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The distribution and variation of Synura species (Chrysophyceae) in Connecticut, USA

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The genus *Synura* was found to be an important member of the phytoplankton communities in many Connecticut lakes, present in more than fifty percent of the 113 collections made during 1984. Thirteen taxa, including a new forma, *Synura petersenii* f. *truttae,* were recorded for the first time in Connecticut waters using SEM. *S. petersenii* was the most important species, present in forty-one percent of the samples. Evidence for denoting *S. petersenii* var. *glabra* as a form, instead of a variety, is presented. Ecological preferences for some species are discussed.

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Introduction

Although the genus *Synura* was first described by Ehrenberg in 1833 (published in 1835), it was not until 1878 that Stein presented the first useful description of the type species, *Synura uvella.* Korshikov (1929) was the first scientist to use scale morphology to differentiate between *Synura* species and since then it has been considered necessary for accurate species descriptions (Huber-Pestalozzi 1941; Petersen & Hansen 1956; Fott & Ludvik 1957; Bourrelly 1957; Kristiansen 1975; and Takahashi 1978).

Since the mid-1950's electron microscopy has become essential for the proper identification of scaled chrysophytes (Wee 1981) and 24 *Synura* taxa have been described with EM to date (Nicholls & Gerrath, in press).

Even though Kristiansen (1971) and Cronberg (1972) introduced SEM as a tool to identify scaled chrysophytes most studies have utilized TEM only. In this study 12 *Synura* taxa, including a new form, are described from Connecticut lakes by means of SEM. These represent the first records of *Synura* species identified with EM in Connecticut and New England waters. Taxonomical and ecological issues are discussed.

Materials and methods

A total of 113 samples were collected from 33 water bodies during 1984 (Tab. 1). Plankton net samples (10 and 63 µm mesh) and water samples were collected from either 1 m at the center of the lake (or pond) or from 0.5 m along shore. Two hundred ml from each water sample were concentrated with centrifugation for 8 minutes at 2000 rpm on the day of collection. Half of each net and centrifuged sample were preserved with Lugol's solution and the remainder refrigerated.

The live refrigerated samples were observed with the light microscope within 48 hours (and in most cases within 24 hours) from collection. For collections not observed within 24 hours, the preserved samples were also analyzed. One ml portions of each concentrated sample were dried onto glass cover slips and a piece of aluminum foil and gently rinsed with distilled water 2 to 4 times to remove excess salt. This method insured in most cases that whole tests or groups of scales would be found. It was found that no scale types were lost with this gentle rinsing technique.

Burnt mounts (Wee 1983), observed at 1000× with phase and Hoffman optics, were used to substantiate

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Tab. 1. The distribution of *Synura* taxa in Connecticut lakes. Figures indicate the number of times each taxon was found in the Connecticut Chrysophyte Survey during 1984. *Synura* abbreviations: peter = *petersenii;* echin. = *echinulata;* spin. = *spinosa;* sphag. = *spagnicola;* lapp. = *lapponica.* Letters denote the various forms: P=f. *petersenii;* G=f. *glabra;* Pr=f. *praefracta;* K=f. *kufferathii;* B=f. *bjoerkii;* T=f. *truttae;* L=f. *longispina;* Le=f. *leptorrhabda;* S=f. *spinosa;* E=f. *echinulata.*

			Synura			
Lake, Town, no. of Samples	peter.	echin.	spin.	uvella	sphag.	lapp.
Bigelow Pond, Union - 11	9P 1G	1E	5S 1L	3	3	2
Break Neck Pond, Union - 7	5P 1B	2E	3S			1
Chamberlain Lake, Woodstock - 7	2P 1Pr	3E		1		
Black Lake, Woodstock - 7	4P 1K					
Forest Lake, New Fairfield - 10	2P 2Pr	4E	1S	1	1	
Kenosia, Danbury - 8	2P			1		
Crystal Lake, Ellington - 5	1P	1E	1S			
State Line Pond, Stafford - 1	1P	1E				
West Lake, Danbury - 2	1P			1		
Dog Pond, Goshen - 4	1P	1E	1S			
Westside Pond, Goshen - 4	1P 1K	3E				
Tyler Lake, Goshen - 4	3P			1		
Indian Pond, Sharon - 1	1P					
Morse Meadow Pond, Union - 1			1S			
Fullers Pond, Kent - 2				1		
Waubeeka, Danbury - 14	2P			1		
Break Neck Pond Swamp, Union - 2		1E				
Trout Pond, Grandby - 2	2T					
Spring Pond, Grandby - 1	1P					
Emmons Pond, Hartland - 1	1G	1Le			1	
Total no. occurrences	46	18	13	10	5	3
Total no. lakes	17	10	6	8	3	2
% of samples taxon found in	41	15	12	9	4	3

Lakes lacking *Synura* populations (Lake, Town, no. sampling trips): East Twin, Salisbury - 3; Wonoscopomuc, Salisbury - 3; Shinipset, Ellington, Tolland, Vernon - 2; Waramaug, Warren, Kent, Washington - 2; Candlewood, Danbury, New Fairfield, Sherman, New Milford, Brookfield - 1; Taunton, Newtown - 1; Mount Tom, Litchfield, Washington - 1; Bantom, Litchfield, Morris - 1; Majorie Resevoir, Danbury, New Fairfield - 1; Riga, Salisbury - 1; Canoebrook, Trumbull - 1; Bog Meadow, Sharon - 1; Ford, Salisbury - 1.

the presence of *Synura* taxa and for attempting to identify each to the species level. For SEM, the aluminum foil sample was trimmed, mounted onto an aluminum stub with apiezon wax, coated with gold for 4.5 minutes using a Polaron sputter and observed with a Coates and Welter scanning electron microscope at 15 to 20 kv.

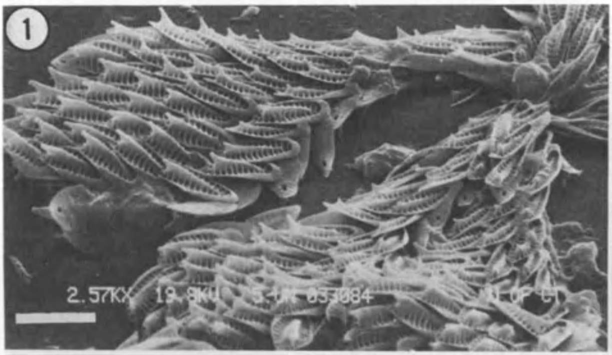
In over 95% of the samples where *Synura* taxa were observed with light microscopy identifications were made with SEM. Only observations where whole tests, groups of scales or scattered scales were found were used in determining percent occurrence. Single isolated scales found with SEM were noted but not used in percent occurrence calculations. Even though the plankton nets were thoroughly rinsed between collections it is possible that these isolated scales were the result of contamination. However, in most instances single scales were believed to be remnants of past populations.

Results

Synura petersenii Korshikov

Cells were arranged in spherically shaped colonies, oblanceolate to pyriform in shape with rounded anterior portions and an extended stalked posterior (Fig. 1). Scales consisted of a centrally raised hollow spine positioned on a perforated basal plate, struts that ran perpendicular from the spine to the scale border, an upturned rim on the posterior half of the cell and a large pore in the base plate beneath the distal portion of the

Fig. 1. *Synura petersenii* f. *praefracta.* Whole cell morphology showing scale arrangement and distribution (bar = 5 µm). – Figs 2–5. *Synura petersenii* f. *petersenii.* – Fig. 2. Close up of posterior portion of a cell showing elongated scales with blunt spines (bar × 2 µm). – Fig. 3. Elongated posterior scales (bar = 2 µm). – Fig. 4. Body Scales. Note the large well defined spines (bar = 2 µm). – Fig. 5. Body scales. Note the pore in the base plate (bar = 2 µm). – Figs 6–7. *Synura petersenii* f. *kufferathii.* – Fig. 6. Note well developed spine and the ribs running perpendicular to and connecting adjacent struts (bar = 1 µm). – Fig. 7. Body scales with ribs connecting adjacent struts and bumps on the raised hollow central area (bar = 2 µm). – Fig. 8. *Synura petersenii* f. *praefracta.* Body scales with blunt spines possessing teeth. Upside down scale is of *Mallomonas multiunca* (bar = 1 µm).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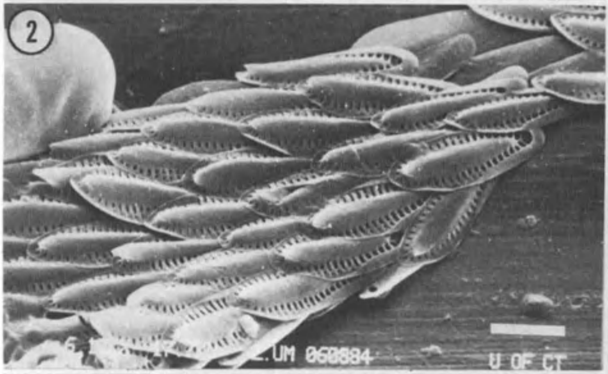
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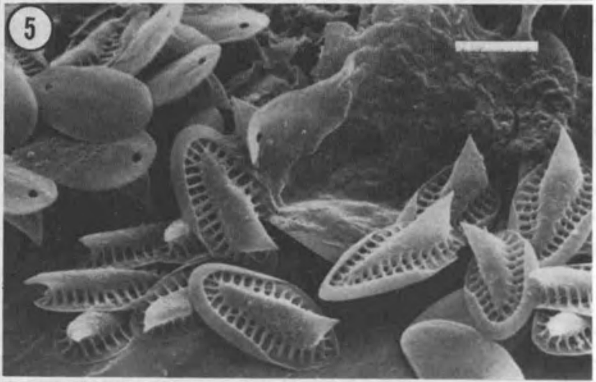
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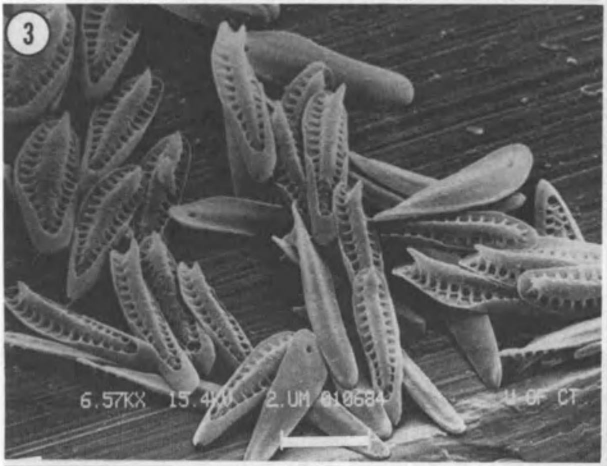
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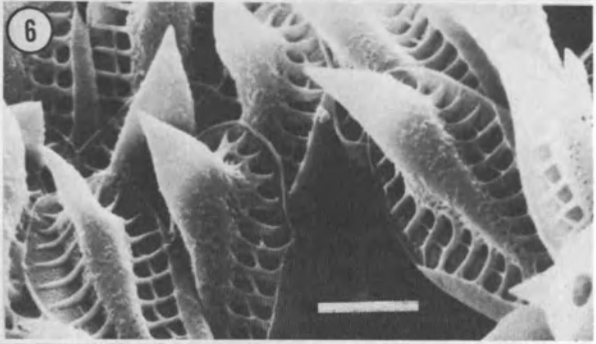
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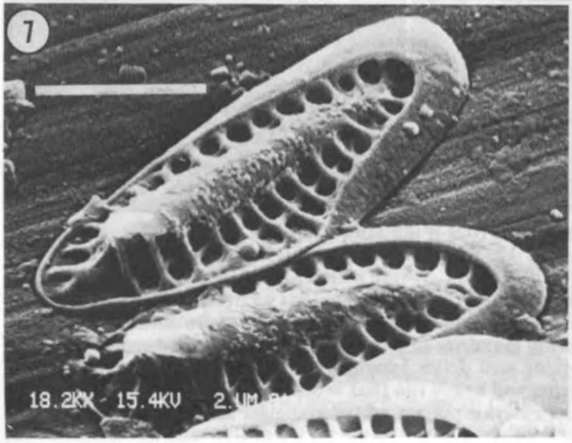
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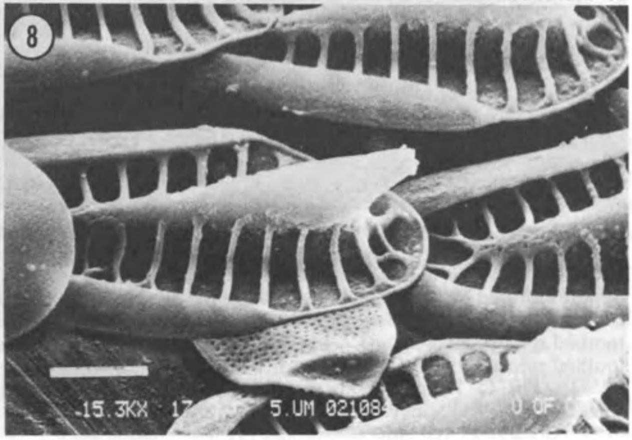
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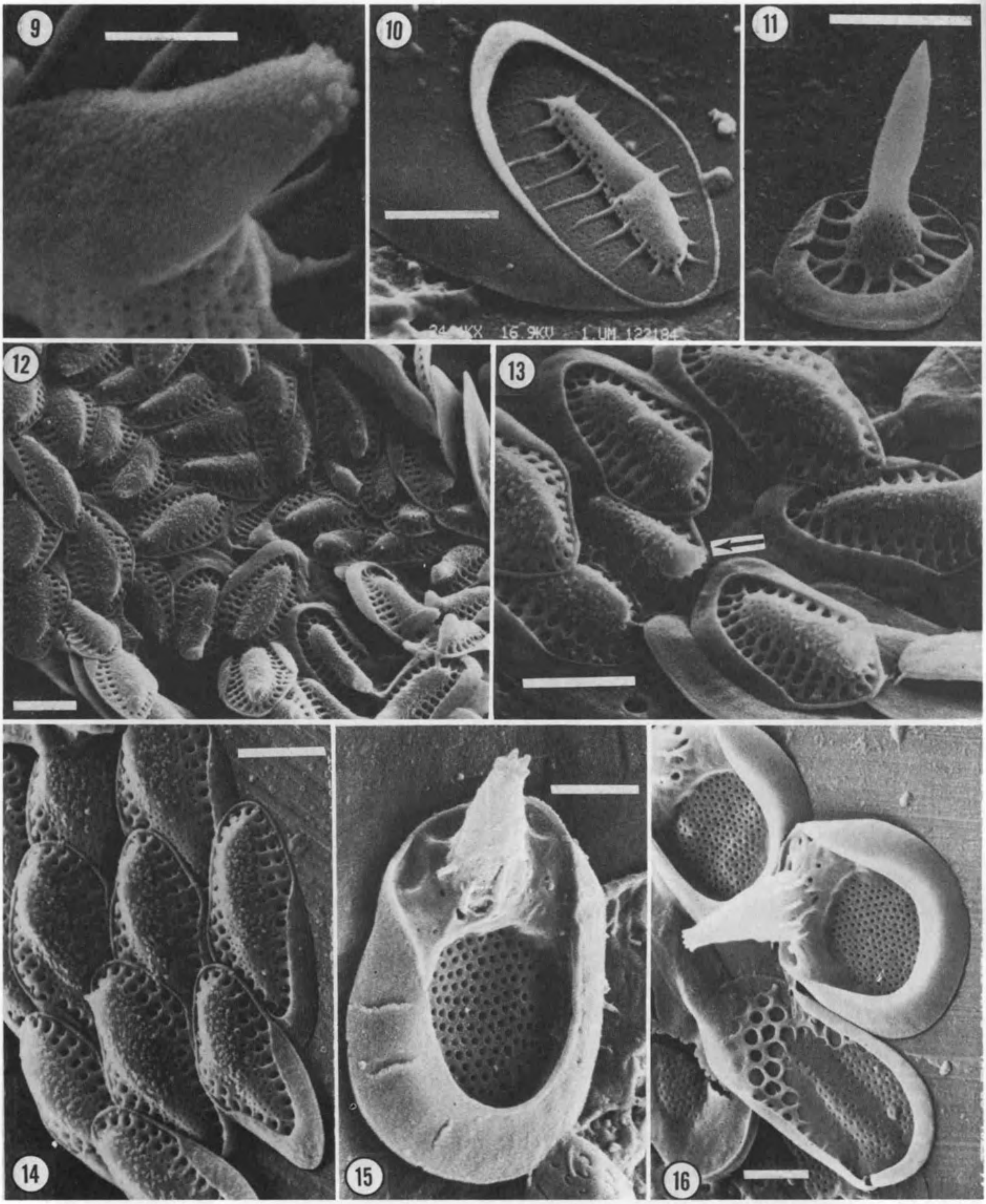


Fig. 9. *Synura petersenii* f. *praefracta.* Close up of spine tip showing the teeth (bar = 0.5 µm). – Fig. 10. *Synura petersenii* f. *glabra.* Body scale with struts not radiating to the perimeter (bar = 1 µm). – Fig. 11. *Synura petersenii* f. *bjoerkii.* Short oblong body scale with stout spine. Note that several struts have furcated (bar = 2 µm). – Figs 12–14. *Synura petersenii* f. *truttae.* – Fig. 12. Note rows of pores formed by the fusion of thick struts to equally thickened perpendicular ribs, and the bumps scattered on the raised hollow central area. Scales in the upper left are from the posterior region of the cell while those in the lower right are anterior scales with toothed spines (bar = 1 µm). – Fig. 13. Close up of body scales showing the series of pores, bumps on the raised central area and toothed spines (arrow) (bar = 1 µm). – Fig. 14. Posterior scales lacking well defined spines (bar = 1 µm). – Figs 15–16. *Synura uvella.* – Fig. 15. Anterior body scale with stout, conical, toothed spine and heavy rim (bar = 1 µm). – Fig. 16. Spined (top) and spineless (bottom) scales. Note the lack of a secondary cover on the anterior portion of the spineless scale (bar = 1 µm).

spine (Figs 1 to 6) (Petersen & Hansen 1956; Asmund 1968; Takahashi 1978 and Wee 1982). The spine projected forward and upward and extended up to or slightly past the front of the scale. Scale shape varied depending on the position on the cell (Fig. 1). In general, scales became more slender and elongated towards the posterior (caudal) portion of the cell (Figs 2 and 3).

Synura petersenii was by far the most common *Synura* taxon, being found in 17 lakes and 41% of the collections (Tab. 1). It was present in all lakes sampled on 4 or more occasions. Although populations were found during each month of the year they were more common and concentrated (formed a greater percentage of the phytoplankton population) from November through March.

Half of the *S. petersenii* populations had scale ornamentation characteristic of the forma *petersenii* (Figs 2–5). Posterior scales usually had spines which were not as raised as on anterior scales and were either pointed or blunt in nature (Figs 2 and 3). In some populations bumps were randomly scattered on the raised hollow area (Fig. 7). Spine size (height above the base plate) was greatest on scales from a population present in Black Lake from July, 1984 through November, 1984 (Figs 4 and 6). In July, a few scales on each cell had short ribs that ran parallel to the spine axis and connected adjacent struts (Fig. 4), a feature characteristic of the forma *kufferathii* Petersen & Hansen (1958). By November the majority of the cells had scales with connecting ribs and the population was designated as *Synura petersenii* f. *kufferathii* (Fig. 6). The increased percentage of ribbing was gradual over time and the distinction between f. *petersenii* and f. *kufferathii* was difficult to make. In other collections where the majority of scales had ribs running perpendicular to and connecting the struts the cells were determined as *S. petersenii* f. *kufferathii* (Fig. 7).

Three populations of *Synura petersenii* f. *praefracta* Asmund characterized by scales with cylindrical, blunt, and toothed spines, were found during the study (Figs 1, 8 and 9; Tab. 1). According to Asmund's (1968) original description spines on anterior scales strongly overlapped the rim of the base plate while those on posterior scales were more like f. *petersenii,* lacking the small teeth and ending with an acute tip. In the populations found during this study spines projected past the distal portion of the scale only slightly and only on the anterior part of the cell (Fig. 1). On most scales spines were pronounced and protruded upward but not past the rim. Spines on posterior scales also had toothed tips and projected almost perpendicular from the base plate (Fig. 1). Many spines had 12 to 14 teeth (Fig. 9).

Synura petersenii f. *glabra* (Korsh.) Huber-Pestalozzi, distinguished from f. *petersenii* by having scales lacking struts or with ones that do not reach the scale perimeter, was found once during the study (Fig. 10 and Tab. 1). There were two instances when isolated scales on a given cell of f. *petersenii* resembled those of f. *glabra.* One population of *S. petersenii* f. *bjoerkii* Cronberg & Kristiansen, characterized by short oblong scales with stout and acute spines, was found (Fig. 11 and Tab. 1). Most of the scales from the f. *bjoerkii* population had a few struts that furcated (Fig. 11).

Two populations were found with a unique combination of scale features and are proposed as a new forma:

Synura petersenii Korshikov f. truttae Siver nov. f.

A f. *petersenii* differt squamis parvis oblongisque (2.2–3.5 μm × 1.5–2.0 μm magnis); spiculis brevibus, dentibus hebetibus terminatis; fulcris spissis crassis inter se costis spissis junctis, una reticulum formantibus foraminibus rotundatis. Pars centralis squamae elevata tuberibus dispersis ornata. Pleraeque squamarum medianarum posteriorumque partem centralem rotundam praebentes, spinis veris destitutae.

Speciminis locus est Trout Lake, in MacLean Wildlife Preserve, Granby, CT, in Provinciis Foederatis Americae Septentrionalis, m. Nov., a. 1985. Iconotypus figurae 12.

S. petersenii f. *truttae* differs from f. *petersenii* in having small oblong body scales (2.25–3.5 μm × 1.5–2.0 μm) similar in outline to *S.* f. *bjoerkii;* anterior scales with cylindrical, blunt spines terminating in several teeth as in f. *praefracta* (Figs 12–13); posterior scales with rounded central keels and lacking spines, a characteristic common to *S. petersenii* f. *bonaerensis* Vigna (Fig. 14); and heavily silicified struts connected to one another by one and often two parallel ribs as in f. *kufferathii* (Figs 12–14). The network of struts and ribs formed series of large pores, a feature also present in f. *bonaerensis.* In addition, scales had bumps randomly scattered on the centrally raised area.

S. petersenii f. *truttae,* a dominant member of the phytoplankton community in Trout Lake during November, 1984 was found with other members of the Chrysophyceae *(Mallomonas caudata, Mallomonas tonsurata, Mallomonas crassisquama, Dinobryon bavaricum* and *Chrysosphaerella longispina),* Bacillariophyceae (*Melosira ambigua, Tabellaria fenestrata, Rhizosolenia* sp. and *Synedra* sp.), and Cryptophyceae (*Cryptomonas* sp.).

Synura uvella Stein em. Korshikov

Cells of this species have spined anterior scales and non-spined posterior scales (Figs 15–16). Anterior spined scales are almost circular in outline except for a straight distal portion. A heavy rim encircles all but the distal portion of the scale and is supported by a series of struts attached to the base plate (Petersen & Hansen 1956, Wee 1982). The outline of struts under the rim, easily seen with TEM, were revealed with SEM on several scales in each population or observed directly on damaged scales. The spine, attached on the anterior portion of the scale, is short, stout, conical in shape and ends with teeth. Wee (1982) stated that the reticulated anterior portion of the scale sometimes may be partly or totally obscured by a secondary cover. In all populations encountered during this study such a secondary layer was present on spined scales, lacking on spineless scales (Fig. 16).

S. uvella was found in 9% of the samples and in 8 lakes (Tab. 1) but was a common member of the phytoplankton community in only 3% of the samples (unpubl. data).

Synura lapponica Skuja

Scales consisted of an oval perforated base plate completely surrounded by an upturned rim and with a central papilla (Figs 17–18). The papillae were columnar with a slightly expanded base (Fig. 17) or spherical (Fig. 18). Smaller posterior scales often lacked papillae (Fig. 17).

S. lapponica was rare, only found in two lakes during the study (Tab. 1). Although isolated scales have previously been recorded from North America (Whitford & Schumacher 1969; Munch 1980) this represents the first time live *S. lapponica* colonies have been found.

Synura echinulata Korshikov

Anterior scales have a raised thickening on the distal end beneath which lie a series of vermiform ribs (Figs 19–21) (Wee 1982). A set of straight, short ribs lies in front of the thickening and runs perpendicular to the scale perimeter (Fig. 19). A single pore may be found between each pair of ribs. On anterior scales spines are rather long, (in this study up to 2.5 μm), slightly curved and tapered to an acute point. The rim generally encircles one-half to two-thirds of the scale (Fig. 19). The area of the shield posterior to the anterior thickening and interior to the rim is furnished with holes that penetrate the base plate (Figs 19 and 22). Posterior scales are elongated with an extended vermiform rib portion and a small spike-like spine (Fig. 21). Extreme caudal scales may lack spines (Fig. 21).

S. echinulata was the second most important species being present in ten of the study lakes and 15% of the samples (Tab. 1). Variation in scale design was minimal and all but one population were of the f. *echinulata* type. In one collection from Emmons Pond, the most acidic lake in the survey (pH = 4.8), a few scales belonging to *S. echinulata* f. *leptorrhabda* Asmund were found (Fig. 22).

Synura spinosa Korshikov

Scales have a perforated base plate, a rim around the proximal two-thirds portion of the scale, a rather long, blunt spine ending in several teeth and a series of ribs forming a honeycomb reticulation on the distal one-third posterior of the base plate (Figs 23–24). Posterior scales are more pointed, smaller in size and possess shorter spines. Extreme posterior scales are lanceolate – slipper shaped, lack both spines and rib reticulation and have a completely encircling rim (Fig. 24). Elongated tubular apical scales, often reported for *S. spinosa* (Takahashi 1978) were found only in populations from Bigelow Lake.

Both *S. spinosa* Korshikov f. *spinosa* (Fig. 23) and *S. spinosa* f. *longispina* Petersen & Hansen (Fig. 24), distinguished on the basis of the size of the spine, were found in this study. *S. spinosa* f. *longispina* has only been recorded from North America once (Nicholls & Gerrath, in press). *S. spinosa* populations were found in 6 lakes and 12% of the collections (Tab. 1).

Synura sphagnicola (Korsh.) Korshikov

Scales are oval in shape, have evenly spaced perforations on the base plate and possess a long slightly tapered, blunt spine (Petersen & Hansen 1958) (Fig. 25). The rim on each scale encircled at least four-fifths of the perimeter, however, on some scales it completely encircled the perimeter.

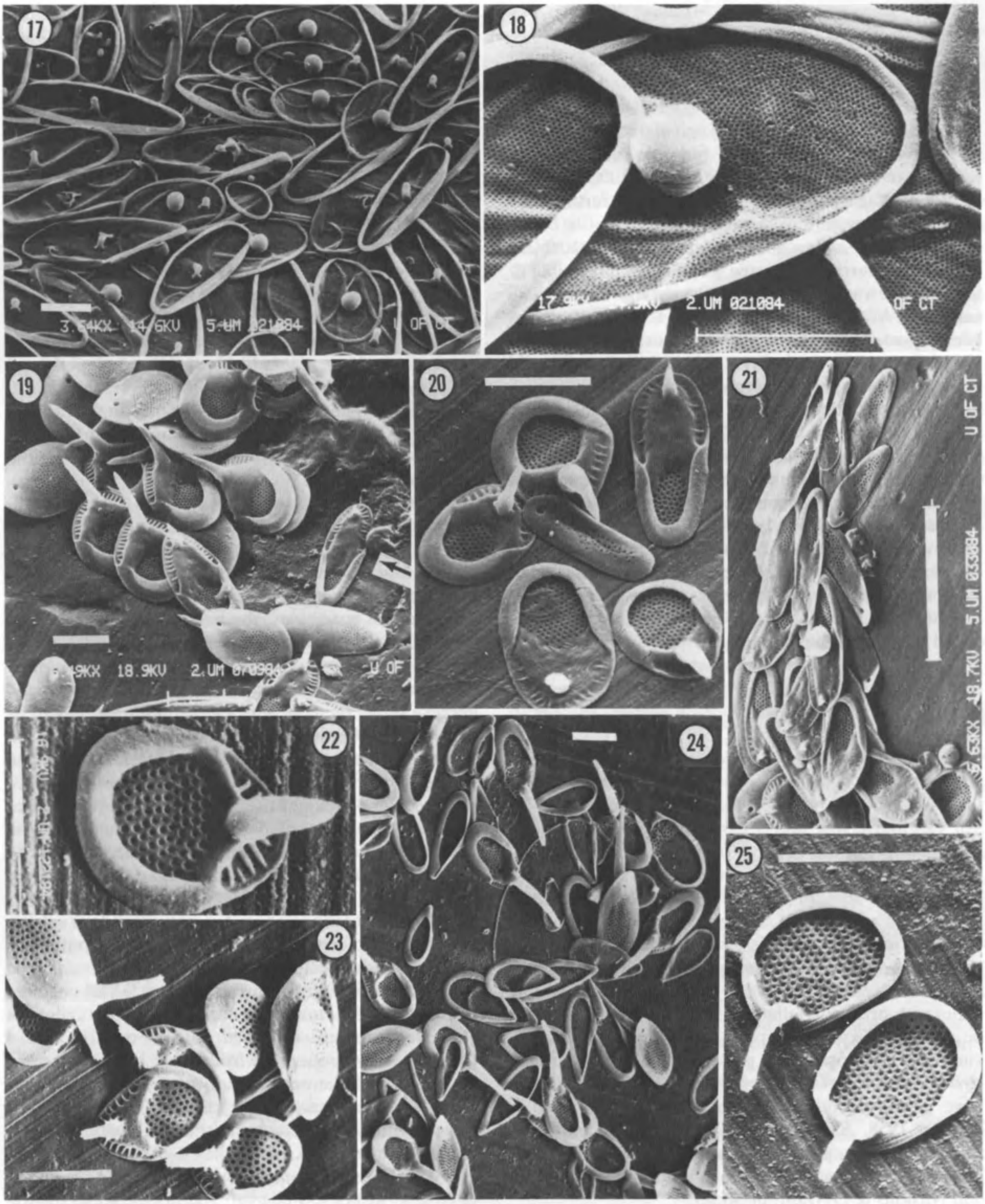
S. sphagnicola was rare in Connecticut waters, being found in only 3 lakes and 4% of the collections (Tab. 1).

Discussion

The genus *Synura* was an important constituent of phytoplankton communities in many Connecticut lakes, being found in 55% of the samples and in 21 of the 34 water bodies surveyed. Because *Synura* species were found in all lakes sampled more than 4 times, it is believed that with further investigation the distribution will be found to span a larger percentage of the water bodies. All descriptions were new records for Connecticut.

Synura petersenii (including all forms) was the most common species in Connecticut lakes and was often found to be one of the dominant phytoplankton members. In most studies from the United States, including reports from Iowa (Wee et al. 1976, Wee 1981), Minnesota (Wujek et al. 1981) and Kansas (Wujek & Weiss 1984), *S. petersenii* was also found to be the most common species. Although these reports represent areas from the Midwestern part of the United States, the present study is the first detailed survey of *Synura* from the northeast. It should be noted that in a study from the southeastern part of the United States (Arkansas), Andersen and Meyer (1977) found *S. curtispina* (Petersen & Hansen) Asmund f. *curtispina* Asmund to be the most common *Synura* taxon.

Although Takahashi (1967) and Kristiansen (1975) found *Synura* to prefer cooler temperatures, both reported that populations could be found throughout the year. This finding was supported in the present study where *Synura* taxa were found during each month of the year, however, in a much larger percentage of the samples from cooler months. In addition, colony concentrations



Figs 17–18. *Synura lapponica*. – Fig. 17. Scales with centrally positioned papilla. Note that several small scales lack the papilla (bar = 3 μm). – Fig. 18. Close up of scale with papilla and perforated base plate (bar = 1 μm). – Figs 19–21. *Synura echinulata* f. *echinulata*. – Fig. 19. Anterior scales with long pointed spines and elongated posterior scales with short spines (arrow) (bar = 2 μm). – Fig. 20. Anterior and posterior (upper right) scales. Note covered vermiform ribbing (bar = 2 μm). – Fig. 21. Elongated posterior scales with short spines. Note that extreme caudal scales lack spines (bar = 5 μm). – Fig. 22. *Synura echinulata* f. *leptorrhabda*. Note the small size and reduced thickened area on the distal part of the cell (bar = 1 μm). – Fig. 23. *Synura spinosa* f. *spinosa*. Body scales with toothed spines (bar = 2 μm). – Fig. 24. *Synura spinosa* f. *longispina*. Anterior scales with long spines and spineless posterior scales with encircling rims (bar = 2 μm). – Fig. 25. *Synura sphagnicola*. Scales with evenly spaced pores and rim (bar = 2 μm).

were often greater in populations found between November and April when temperatures were below 12°C (unpubl. data). This distributional pattern, a wide temperature tolerance but preference for cold water, was found previously by Kristiansen (1975) and in the present study for *S. petersenii*. In addition, *S. petersenii* has been observed at 0° to 10°C (Asmund 1968), 7° to 10°C (Gretz et al. 1983), 0° to 12°C (Siver & Chock 1986) further substantiating its preference for cold water.

Synura echinulata and *S. spinosa* were both found more often during the spring and fall months while *S. sphagnicola* was most common during the summer and early fall. Also, in previous studies, *S. sphagnicola* has been reported to prefer warmer temperatures (Asmund 1968; Kristiansen 1975; Takahashi 1978). *S. uvella* did not exhibit a temperature preference whereas *S. lapponica* here appeared to be a cold water species since it was found only between 1 and 4°C.

Both *Synura echinulata* and *S. sphagnicola* had a distinct preference for humic and acidic waters, occurring at pH values usually between 5.5 and 6.5 and as low as 4.8. *S. echinulata* (Takahashi 1967, Wee 1981, and Smol et al. 1984) and *S. sphagnicola* (Takashashi 1967, Green 1979, Wujek & Hamilton 1972, Kristiansen 1975, Wujek et al. 1981, Wujek & Weis 1984) have previously been reported to prefer acidic waters. In addition, both taxa have been found in humic waters (Asmund 1968, Green 1979, Wujek & Weis 1984). Such acidibiontic species, which may represent the only persistent microalgal fossils in acidic lakes, are being used in acidification studies (Smol et al. 1984).

Populations of *Synura echinulata, S. uvella, S. lapponica* and *S. sphagnicola* all exhibited fairly uniform scale structure. However, a large degree of morphological variability was found among *S. petersenii* and *S. spinosa* populations. Several forms and species and a variety have been separated from both type species, *S. petersenii* and *S. spinosa* (see Tab. 3 in Nicholls & Gerrath, in press, for a summary). The criteria used to distinguish between the ranks of species, variety and formae in *Synura* have been discussed and questioned by Kristiansen (1979). For example, should *S. petersenii* cells possessing scales with struts not radiating all the way to the perimeter be considered a separate species (*S. glabra* Korshikov), a variety (*S. petersenii* var. *glabra)* or as a form *(S. petersenii* f. *glabra)*. Organisms with such a scale structure have recently been reported as *S. glabra* (Petersen & Hansen 1958, Kristiansen 1980). However, most researchers have reported this taxon as *S. petersenii* var. *glabra* (e.g. Balonov 1976, Takahashi 1978, Wee 1982 and Nicholls & Gerrath, in press).

Kristiansen (1979) stated that both *S. petersenii* and *S. glabra* had a similar ecology, were often found in the same localities and that there was a continuous transition between the two extreme scale types. He further questioned how a variety, the rank given to this taxon by most workers, was defined. In an in depth study Takahashi (1967) also found a continuous transition between *S. petersenii* f. *petersenii* and var. *glabra* scale types in the same pond and suggested that the change represented cyclomorphosis.

It is my opinion that the distinctions between the type, *S. petersenii* f. *petersenii,* and f. *kufferathii,* f. *praefracta,* f. *asmundiae,* f. *bjoerkii* and f. *truttae* are of equal or greater magnitude to those between the type and var. *glabra.* Some of the characters used to separate the forms from the type were more stable than those used to distinguish var. *glabra.* For example, in this study all *S. petersenii* f. *praefracta* cells had scales with toothed spines and were never found associated with the typical spined scale type. On the other hand var. *glabra* type scales were commonly found on *S. petersenii* f. *petersenii* cells. The association of var. *glabra* like scales among f. *petersenii* scales has been reported in previous studies (Andersen & Meyer 1977, Kristiansen 1979, Nicholls & Gerrath, in press). It is thus suggested that spines with teeth is a more stable characteristic than whether the struts reach the scale perimeter.

Denoting var. *glabra* as a variety or as a separate species *(S. glabra)* implies a genetic difference and suggests that organisms forming f. *petersenii* like scales could not produce var. *glabra* like scales. If progeny were able to form either scale type, depending on environmental or physiological conditions, the two types should be considered at the forma level. Nicholls and Gerrath (in press) found coexisting populations of f. *petersenii* and var. *glabra* where scale types were not integrated and suggested that the taxa were valid entities and should be separated at the variety level. They further pointed out that although var. *glabra* like scales have been found on f. *petersenii* cells, f. *petersenii* like scales have not been reported on whole cells of var. *glabra.* In the present study a population of *S. petersenii* was observed in Chamberlain Lake over a four month period. During the first two months all colonies had cells with f. *petersenii* type scales. However, during the third and fourth months cells had both f. *petersenii* and var. *glabra* type scales. Colonies isolated during the first month were found to produce cells with *S. petersenii* f. *petersenii* type scales when initially transferred into DYIII medium (Lehman 1976). However, older cultures had cells with var. *glabra* type scales (unpubl. data). It could be argued that the observations made from the field populations in Chamberlain Lake were actually of two separate organisms. However, based on the initial culture work, some *S. petersenii* f. *petersenii* organisms are capable of forming *glabra* like scales.

If a *S. petersenii* f. *petersenii* population were stimulated to switch to forming var. *glabra* type scales the following situations could occur:

1. If the switch (i.e. the ability to form var. *glabra* like scales) occurred at the same time that new colony formation ceased, the population would remain all *S. petersenii* f. *petersenii* type colonies.

2. If the switch occurred towards the latter part of the populations growth but prior to the end of new colony

formation, then colonies with some or all var. *glabra* like scales would be expected. If the switch was triggered quickly it could explain the coexistence of both *S. petersenii* f. *petersenii* and *S. petersenii* var. *glabra* colonies as reported by Nicholls and Gerrath (in press).

3. If the switch occurred early in the growth of the population but long before termination of new colony formation only var. *glabra* like colonies may be found.

In summary, because the characteristics used to separate the forms are of equal or greater magnitude to those used to differentiate var. *glabra* and that some *S. petersenii* f. *petersenii* cells can produce progeny capable of forming var. *glabra* like scales I feel that var. *glabra* should be recognized at the forma level. This option has been followed in this paper.

In this survey, the distinction between f. *petersenii* and f. *kufferathii* was also sometimes difficult to make (e.g. in Black Lake) and many f. *petersenii* cells had scales with a few ribs connecting adjacent struts. Based on these observations I feel f. *kufferathii* is also a true form. On the other hand, f. *praefracta* populations were always stable and always found only with its typical spine indicating that it may be based on a genetic difference. If so, this taxon should be raised to variety or species rank. Only three populations of f. *praefracta* were found, none of which persisted for extended time periods. Thus, I do not feel I have enough data to make such a change, however, I suggest that when f. *praefracta* populations are found they be closely examined so that this problem can be solved. Similarly, with further observation the remaining forms, including f. *truttae,* may be found to be conservative and stable suggesting that they too be raised to variety (or species) level.

If a newly described organism appears to have stable features that are distinct from the type species, but, has not been found enough to show the effect of the environment on its morphology, a dilemma exists as to whether the taxon be treated as a form or variety. In the past such *Synura* taxa have usually been described as forms (although many are now recognized at the species rank).

Scales from *S. petersenii* f. *truttae* possessed a unique combination of features and based on the present taxonomy of the genus has been given status as a new forma. Forma *truttae* is similar to *bjoerkii* in shape, *praefracta* in spine detail and *kufferathii* in having ribs running perpendicular to and connecting adjacent struts. Forma *truttae* appears to be closest in morphology to f. *bonaerensis* because of the series of pores formed by the heavy silicified strut-rib network and the lack of spines on posterior scales. However, because of the presence of blunt spines with teeth and the bumps on the raised hollow area, characteristics not distinguishable in the original photos or mentioned by Vigna (1979) in the original description, the two are considered different at the form level.

Including *S. petersenii* f. *truttae* 25 taxa are now known from electron microscopy. Only 2 of the 25 taxa, *S. petersenii* f. *bonaerensis* and *S. punctulosa* Balonov, have not been reported from North America (see Nicholls & Gerrath, in press, Tab. 3 for a review).

In the present work little difficulty was encountered in identifying *Synura* taxa with SEM and not with TEM. There are, however, several species where caution must be exercised. Some isolated scales of *S. uvella* could be confused with those of *S. spinosa* if the struts under the upturned rim could not be seen. The vermiform ribs on apical scales of *S. echinulata* are only barely visible with SEM and the extent of the honeycomb reticulation on the shields of some scales (e.g. *S. spinosa*) may be difficult to determine. In such cases other features such as scale shape, thickness and detail of the spines and the structure of the spineless scales, can also be used to substantiate the identifications. Since SEM offers a better view of scale surface detail, whole cell morphology, and scale orientation and attachment than TEM, it should be further utilized in scaled chrysophyte studies.

During this investigation four *Synura* populations with elongated ellipsoidal shaped colonies were observed. In each case they were identified with SEM as *S. spinosa.* Bradley (1966) and Takahashi (1967, 1978) found similar shaped colonies which were also verified as *S. spinosa* with EM. Other *Synura* species have been illustrated as being able to form rectangular shaped colonies (Huber-Pestalozzi 1941), however, because they were not confirmed with EM the validity remains questionable (Wee 1981).

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