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DESMIDS OF THE *STAURASTRUM TETRACERUM*-GROUP FROM A EUTROPHIC LAKE IN MID-WALES

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Seven desmids have been found in the phytoplankton of a markedly eutrophic lake in mid Wales. All have grown well in laboratory cultures and so an opportunity has been provided to explore the taxonomy and morphological variability of four species, *Staurastrum tetracerum*, *S. irregulare*, *S. bibrachiatum* and *S. pseudotetracerum*, previously described inadequately. Suggestions for nomenclatural changes are made for *S. irregulare* and the very variable *S. bibrachiatum*, which is recorded from the British Isles for the first time. Reasons for the occurrence of the seven desmid species in the eutrophic lake plankton are discussed.

Llandrindod Wells Lake is an artificial impoundment, constructed in 1870 on the edge of the resort town of Llandrindod Wells in Powys, mid-Wales and is now maintained as a carp sport-fishery. It was formed by damming the outflow of a marsh and the basin made impervious by clay puddling. The lake is roughly elliptical with a maximum length 358 m, breadth 271 m, and a surface area of 6798 m^2. It has a maximum depth of less than 2·0 m and an average depth of only 1·04 m. The water retention time has been calculated to be in the region of 1 month, so that there would seem to be no possibility of plankton "wash-outs" (Brook & Woodward, 1956). Throughout the year there is an abundant phytoplankton population, this despite the fact that light penetration values are extremely low (e.g. 1% transmission at 0·9 m and Secchi disc readings of only 36–41 cm) due to high turbidity resulting from suspended solids derived from the clay bed of the lake.

Blue-green algae (Cyanobacteria) dominate the phytoplankton with *Lyngbya limnetica* Lemm. being most frequent, but also present are *Oscillatoria redekii* Van Goor, *Anabaena flos-aquae* (Lyngb.) Bréb., *Aphanizomenon flos-aquae* (L.) Ralfs and *Microcystis aeruginosa* Kütz. emend. Elenkin. Chlorococcales of the genera *Scenedesmus*, *Tetraedron*, *Pediastrum*, *Ankistrodesmus*, *Tetradesmus*, *Coelastrum*, *Crucigenia*, *Micractinium*, *Lagerheimia* and *Oocystis* are always present, as are species of the Euglenophyta of the genera *Euglena*, *Phacus*, *Lepocinclis* and *Trachelomonas*. The presence of these phytoplankters and the filamentous centric diatom *Melosira granulata* var. *angustissma* Müll. are unmistakable indicators of the lake's pronounced eutrophy.

The considerable summer biomass of phytoplankton is indicated from chlorophyll *a* determinations which have been found to range from 27·7 to 83·3 μg l^{-1}

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with an average value of 58·2 $\mu g\ l^{-1}$, and by the fact that although alkalinity values are only moderate (17·5–29·0 $mg\ l^{-1}$ $CaCO_3$), pH values of up to 8·9 have been recorded. Measurements of plankton community photosynthesis and respiration have given values of P_G 0·79 mg $O_2\ l^{-1}$ day^{-1}, P_N 0·26 mg $O_2\ l^{-1}$ day^{-1} and R 0·525 mg $O_2\ l^{-1}$ day^{-1} (Bowker, pers. comm.).

THE DESMID PLANKTON

Despite the eutrophic nature of its waters and associated phytoplankton, it is remarkable that seven species of desmids are present in the lake. These have been identified as follows:

Closterium acutum var. *linea* (Perty) W. & G. S. West
Closterium limneticum var. *limneticum* Ruzicka
Staurodesmus cuspidatus (Bréb.) Teiling
Staurastrum tetracerum Ralfs
S. pseudotetracerum (Nordst.) W. & G. S. West
S. irregulare W. & G. S. West
S. bibrachiatum Reinsch

All have survived and multiplied in ASM-enriched lake water; also in the lake water in which they were collected in June 1980, at low intensity daylight in the laboratory at an ambient room temperature of between 18 and 20°C. The cultures on which this report is based are mixed cultures and so far no attempt has been made to produce uni-algal or axenic cultures in chemically defined media. However, the observations on the cell morphology of the desmids has been supported by the examination of freshly collected material collected monthly by Dr Fred Slater of the UWIST Field Centre at Newbridge-on-Wye, who initially drew my attention to the lake and its abundant phytoplankton.

The taxonomy of the small *Staurastrum* species of the *S. tetracerum*-group is difficult and confused because of the small size of the algae and because, as with so many desmids, they show considerable variability. The present material, observed in culture and in a series of lake samples, has presented an opportunity to investigate four species in detail and thus clarify some of the group's taxonomic problems.

S. tetracerum Ralfs

This, the "basic" and first described species of the group has few adequate illustrations ascribed to it. The originals by Ralfs (1848) show a small biradiate *Staurastrum* with slender processes moderately long in relation to the body. Where his drawing is very open to question, however, is that the processes are conspicuously ornamented with successive rows of granules. Also as Ralfs' description states "the frond is rough with minute puncta-like granules, which form transverse lines on the processes and give them a jointed appearance". This would seem to be quite incorrect, for in all acceptable, subsequent illustrations of this *Staurastrum* (e.g. West & Carter, 1923; Smith, 1924; Borge, 1925; Nygaard, 1945; Grönblad, 1960; Parra, 1975; Taylor, 1935; Compère, 1977; Ružička, 1972) although the processes are shown correctly to be denticulate when seen in "front" view (cf. Brook, 1981, fig. 15, 2A), and indeed conspicuously so, there are no rings of granules forming "transverse lines on the processes". Unfortunately, type material of the species does not exist.

The four characteristic features of *Staurastrum tetracerum* are first that the cells are biradiate, and second that the cells are almost invariably twisted at the isthmus showing torsion asymmetry (Teiling, 1957; Brook, 1981), so that as Ralfs (1848, p. 137) states in the original description, "one of its processes is situated behind its companion" and may not immediately be seen unless "carefully looked for". The third distinctive character is the ornamentation of the processes. As stated already, though unmistakably denticulate when seen in "front" view, the denticulations are not part of a series of rings of granules encircling the processes as in other *Staurastrum* species, such as *S. cinglum* (W. et G. S. West) J. M. Smith, or *S. anatinum* Cooke et Wills (Brook 1959, fig. 4, plates VIII and XII). When examined with care it can be seen that the upper denticulations do not coincide with the lower, so that as shown in Fig. 1 (a)–(l), their disposition is very obviously alternate. This very characteristic feature of desmids of this group does not seem to have been pointed out or illustrated previously. If cells are examined under $\times 100$ oil immersion with phase contrast, or if stained with methyl violet 6B and viewed under bright field, then small individual granules may be seen down the processes as shown in Fig. 1 (a)–(f). The ends of the processes are rounded and very slightly swollen and terminate in three or four delicate divergent spines. Size is the fourth characteristic feature of the group since they are amongst the smallest of the *Staurastrum* species in which the angles are well developed into processes. Thus the cells of *S. tetracerum*, including processes, are mostly between 18 and 24 μm long and of similar breadth; with processes the cell body is from 9 to 12 μm long, and the isthmus is between 5 and 6 μm in width. The width of the semicell body above the isthmus is 8–9 μm.

The body of the semicells from which the processes diverge, range in shape from obversely triangular, with ventral margins sublinear [Fig. 1 (b), (c)] to shallow and cup shaped [Fig. 1 (d)–(l)]. The angle of divergence of the processes may be a continuation of the side of the cell body, or somewhat less, so that they are sub-parallel. More rarely they may curve upwards [Fig. 1 (i)].

Most illustrations of *S. tetracerum* suggest that there is no ornamentation of the cell body. However, when empty semicells are viewed with a $\times 100$ objective under phase contrast, or stained with methyl violet 6B, some but not all cells can be seen to possess regularly disposed granules. Occasionally without this treatment these body granules are visible. As shown in Fig. 1 (d)–(e) there is usually a centrally apical granule visible, on either side of which there may be single granules which would seem to be part of a ring surrounding the semicell angles. Also on the body itself there may be two or more small granules, which seem to be part of a ring encircling the body above the isthmus [Fig. 1 (a), (c)–(g)]. There may also be a small granule or even spines at each corner of the body of the semicell just above the isthmus [Fig. 1 (b)–(d), (f), (g), (k), (i)]. However, it must be emphasized that these do not form part of an isthmal ring of granules encircling each semicell body, as in *S. cingulum* or *S. chaetoceras* (Schröd.) G. M. Smith (Brook, 1959).

Although *S. tetracerum* is typically biradiate, as in the case of many other such *Staurastrum* species, triradiate forms have been described in the

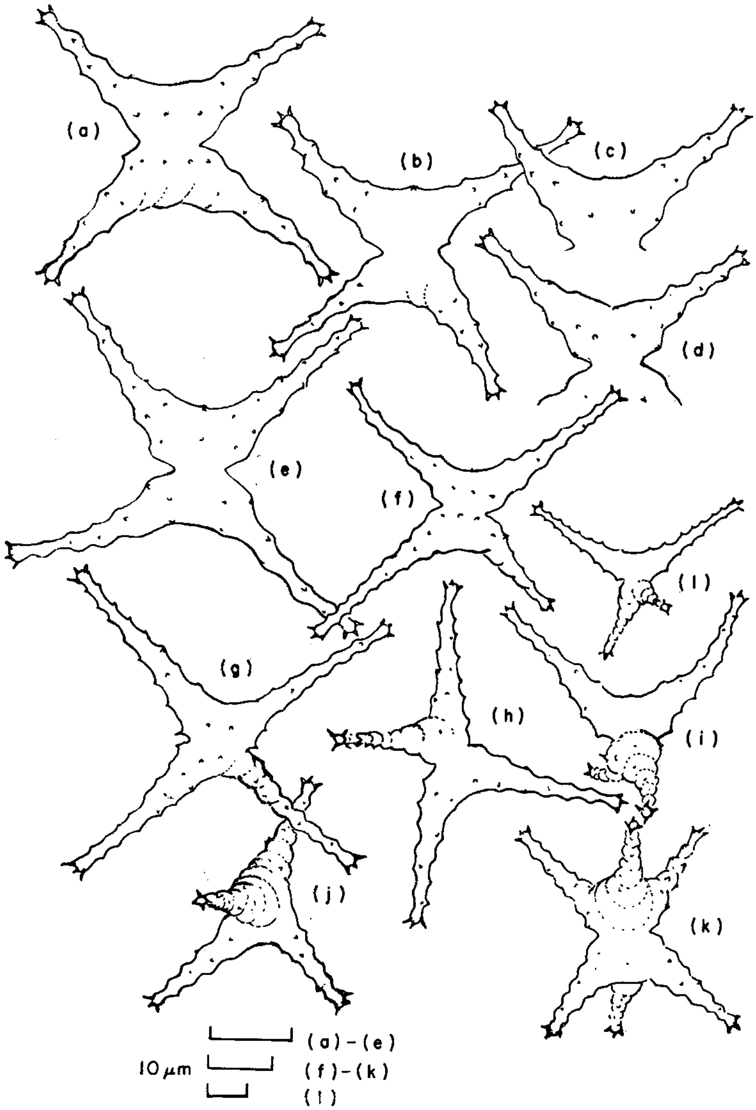

FIG. 1. *Staurastrum tetracerum* Ralfs from Llandrindod Wells Lake [(a)–(e)], from various lochs in North Uist, Outer Hebrides [(f)–(k)] and from St John's, Newfoundland (l).

literature (West & Carter, 1923; Smith, 1924; Krieger, 1932; Taylor, 1935). Dicotypical specimens (Teiling, 1950) have also been recorded. Since triradiate forms can be, and probably have been, confused with other small triradiate species such as *S. iotanum* Wolle and *S. pseudoiotanum* Grönblad and *S. pseudotetracerum* (see below) and even *S. chaetoceras*, records of the occurrence of what must now be named the facies *triradiata* (Teiling, 1950; Brook, 1959) must be viewed with caution and reserve. Certainly none have been seen in

Llandrindod Wells Lake nor in the cultures developed from it. Specimens of both biradiate and triradiate forms have, however, been found in several lochs in North Uist in the Outer Hebrides. The pH of the lochs where these occur range from 6·2 to 8·4 and alkalinities from 10·00 to 62·5 mg l^{-1} $CaCO_3$. The specimens illustrated in Fig. 1 (f)–(k) are from North Uist lochs, and a form with long, slender processes from a bog near St John's, Newfoundland [Fig. 1 (l)].

Staurastrum irregulare W. et G. S. West

This desmid is of similar dimensions and appearance to *S. tetracerum* so that it may readily be mistaken for the latter unless material in front view is examined with care, or specimens are seen in apical or in end view. Because of its obvious close relationship to *S. tetracerum* it is proposed that it be reduced to varietal status (see below). In support of this proposal is the statement by West & West (1894) in the original description to the effect that it is a species "probably coming nearer to *S. tetracerum*".

The one distinguishing feature of the desmid is the prominent protuberance on the front of each semicell body which bears sometimes two, but more frequently three or occasionally four, short spines (Fig. 2). It is this feature that can be overlooked unless cells are examined with care at high magnification. When three spines are present on the central protuberance there is a single spine at the top and two spines below. Whereas the cell body of *S. tetracerum* when viewed apically is elliptical, those of *irregulare* are trapeziform because of the prominent central protuberance [Fig. 2 (d)–(f)]. The latter are also conspicuous when cells are viewed from the side. The examination of drawings in the literature of other small biradiate desmids obviously related to *S. tetracerum* prompts the suggestion that the *S. pseudoiotanum* of Grönblad (1921) is in fact *S. tetracerum* var. *irregulare* (cf. especially Bourrelly 1966, fig. 8). It is also proposed that the varieties of *S. irregulare* named var. *suboscidense* Grönblad (1944) and var. *spinosum* (Krieger & Bourrelly, 1956) should be reduced to the status of formae.

Several authors (e.g. Kreiger, 1932; Tell, 1980) have commented on the very obvious similarity between *S. irregulare* and *S. perundulatum* Grönblad, including Grönblad (1920) himself when establishing the latter species. It is also of some significance to note that Scott & Prescott (1961) describe a variety, *dentatum*, of *S. perundulatum* from Indonesia with a small spine at the basal angle of each semicell and thus very similar to that found in this Welsh material (cf. Scott & Prescott, 1961, fig. 10 with Fig. 2 (a)–(c), (h) in the present paper; also Kreiger (1932) pl. XV, fig. 19 and Foster (1969) figs 7, 8). Since this character, and also the extent to which the central protuberance on the semicell body is developed have been shown in the present study to be very variable attributes, it is suggested that *S. perundulatum* and the var. *denticulatum* must also be regarded as synonomous of *S. tetracerum* var. *irregulare*.

Hence the proposed revised taxonomy for *S. irregulare* is as follows.

Staurastrum tetracerum var. *irregulare* (W. et G. S. West) stat. et comb. nov.
Basionym—*S. irregulare* W. et G. S. West (1894), p. 48, figs. 49, 50
Synonym—*S. pseudoiotanum* Grönblad (1921)
—*S. perundulatum* Grönblad (1920)

S. tetracerum var. *irregulare* f. *suboscidense* (Grönblad) stat. et comb. nov.
Basionym—*S. irregulare* var. *subsocidense* Grönblad (1944), p. 56, fig. 213

S. tetracerum var. *irregulare* f. *spinosum* (Krieger et Bourrelly) nov. comb.
Basionym—*S. irregulare* var. *spinosum* Krieger et Bourrelly (1956), p. 23, fig. 110

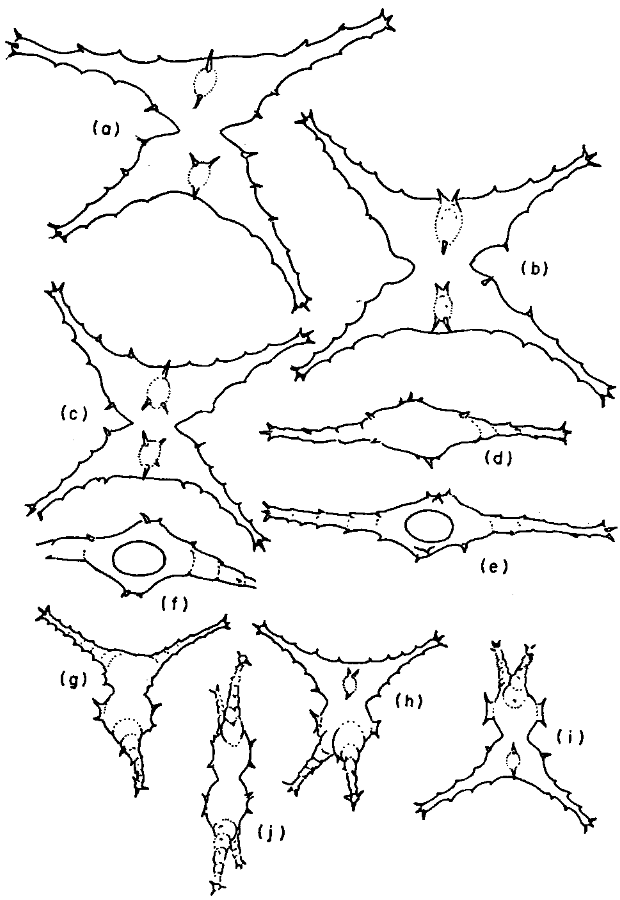

FIG. 2. *Staurastrum tetracerum* var. *irregulare* (West) nov. comb. (=*S. irregulare* West) from Llandrindod Wells Lake cultures.

S. bibrachiatum Reinsch

This is by far the most interesting desmid from Llandrindod Lake and especially in the cultures raised from it. In samples examined directly from the lake there is a third small biradiate *Staurastrum*, again showing some torsion asymmetry but differing from *S. tetracerum* in that its processes tend to be longer, and especially in that the cell body possesses a wide, open sinus. In this respect it approaches *S. tetracerum* var. *subexcavatum* Grönblad. In many specimens there are prominent granules, or occasionally a spine, at each corner of the semicell body where it bends sharply above the isthmus to join the base of each process. Because of the angle of divergence of the processes in many, though not all specimens, the apices of the semicells are concave [Fig. 3 (g), (h), (i)] (cf. *S. excavatum* W. et G. S. West, 1895). In some specimens the processes are almost parallel [Fig. 3 (a), (b), (d)]. The cells, including the processes, are 40–45 μm in width and, depending on the angle of divergence of the processes, 25–40 μm long. The cell body is from 12 to 15 μm long and the isthmus 6–7 μm wide.

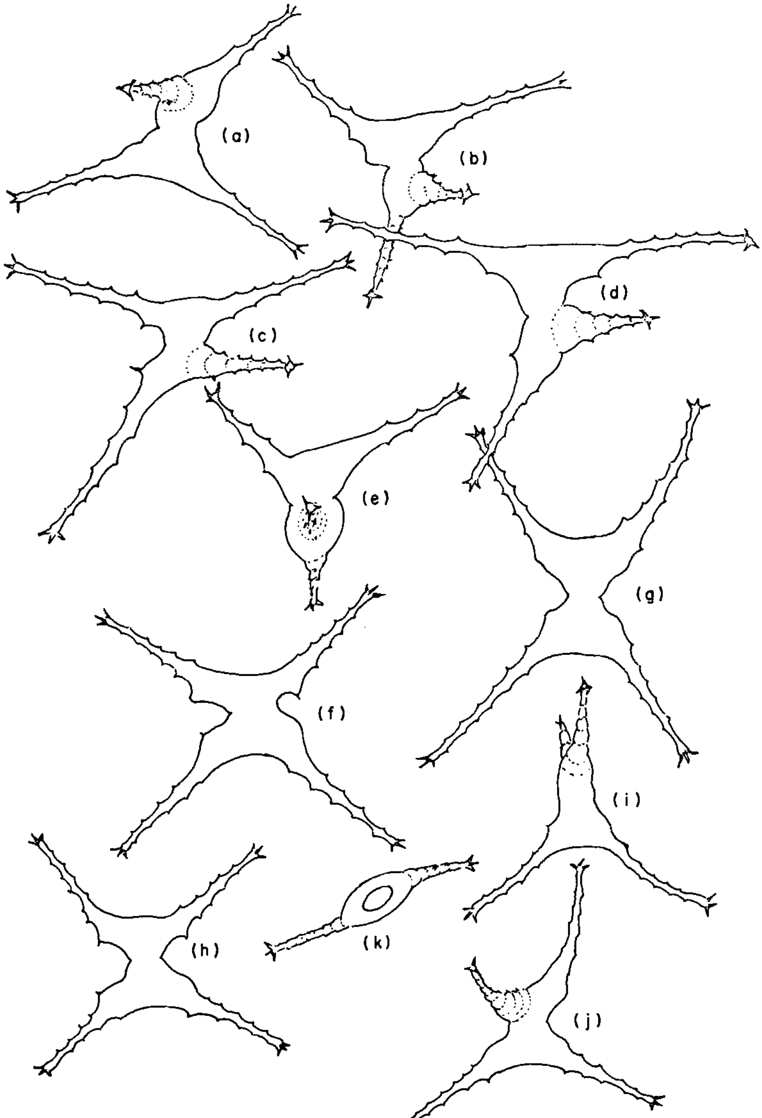

FIG. 3. (a)–(e), (i)–(k) *S. bibrachiatum* Reinsch f. *smithii* from Llandrindod Wells Lake; (f)–(h) f. *excavatum*(?) from cultures.

On first examination this desmid with its marked torsion asymmetry, was thought to be a form of *S. smithii* Teiling and especially the var. *verrucosum* Nygaard (1949) with which it agrees closely with respect to the shape of the cell body. The prominent granule or spine at each corner mentioned above is clearly shown in Nygaard's fig. 40a. It also has similarities with *S. excavatum* and especially the var. *planctonicum* Krieger in Huber Pestalozzi, 1935, fig. 9 (see also Fritsch & Rich, 1937, fig. 22; Thomasson, 1959, fig. 12).

After the desmid was established in the laboratory in a mixed culture, significant changes in the morphology of numerous cells became apparent, including many which were dichotypic (Teiling, 1950; Brook, 1981). Thus, while one semicell was of the biradiate type described above, the adjoining semicell could without question be referred to the species *S. bibrachiatum*. After some searching, wholly *bibrachiatum*-like cells were observed (Figs 4, 5). As may be seen from these illustrations, this species has additional or supernumerary processes developed above the isthmus from the corner of the cell body where it curves abruptly above the isthmus and where in the biradiate form, there is a granule or small spine [see above and Fig. 4 (a), (b), (f), (g)]. Thus when fully developed each semicell bears four processes one above the other, and each complete cell has eight processes in all.

Some of the cells in the cultures have shown various degrees of development of the supernumerary processes (Figs 4, 5). Also, as seen in Fig. 5, they are not always developed equally on different sides of a given semicell, so that the *bibrachiatum*-type cells may bear from five to eight processes. An analysis of process occurrence in a culture which had been growing in the laboratory from the end of June 1980 to March 1981 showed the following proportions of cell types from a total of 201 cells examined.

No. of processes per semicell	No. of cells	Occurrence (%)
2+2	124	62
2+3	23	12·5
3+3	0	0
3+4	6	3
4+4	10	5
2+4	37	18·5
1+4	1	0·5*

N.B. (4+4) cells=*S. bibrachiatum* [Fig. 5 (i)]
(2+4) cells="Janus" cells of *S. bibrachiatum*/"*smithii-excavatum*" [Fig. 5 (a), (e), (f)]
*A very aberrant cell [see Fig. 5 (h)].

Despite a careful examination having been made of samples collected from the lake each month since June 1980, no *bibrachiatum* cells have so far been observed the naturally occurring phytoplankton. However, it is of interest to note that the range of forms encountered in culture is virtually identical with the natural populations of *S. bibrachiatum* described by Grönblad & Scott (1955) from Lago di Nemi and Lago d'Albano in Italy and from a lake in Mississippi in the U.S.A. Dichotypic specimens of the var. *cymatium* W. et G. S. West (1909) have also been illustrated by Bohlin (1901), West & West (1895, 1909), Gayral

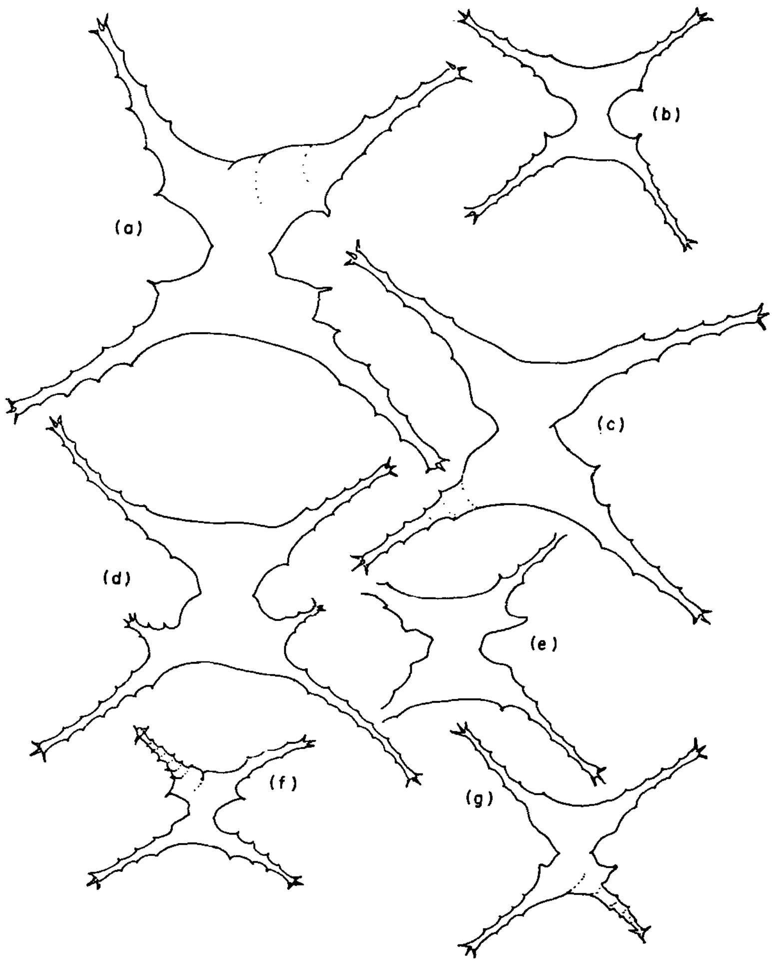

FIG. 4. *S. bibrachiatum* f. *excavatum* (?) from cultures.

(1954) and Bourrelly (1966). Krieger's *S. excavatum* var. *planctonicum* f. *bibrachiatum* shows a dichotypic cell (Krieger, 1938 pl. XV, fig. 18) and it would seem that this should be referred to *S. bibrachiatum*.

In their examination of the Italian and American specimens, Grönblad & Scott (1955) emphasize that since in these collections there existed dichotypic cells, they are forced to assume that *S. bibrachiatum* is a very variable species and as they state "in some unusual way inconsistent". They also stress that in describing the species it must include both the *bibrachiatum* and the *smithii*-like forms. As they emphasize, it would be quite incorrect to make one a form and the other a species. Grönblad (1960) records *S. bibrachiatum* from numerous lakes in Italy, though comments that in a few, only *S. smithii*-like cells were present. It should also be stressed that the two forms are not different "facies" such as one finds in many species of *Staurastrum* (Teiling, 1950; Brook 1959, 1981)

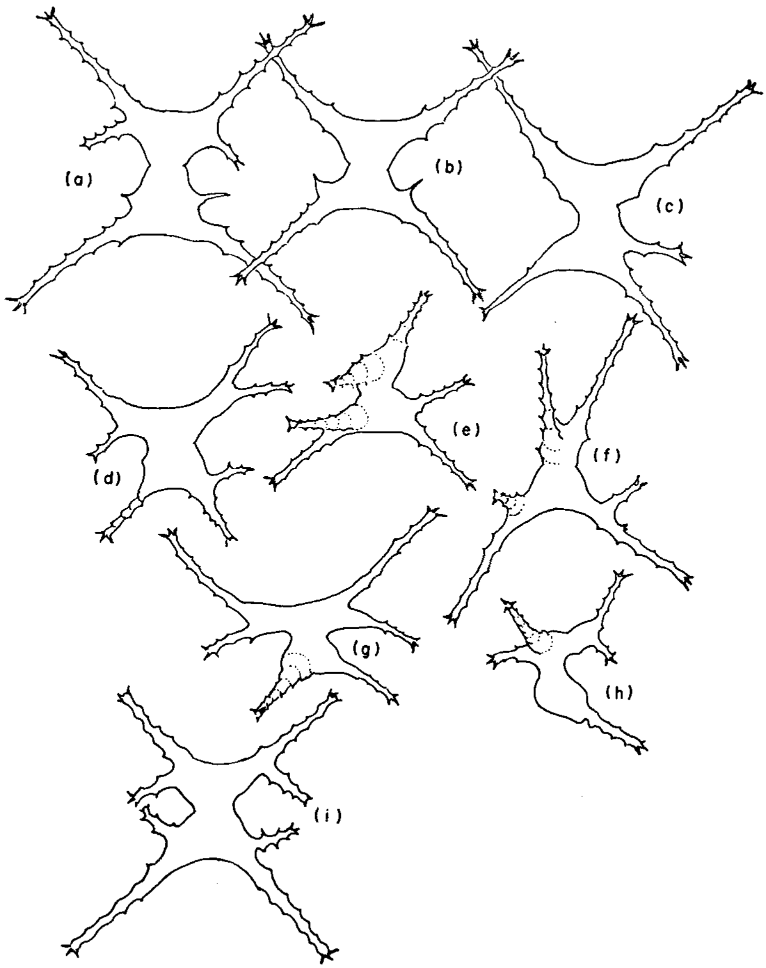

FIG. 5. *S. bibrachiatum* f. *bibrachiatum* a series of growth forms from cultures from Llandrindod Wells Lake.

since all the specimens encountered are biradiate.

Experimental studies of desmid polymorphism in which cells have been grown in controlled culture conditions are few (Ondracek, 1936; Lefèvre, 1939; Rosenberg, 1944). In the latter study, Rosenberg examined the development of spines round the cell margins of *Xanthidium subhastiferum* West. When fully developed there are eight (four pairs) regularly disposed round the margin of each semicell. Many semicells possess less than eight (often only four) and there are even some cells in which there is no production of spines, so that the cells look like a *Cosmarium*. From her study of *X. subhastiferum* in the plankton from the N. basin of Windermere and cultures, she expresses the view that morphologically homogeneous populations of desmids can be maintained only if their division rate is high, and that as it declines, so the proportion of aberrant cells within it increases. Certainly the naturally occurring population of *S. bibrachiatum* (*S. smithii*-form) is morphologically homogeneous in Llandrindod Lake but unfortunately no data are available at present to compare growth rates in the lake and the laboratory cultures. It is assumed that they were lower in the latter and that the slower rate of cell growth between divisions allowed the full potential of at least some of the cells to be expressed and produce eight processes.

It would be of interest to examine critically the morphology of natural populations which have been recorded as containing *S. smithii* and also to grow them in culture. This inadequately described taxon would seem to be fairly widely distributed in North American lakes. Like its allied species *S. tetracerum* it has been found to show a preference for eutrophic waters (Brook, 1971). Until it has been studied fully from naturally occurring phytoplankton populations and in culture however, the taxon *S. smithii* must be retained. It is proposed that the three major forms of *S. bibrachiatum* discussed above should be designated:

S. bibrachiatum Reinsch f. *bibrachiatum* forma nova

Species tribus vel quattuor processis (quattuar plerumque), in forma plana eadem, binae et rectis angulis iacentibus; auaruai pars inferior est brevior dimidia salteam parte quam superior.

Forms with three to four, though typically four processes, lying in the same plane in pairs at right angles to one another; the lower of each at least half as long as the upper one.

S. bibrachiatum Reinsch f. *smithii* forma nova

Species duobus processis diversis, in forma plana eadem iacentibus; spina praminenti saepe ad utrumque angulum semicellae super isthmum. Processi paene congruentes vel paullum modo diversi (minus 45°). Apices cellae vel plani vel paullum convexi.

Forms with two divergent processes lying in the same plane, often with a prominent spine at each corner of the semicell above the isthmus. Processes almost parallel or slightly divergent (less than 45°). Cell apices flat or slightly convex.

S. bibrachiatum Reinsch f. *excavatum* forma nova

Species duobus processis diversis, in forma plana iacentibus. Processi valde diversi (magis 45°): ita ut apices cellae sint manifesto concavi.

Forms with two divergent processes lying in the same plane. Processes strongly divergent (greater than 45°) so that the cell apices are distinctly concave.

S. pseudotetracerum (Nordst.) W. et G. S. West

This is the only triradiate *Staurastrum* in the lake plankton, and because of its small dimensions similar to those desmids described already, and its superficial resemblance to *S. tetracerum*, it was at first assumed to be the three-armed facies of the latter species. Careful examination has indicated, however, that it is a distinct taxon, and in fact a small member of the *S. gracile-cingulum* group (Brook, 1959), though less than half their average body length.

There would seem to be no complete descriptions of *S. pseudotetracerum*, but illustrations scattered through the literature from 1888 onwards are fairly consistent. Because the desmid grows well in the mixed and enriched laboratory cultures producing very few aberrant forms, it has been possible to examine large numbers of specimens and thereby provide the following more complete description and associated drawings than was previously possible. In culture, however, the processes tend to be somewhat shorter than in naturally occurring specimens.

The triradiate cells show, only occasionally, slight torsion asymmetry. In front view the semicells range from a few that are cyathiform to the majority that are broadly cup-shaped. The angles of the semicell body attenuate quite markedly as they are produced into the short, divergent processes, which, in the naturally occurring population, tend to curve upwards. In a series of three (or four) step-like undulations, these taper towards their extremities which are very slightly swollen and terminate in four, short divergent spines. The crest of each undulation on the processes bears a ring of barely perceptible granules.

It is the ornamentation of the semicell body which indicates the relationship of this small *Staurastrum* to the *gracile-cingulum* group. One characteristic feature is the ring of granules (some may be difficult to discern) encircling the semicells body just above the isthmus. The other essential feature of the ornamentation can best be seen when cells are viewed apically. In this position it can be seen that the margins are straight or slightly concave and have three barely perceptible undulations, on the crest of which is a small granule. Situated intermarginally from each are three apical granules; hence each semicell apex bears nine in all. A line of two or three small granules run downwards from each central apical granule on to the semicell body while from the two outer granules, a ring of granules encircles each angle of the cell. The centre of the semicell apex is devoid of ornament, though what seem to be five or six mucilage pores can be seen in this area [Fig. 6 (h), (i)].

The cells of *S. pseudotetracerum* show only a small range of size differences, their breadth and length including the processes being 25–30 μm and 18–27 μm respectively. The cell length without processes is 13–14 μm and breadth 11–13 μm. The isthmus is 6·0–6·5 μm broad.

DISCUSSION

It is generally accepted that the greater the number of desmid species present in a lake's phytoplankton, the greater its degree of oligotrophy (Pearsall, 1932; Thunmark, 1945; Nygaard, 1949; Hutchinson, 1957). More recent studies suggest, however, that there are several desmid species that thrive in markedly alkaline waters and in conditions which are distinctly eutrophic (Moss, 1972; Brook, 1964, 1971, 1981). It is thus unusual to find in productive waters more than two or three desmid species as components of the plankton. Hence the occurrence of seven species in the Llandrindod Wells Lake plankton is noteworthy.

Of these Llandrindod desmids, only *Closterium acutum* (Lyngb.) Bréb. is known to occur in distinctly eutrophic British lakes. Other typically eutrophic species of *Closterium* in these lakes are *C. aciculare* var. *subpronum* W. et G. S. West, *C. gracile* (Bréb.) ex Ralfs, *C. strigosum* Bréb. and *C. nordstedtii* Chod. (Brook, 1965, 1981; Swale, 1968; Reynolds, 1973; Youngman et al., 1976; Williamson, pers. comm.). It should be pointed out that *C. limneticum* is probably a new record for the British phytoplankton.

With reference to the occurrence of *Staurodesmus cuspidatus* this species along with *S. dejectus* (Bréb.) Teiling are the only *Staurodesmus* species which have been found in mesotrophic or slightly eutrophic lakes. In general, members of

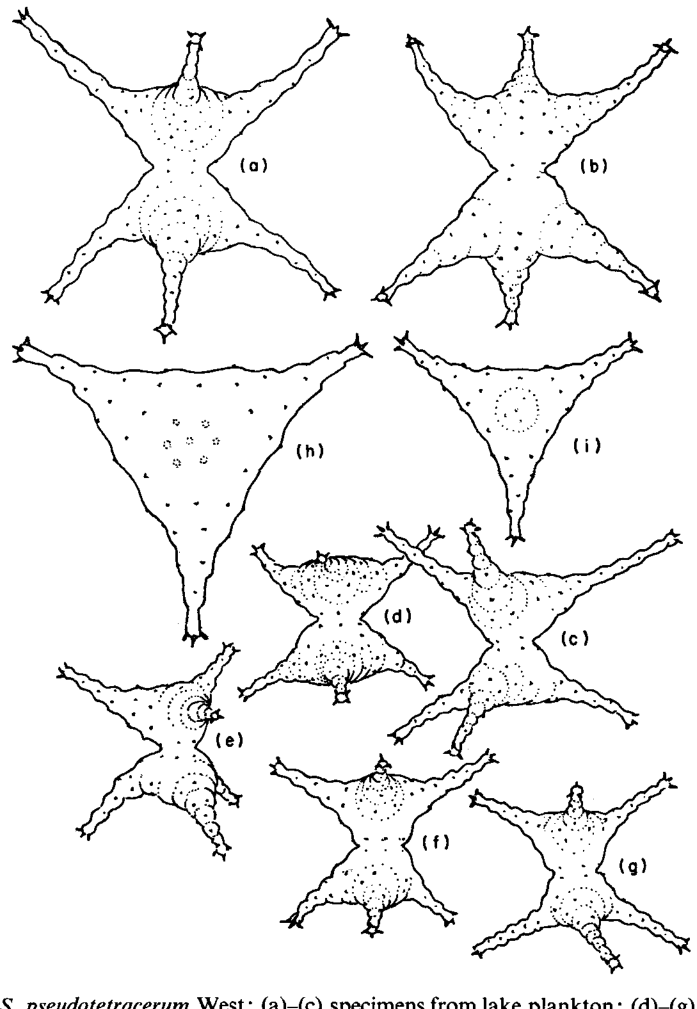

FIG. 6. *S. pseudotetracerum* West: (a)–(c) specimens from lake plankton; (d)–(g) specimens from cultures—side view; (h)–(i) specimens from cultures—apical view.

this genus, both in British and American lakes, are usually associated with oligotrophic conditions and waters of low alkalinity. It should be pointed out however, that *S. glabrus* var. *ralfsii* (W. et G. S. West) Teiling, produced the largest desmid bloom ever recorded in an accidentally enriched reservoir at Siblyback in Cornwall (Lack, pers. comm.; Brook, 1981).

Of the *Staurastrum* species, *S. tetracerum* would appear to be of fairly widespread occurrence both in the plankton and metaphyton. It has been observed from time to time as the only desmid in the plankton of moderately eutrophic lakes, including one markedly alkaline one in southern England, but also in the metaphyton of oligotrophic waters. It was also found, with *Staurodesmus* *extensus* (Anders.) Teiling, to constitute over 82% of the total desmid plankton in three small meromictic lakes in Minnesota (Bland & Brook, 1974).

The recognition of *S. pseudotetracerum* as a member of the *S. gracile* group of desmids, possibly makes its occurrence in this productive lake less noteworthy than the other desmid species in that in detailed surveys of the distribution of desmids in relation to the trophic status of lakes in both Britain and America (Brook, 1965, 1971, 1981), *S. gracile* was found to be the desmid most frequently associated with eutrophic conditions.

As a new record for the British plankton and its infrequent occurrence elsewhere, no views can be expressed about the occurrence of *S. bibrachiatum*. However, *S. smithii* with which it seems to have some affinity and *S. excavatum* have been found in the phytoplankton only of productive lakes in Minnesota, U.S.A. (Brook, 1971). There appears to be no previous knowledge of the water chemistry of the environments in which *S. tetracerum* var. *irregulare* (=*S. irregulare*) occurs.

The occurrence of seven desmids in the Llandrindod plankton may in part be a consequence of the lake's fairly low alkalinity, which is less than 30 mg l^{-1} $CaCO_3$ (cf. table 6 in Brook, 1965). Their presence, however, provides a misleading indication of the lake's trophic status, if this is assessed on the basis of Nygaard's Compound Phytoplankton Quotient (Nygaard, 1949), for with some 40 species in the numerator and seven desmids in the denominator, the resulting quotient would be 5·7. This value is much less than that found for other lakes of comparable productivity both in Britain and the U.S.A. (Brook, 1965, 1971, 1981). Such an observation adds weight to the view expressed some time ago that in order to improve the reliability of methods which use phytoplankton species-occurrence in assessing the trophic status of lakes, it is essential to have detailed knowledge of the ecology, and especially the nutritional requirements, of individual phytoplankton species, and in particular of desmids.

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