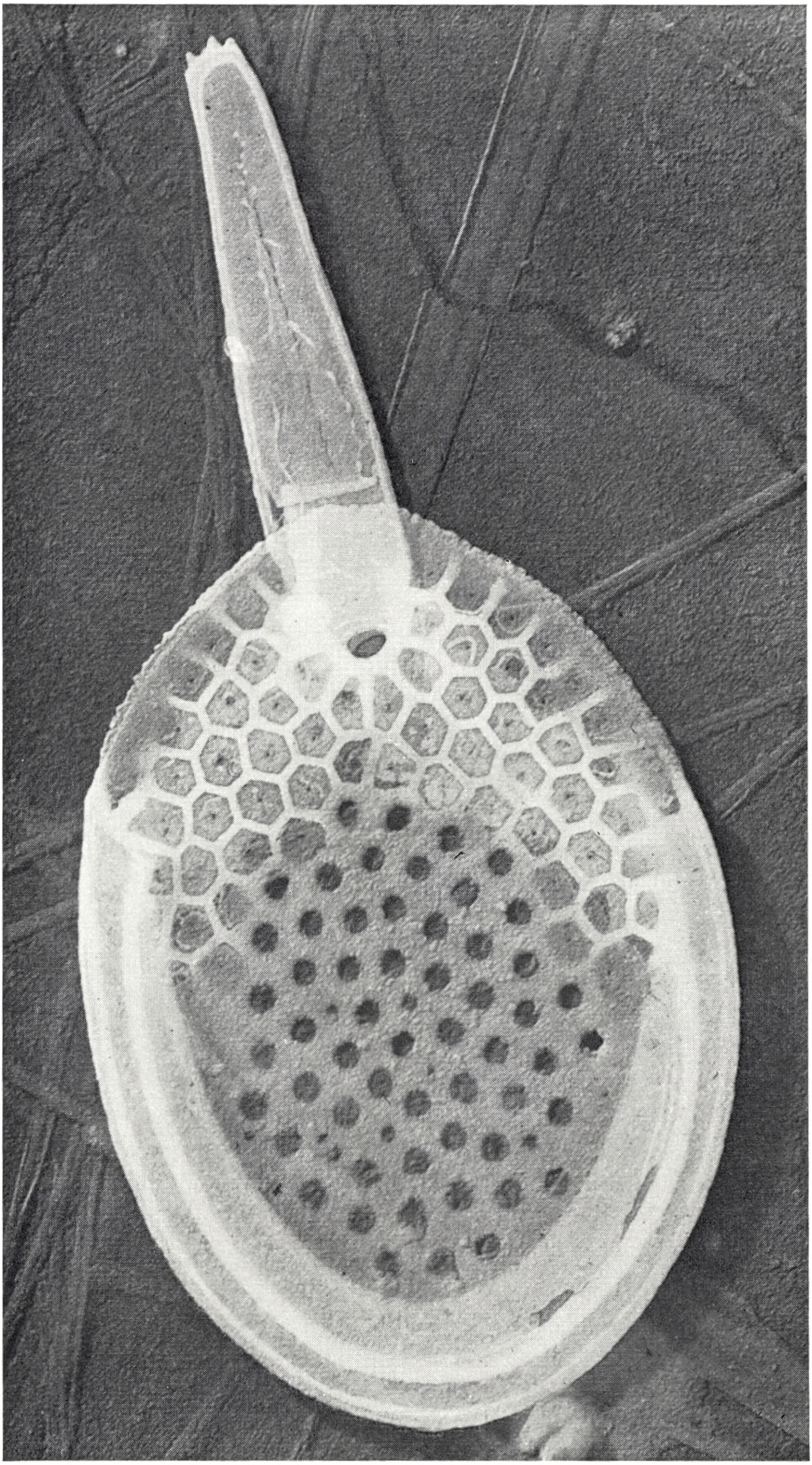

Fig. 9. *Synura spinosa* Korsh. f. *spinosa* n. f. Apical scale. ×32.400.

pattern ribs, meshes hexagonal (0.2 μ in diam.); each mesh covered with thin membrane containing small hole (0.01 μ).

Rear plane smooth, with round holes (ca. 0.1 μ in diam.), ca. 5 in 1 μ. The spine is 2.8—3.5 μ long, attached slightly within the upper edge of the scale, hollow, 2—3 teeth in front. Thickness at base, 0.5—0.7 μ, at top 0.2 μ. Thickness of wall 0.03 μ. At the bottom a hole, ca. 0.5 μ in diam.

Basal scales ovoid, tip turned upwards, l. 3.4—4.8 μ, br. 1.5—2.2 μ. Upturned edge all the way round (0.3 μ broad). Whole of surface smooth, with round, sparse holes (0.1 μ in diam.), especially in lower, broader part.

Observed in the Bondedammen and Bøgholm Sø.

S. spinosa f. *longispina* n. f. Plate III, figs. c, d, Text, fig. 10.

Apical scales, l. 3.9—5.0 μ, br. 2.5—3.7 μ. Spines 3.5—4.3 μ long, blunt-edged, no teeth at tip; 0.5 μ broad, seems rather thin-walled, apical portion apparently being attached to formvar film, collapsed and rather flat. Basal scales same size and equipment, as in f. *spinosa* (l. 5.3 μ, br. 1.9 μ).

Observed in the Sortesø on Aug. 27, 1948.

S. spinosa f. *curtispina* n. f. Plate III, figs. a, b.

Apical scales, l. 3.9—4.3 μ, br. 2.9—3.1 μ. Spine, l. 1.9—2.4 μ, thickness 0.4—0.7 μ, at tip with 3—4 teeth. Except at the top of the cells the scales are without spines, but still with mesh-pattern ribs on the front part of the surface, and small round holes at the rear of the surface. The basal scales on the stalk are shaped like slippers (l. 2.7 μ, br. 0.8 μ), without holes on the surface. These scales are very slightly silicified.

Observed in the Kathale bog on Nov. 12, 1955.

S. spinosa f. *Nygaardii.* Plate III, fig. e.

S. Adamsii Nygaard 1949, p. 139, fig. 72 bis.

The material representing this form was collected by Dr. E. Teiling in the Ryven lake in Sweden.

Nygaard mentioned and described it (l. c.) by the name of *S. Adamsii.* Evidently this description is based essentially on the

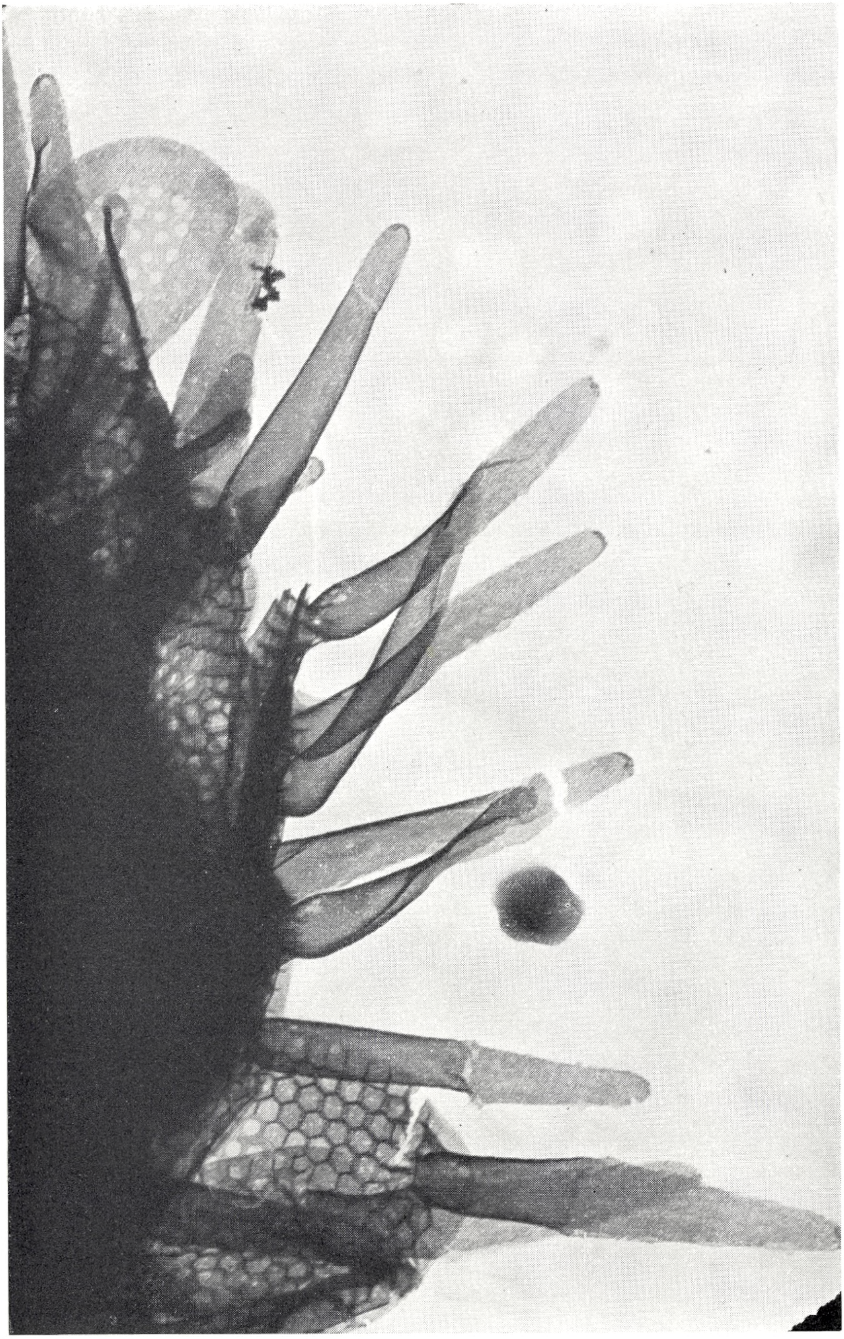

Fig. 10. *Synura spinosa* Korsh. f. *longispina* n. f. Border of a cell, showing the insertions of the spines. Positive, non-shaded print. ×14.400.

shape of of the cells, which have great similarity with *S. Adamsii* G. M. Smith. The cells are broadest in front, narrowing very gently towards the rear, without any clearly drawn stalks. Differing completely from the usual pictures is the fact that all the scales are provided with very distinct, projecting spines. It will, therefore, be fair to assume that the form in question has no connection with *S. Adamsii*. The subsequent e. m. examination revealed that it is very closely related to *S. spinosa*, as regards the structure of the scales. Owing to the sparsity of the material at our disposal, we have not been able to discern with complete certainty any particular basal scales without spines, as in other forms of *S. spinosa*. Provided Nygaard's drawing is correct (l. c. fig. 72 bis), such scales are not to be expected, either. It seems as if all the scales are more or less alike and have spines.

Most of the scales in our preparations appeared more or less crushed. An intact scale (table III, fig. e) showed the following measurements:

L. 5.2 μ, br. 3.4 μ. Upturned edge 0.7 μ broad, reaching upwards two-thirds from base. Front surface provided with mesh-pattern ribs forming hexagonal meshes (0.25 μ in diam.); each mesh covered by a membrane with a round hole (0.05 μ in diam.).

Rear part smooth with round holes 0.15 μ in diam., surrounded with a thickened border. Holes arranged in somewhat irregular rows, ca. 4 in 1 μ.

Spine 2.7 μ long, 0.7 μ broad at base, 0.35 μ broad at top. Point truncated abruptly with up to 7 teeth. Spine appears rather thick-walled and stiff.

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Diagnoses formarum novarum.

Synura spinosa Korsh. f. *mollispina* n. f.

A f. spinosa differt tota facie plana reticulatim costata spina molli, sicca collabente, denticulis binis terminata.

Synura spinosa Korsh. f. *longispina* n. f.

A f. spinosa differt spina longiore, obtusa, edentula, minus rigida.

Synura spinosa Korsh. f. *spinosa.*

Spina longa, rigida, denticulis ternis terminata, facie plana in parte anteriore modo reticulatim costata, ceterum foraminibus minutis perforata insignis.

Synura spinosa Korsh. f. *Nygaardii* n. f.

A f. spinosa differt spina breviore, apice truncata, denticulis usque ad 7 terminata.

Synura spinosa Korsh. f. *curtispina* n. f.

A f. spinosa differt spina breviore, crassiore, apice rotundata, denticulis ternis terminata.

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Plates.

All figures are from shadowcast preparations, except plate IV a. Enlargement: 14.400 ×, except Plate IV b and Plate V and VI.

Plate I.

Synura Petersenii Korsh. a. apical scale, b. apical scale, c. basal scale.

Synura glabra Korsh. d. apical scale, e. basal scale.

Synura echinulata Korsh. f. apical scale, g. middle scale, h. basal scale.

Plate II.

Synura uvella Stein. a. apical scale, b. basal scale.

Synura spinosa Korsh. f. *spinosa* n. f. c. apical scale, d. basal scale.

Plate III.

Synura spinosa Korsh. f. *curtispina* n. f. a. apical scale. b. basal scale.

Synura spinosa Korsh. f. *longispina* n. f. c. apical scale, d. basal scale.

Synura spinosa Korsh. f. *Nygaardii* n. f. e. apical scale.

Plate IV.

Synura spinosa Korsh. f. *mollispina* n. f. a. apical scale.

Synura spinosa Korsh. f. *curtispina* n. f. b. part of colony, Kathale bog Nov. 12, 1955. Mordanting and staining after Vilh. Jensen (cfr. Boye Petersen & Hansen 1954, p. 285). Light microscope 1650 ×. Note the two kinds of flagella: the long flimmer-flagella, and the shorter, smooth whip-lash flagella, and scales. Phot. E. Tellerup.

Plate V.

Stereoscopical pictures. Upper: Scales of *Synura Petersenii* Korsh. Lower: Scales of *Synura spinosa* Korsh. f. *spinosa* n. f. The scales are partly broken.

Plate VI.

Stereoscopical pictures. Upper: Scales of *Synura uvella* Stein, partly broken. Lower: Single intact apical scale of *Synura spinosa* Korsh. f. *spinosa* n. f.

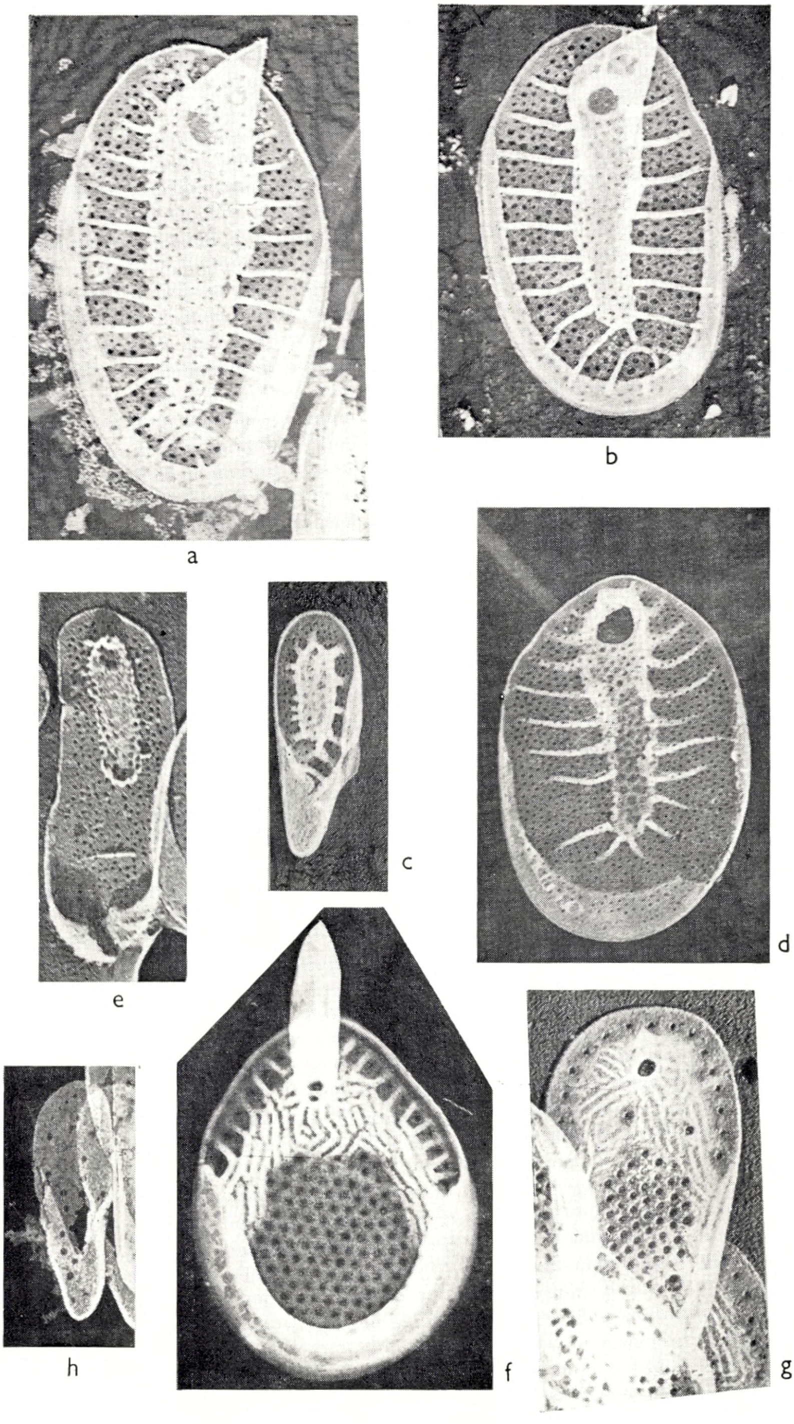
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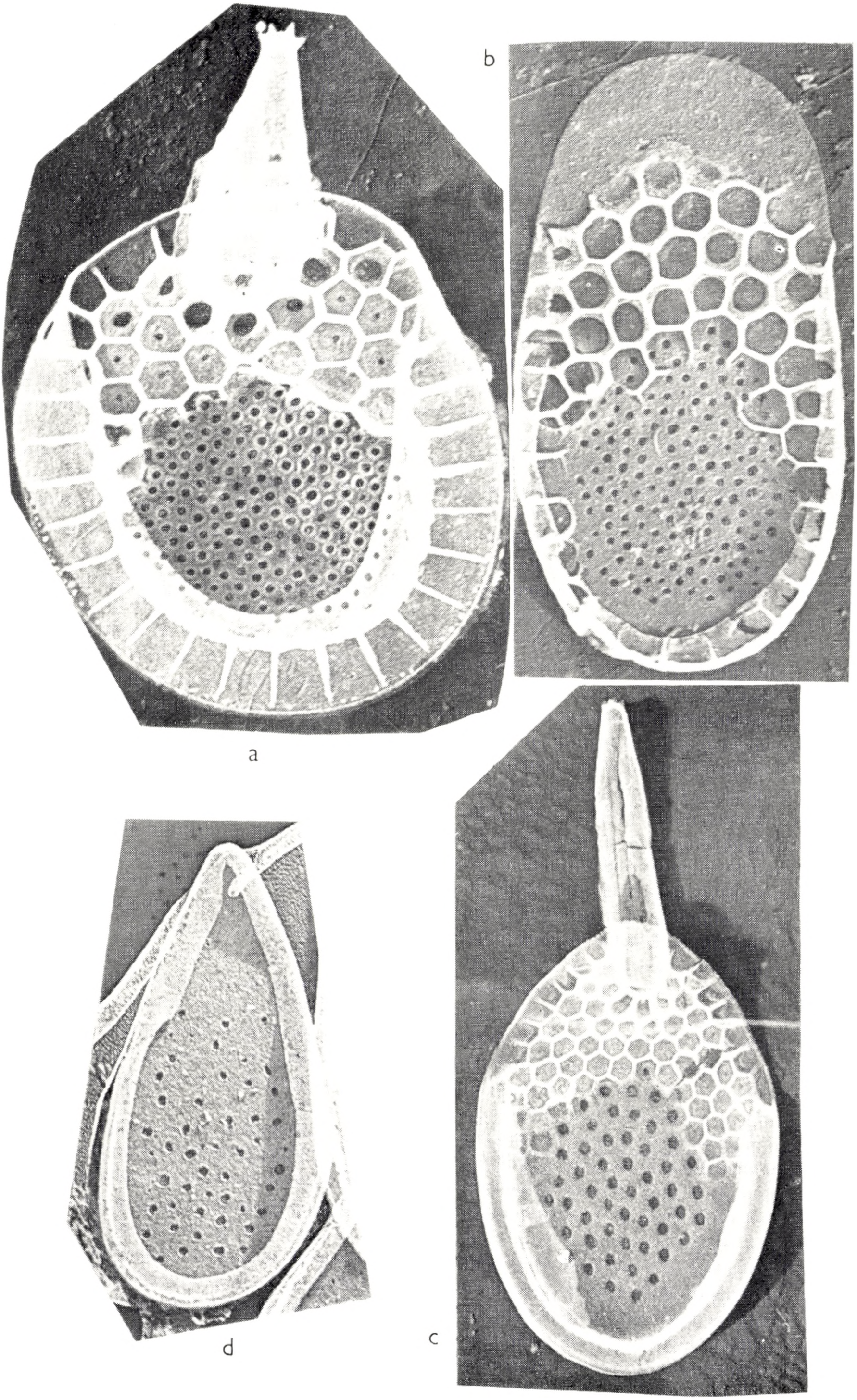
Plate II.



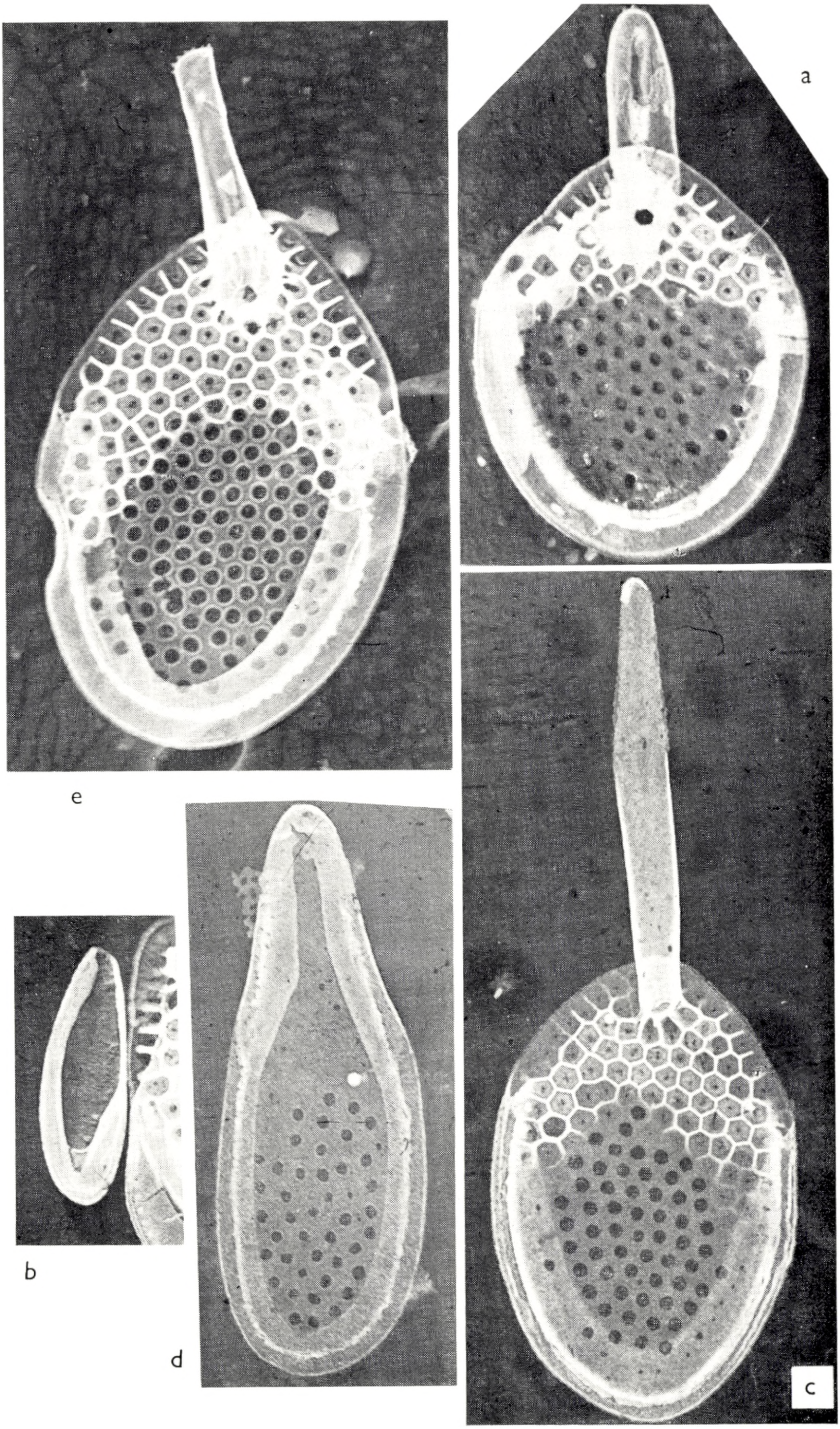

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Plate IV.

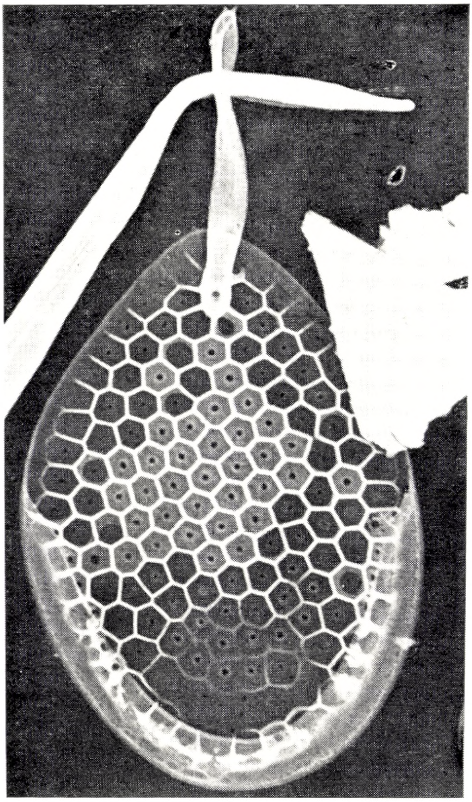

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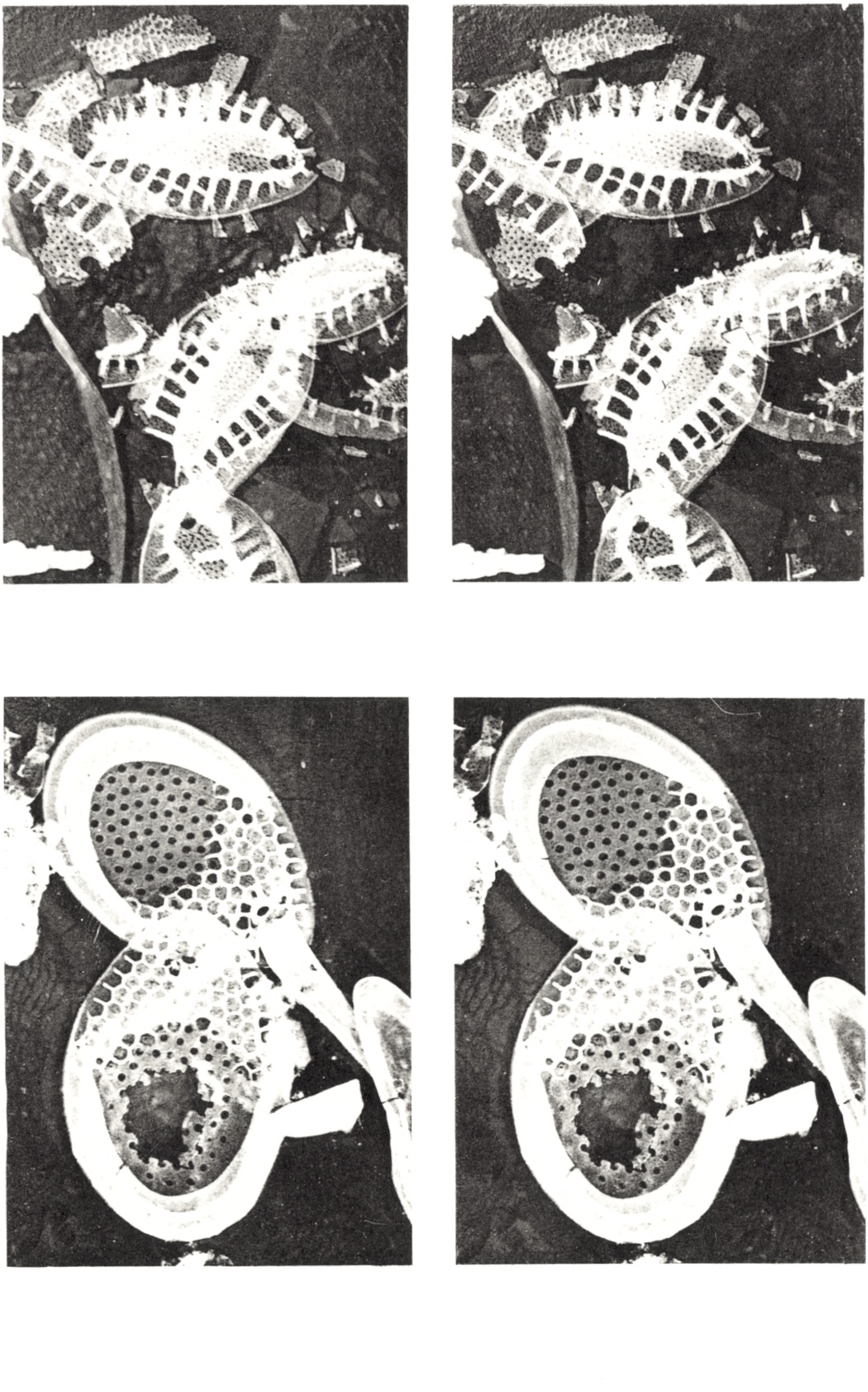
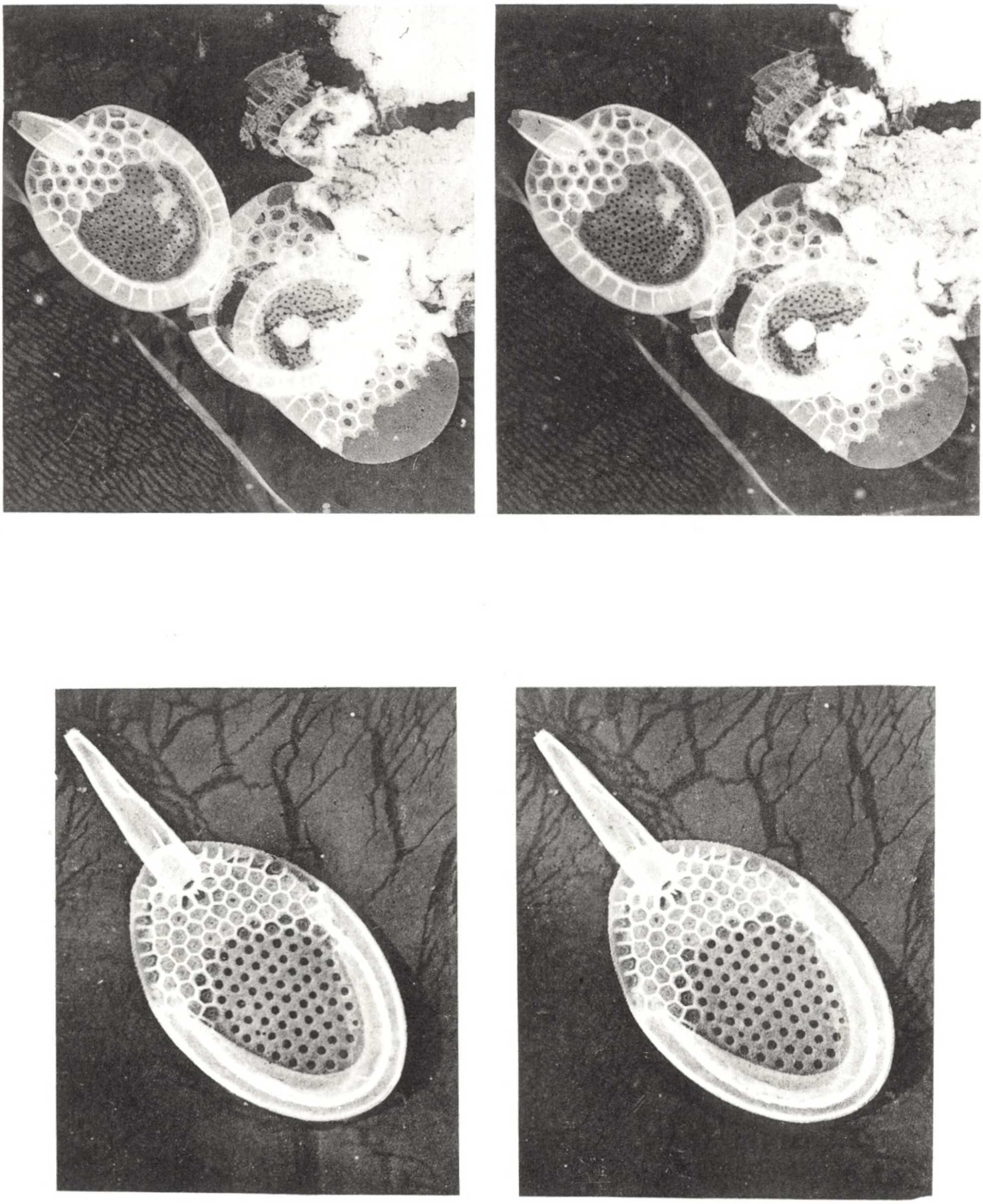
PLATE V.





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