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TAXONOMIC IMPLICATIONS OF SEM REVEALED CELL WALL SCULPTURING IN SOME SMALL-SIZED DESMID SPECIES (CHLOROPHYTA, CONJUGATOPHYCEAE)

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SUMMARY

SEM studies of some smaller, unornamented desmid taxa of the genera *Cosmarium* and *Euastrum* showed that the superficial cell wall pattern of pores and scrobiculations provide useful, auxiliary taxonomic characters. *Euastrum lacustre* (basionym *E. binale* var. *lacustre* Messik.) and *E. groenbladii* (basionym *E. binale* forma *groenbladii* Messik.) are raised in rank and compared morphologically and ecologically with some other, light microscopically very similar species with which they can easily be confused when naming is attempted by means of conventional methods.

1. INTRODUCTION

The often profusely sculptured and firm desmidial cell wall is eminently suited for scanning electron microscopy. The first SEM micrographs of species of such well-known genera as *Cosmarium, Micrasterias* and *Staurastrum* appeared in the late 'sixties and early 'seventies (LYON 1969, PICKETT-HEAPS 1973). Since desmids are renown on account of their graceful and often spectacular shapes it is not at all surprising that such features become even more pronounced in SEM observation. The majority of the earliest pertaining publications suggest that one aimed at the presentation of esthetically appealing forms rather than at the solution of some scientifical problem (see, e.g., the SEM micrographs in PICKETT-HEAPS 1975). The onset of the application of SEM information to the systematics of desmids by COUTÉ & TELL (1981) consisted of an overview of SEM images of representatives of nearly all genera which provided a first impression of the taxonomical ranges of a number of submicroscopical characteristics of the cell wall not or hardly discernible by light microscopical methods. Also in this case it has to be noted, however, that the emphasis was almost entirely laid on the more striking (and in a taxonomical sense less problematical) representatives of the various genera. The presentation is not very thorough either, because the authors give hardly any taxonomical, morphogenetic or functional evaluation or interpretation of the patterns of cell wall sculpturing shown. Only recently did a SEM study appear (NEUHAUS & KIERMAYER 1982) in which various types of pores and patterns are shown and related to taxonomic entities

albeit at the genus level only. One may expect that SEM revealed cell wall structures may also provide useful information for the distinction of taxa of lower rank especially in cases where light microscopically observed features cause doubt and not rarely confusion. One of the groups for which such a study seemed indicated is that of the smaller species of *Cosmarium* whose cell wall sculpturing is barely discernible light microscopically (or not at all) so that the diagnoses were hitherto solely based on differences in size and in outline of the cells.

The delimitation of these taxa was often problematic, not only so when taxa were compared within the genus *Cosmarium* but in a number of cases also in respect of representatives of the genus *Euastrum*. It has repeatedly been said (RŮŽIČKA 1977 p. 240, BROOK 1981, p. 11, 13) that several desmid genera are by no means natural assemblies and may comprise mutually not so closely affined components, so that they cannot be satisfactorily characterised as a genus and are sometimes even connected by intermediate forms. Some of the forms more or less intermediate between *Cosmarium* and *Euastrum* were subjected to SEM studies so as to establish the presence of possibly differential kinds of cell wall sculpturing.

2. MATERIAL AND METHODS

Formalin-fixed material from the following locations was used:

Euastrum insulare var. *insulare* – Oisterwijk 1921, Valkenswaard 1931, N.W. Overijssel 1971, 1974 (The Netherlands).

E. insulare var. *basichondrum* – N.W. Overijssel 1974 (The Netherlands), Hjerkinn 1982 (Norway).

E. insulare var. *lacustre* – Terschelling 1972, Schiermonnikoog 1979 (The Netherlands).

E. binale var. *groenbladii* – Valkenswaard 1931, Neede 1974, N.W. Overijssel 1974 (The Netherlands).

E. binale var. *gutwinskii* – Vierhouten 1972, Spier 1973 (The Netherlands), Hjerkinn 1982 (Norway), Besse en Chandesse (France).

E. montanum – Jokkmokk 1982 (Sweden).

Cosmarium quadratulum – Oisterwijk 1921 (The Netherlands).

C. subreinschii – N.W. Overijssel 1972, 1974 (The Netherlands).

C. venustum – Spier 1973 (The Netherlands), Hjerkinn 1982 (Norway).

C. spec., cf. *C. regnellii* var. *chondrophorum* sensu FÖRSTER (1965) – N.W. Overijssel 1971, 1974 (The Netherlands).

For SEM observation the formaldehyde (3%) fixed samples were rinsed in distilled water subsequently transferred to 1% glutaraldehyde for one hour at room temperature, rinsed in double-distilled water, dehydrated in an alcohol series and critical-point dried with liquid CO_2. The material was finally gold-sputtered and examined with a Cambridge Stereoscan Mark 2A.

3. RESULTS

The above-mentioned taxa of which SEM micrographs were obtained can be referred to three overall resemblance groups to be discussed separately below, a randomly chosen component being used as a starting point.

Euastrum montanum W. & G. W. West

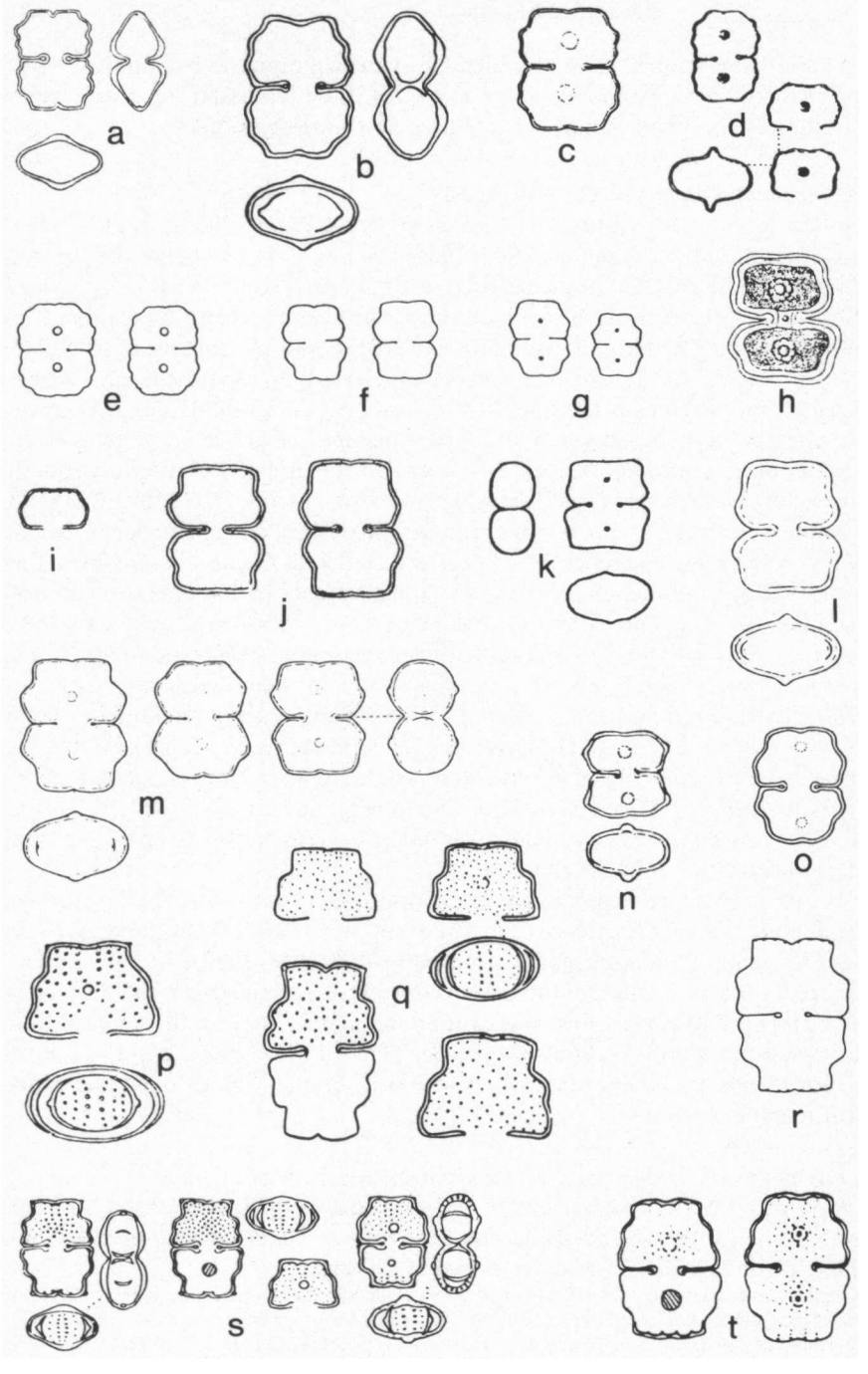
In their original description the authors (WEST & WEST 1905, p. 17, t. 1: 11–12) state that this taxon is identical with *Cosmarium subreinschii* Schmidle var. *boldtiana* Schmidle and that it can easily be distinguished from typical *C. subreinschii* (SCHMIDLE 1894, p. 59, t. 7: 24) "by its larger and broader central protuberances, by its relatively wider and more angular apices, and by the apical notch" (see our *figs. 1a* and *1d*). It is by no means always so easy to separate them, however, because the differences are quantitative rather than qualitative and both taxa are quite variable. *C. subreinschii* has, for instance, also been figured as having a faint apical notch (*fig. 1e*), and *E. montanum* sometimes with broadly rounded angles, a retuse apex or a small central protuberance (*figs. 1b, c*). RŮŽIČKA (1981, p. 436), accordingly, reports in his monograph of the Central-European desmids that *E. montanum* has repeatedly been confused with *C. subreinschii*. Still, there is a rather cogent indication of their specific difference in that they seem to prefer different environments. The type collection of *C. subreinschii* was reported to be from pools with lime-rich water with dense stands of *Myriophyllum*, *Potamogeton* and reed ("Schilfgrase") in the vicinity of Virnheim, Germany (SCHMIDLE 1894). The present author recorded it from the N.W. part of the Dutch province of Overijssel in shallow fen hollows covered with the moss *Scorpidium* and with an average conductivity of about 500 μS cm^{-1}, a pH 6.7 and a calcium content of about 40 mg l^{-1} (COESEL 1981). *E. montanum* was said to be "widely distributed in the upland districts of the British Islands" (WEST & WEST 1905) and qualified as acidophilous by RŮŽIČKA (1981).

A comparison between the SEM micrographs of both forms (*fig. 2a, b* and *2c, d*) confirms that they constitute different taxa. Apart from the above-mentioned and light microscopically noticeable differences they also have a clearly different outer cell wall sculpturing. In contrast to *E. montanum*, that has irregularly arranged scrobicles in a zone around the central bulge of the semicell which rather abruptly thin out towards the periphery, in *C. subreinschii* the cell wall is more densely and more evenly beset with minute pits all over, the central protuberance excepted.

Euastrum binale Ralfs var. *groenbladii* (Messik.) W. Krieg.

This taxon, originally described by MESSIKOMMER (1927, p. 98, t. 1: 17, 3:9) as forma *groenbladii*, was identified by him with *E. binale* formae of GRÖNBLAD (1921, p. 14, t. 3: 20–23), and diagnosed as follows:

"Forma lobo polare medio leniter retuso, angulis non acutis, sub margine apicali granulis 4 difficilime conspicuis ornato, interdum granula nulla. Ceterum membrana laevis. A vertice visae semicellulae ovales medio utrinque angulate prominentes. Long. cell. 15–21 μ; lat. cell. 13-16,5 μ; lat. isthm. 3-4,5 μ. Hab. in fossis turfosis prope Robenhausen".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Among the species comparable with this form GRÖNBLAD (1921) mentioned *Cosmarium quadratulum* (Gay) De Toni, originally described as *Euastrum quadratulum* (GAY 1884, p. 58, t. 1: 15) and diagnosed by the original author as follows:

"Cellules très petites, rectangulaires, à étranglement très profond *en forme d'angle aigu*. Demi-cellules *rectangulaires, à sommet et côtés à peine sinués*, à angles tronqués ou arrondis. Membrane glabre. Chromoleucites simples. Long. 15 μ; larg. 11 μ; isth. 2 μ. Hab.: Mares tourbeuses de Gourgons et de Châteauneuf-de-Randon".

This species transferred to the genus *Cosmarium* without comment by DE TONI (1889, p. 934) appears to be hardly distinguishable from *E. binale* var. *groenbladii* judging by the original descriptions and the published illustrations (*fig. 1h* and *1i, j*). The minute subapical granules found in the taxon mentioned last need not always be present according to the original diagnosis. Another possible differential feature, viz. the indication of a small and well outlined central protuberance in *E. binale* var. *groenbladii*, is not too satisfactory either because no apical view of *C. quadratulum* has been depicted or described in the original diagnosis. The distinction between the two forms under discussion has later become even more problematical after several varieties of *C. quadratulum* had been described so that the concept of this species was essentially, but most probably unwarrantedly, extended. *C. quadratulum* var. *boldtii* (Messik.) W. Krieg. et Gerloff described by MESSIKOMMER (1929, p. 153, t. 1: 6) as *C. norimbergense* forma *boldtii* was characterised as having a small central hump on the wall of the semicell. In spite of the fact that RŮŽIČKA (1973, p. 211) states as his opinion that this form should be retained in *C. norimbergense*, he simultaneously described (p. 212, t. 12: 9) the var. *pseudoboldtii*, as a new infraspecific taxon of *C. quadratulum* likewise characterised as having a small central protuberance but otherwise as identical with the "typical" var. *quadratulum*. Apart from the somewhat larger size it is hardly different from *C. norimbergense* fa. *boldtii* of MESSIKOMMER (1935, p. 48, t. 4: 40), however; compare our *figs. 1k* and *1l*). To add to the confusion, RŮŽIČKA (1973) identified the var. *pseudoboldtii* with the by him earlier presented and in its length-breadth ratio very variable *C. quadratulum* var. *boldtii* forma (*fig. 1m*). Also on the basis of the last-mentioned figures I have earlier (COESEL 1979b, p. 390, t. 15: 43–46 – see *fig. 1f, g*) discussed some forms under

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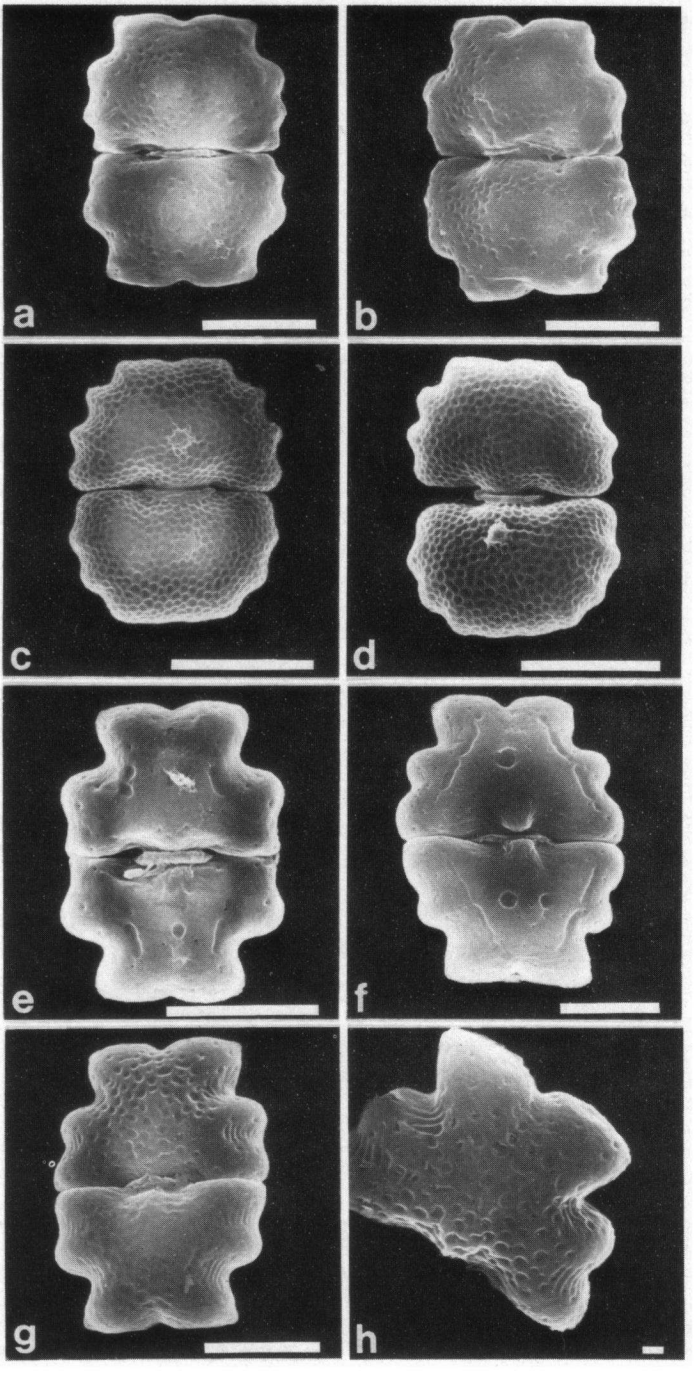
Fig. 1. Reproduction of illustrations from literature. a. *Euastrum montanum* (WEST & WEST 1905, t. 1: 11). b. *E. montanum* (KRIEGER 1937, t. 76: 1–3). c. *E. montanum* (RŮŽIČKA 1981, t. 71: 12). d. *Cosmarium subreinschii* (SCHMIDLE 1894, t. 7: 24). e. *C. subreinschii* (COESEL 1979b, t. 15: 30–31). f. *C. quadratulum* var. *quadratulum* (COESEL 1979b. t. 15: 43–44). g. *C. quadratulum* var. *boldtii* (COESEL 1979b, t. 15: 45–46). h. *C. quadratulum* (GAY 1884, t. 1–15, as *Euastrum quadratulum*). i. *E. binale* var. *groenbladii* (MESSIKOMMER 1927, t. 1: 17, as forma *groenbladii*). j. *E. binale* var. *groenbladii* (MESSIKOMMER 1927, t. 3: 9, as forma *groenbladii*). k. *Cosmarium norimbergense* forma *boldtii* (MESSIKOMMER 1935, t. 4: 40). l. *C. quadratulum* var. *pseudoboldtii* (RŮŽIČKA 1973, t. 12: 9). m. *C. quadratulum* var. *boldtii* forma (RŮŽIČKA 1972, t. 60: 37–39). n. *C. regnellii* var. *chondrophorum* (SKUJA 1949, t. 29: 5). o. *C. regnellii* var. *chondrophorum* (FÖRSTER 1965, t. 5: 31). p. *Euastrum insulare* var. *lacustre* (MESSIKOMMER 1927, t. 1: 16, as *E. binale* var. *lacustre*). q. *E. insulare* var. *lacustre* (MESSIKOMMER 1938, t. 2: 9–12). r. *E. insulare* (VAN TOOREN & VAN TOOREN 1981, f. 2a). s. *E. insulare* var. *lacustre* (FÖRSTER 1965, t. 1: 23–26). t. *E. insulare* var. *lacustre* (FÖRSTER 1972, t. 1: 5–6).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the specific name *C. quadratulum* which deserved a thourough examination by SEM observations.

The two forms said to be light microscopically distinguishable and provisionally referred to as (a) and (b), respectively, were at that time identified as *C. quadratulum* var. *quadratulum* and *C. quadratulum* var. *boldtii*. SEM micrographs of their respective cell wall sculpturing indicate a marked difference (compare *figs. 3a–d* with *3e–h*). Form (a) has a mostly smooth wall surface with at best a few scrobicles mainly grouped around the central hump whereas in form (b) the outer wall surface is strikingly and evenly covered with densely set scrobiculae. Already on the basis of light microscopical images one could prefer to include form (a) in *Euastrum* and form (b) in *Cosmarium* mainly on account of the somewhat more clear-cut and more V-shaped median notch in (a) and the more retuse apex of form (b). Such a re-alignment now appears to be supported by SEM images. A more or less clearly linear arrangement of the apical pores in form (a), see *fig. 3c.*, is known from many species of *Euastrum* and may be associated with the presence of the in this genus frequently occurring median notch (compare also NEUHAUS & KIERMAYER 1982). The scattered scrobiculation pattern in form (a) has also been observed by the present author in several small-sized species of *Euastrum* such as *E. binale* var. *gutwinskii* (*fig. 4a*) but was hitherto never recorded in smaller forms of *Cosmarium* with a more or less euastroid habit form (such as *C. regnellii, C. meneghinii, C. impressulum* and *C. subreinschii*), which all exhibit a kind of embossed structure of closely set scrobicles covering almost the entire cell wall surface whereas in apical view the pores are arranged in concentric rows rather than in rows transversely in respect of the transapical axis (see *C. subreinschii, fig. 4d*). The latter feature is in agreement with the situation recorded in larger and more "typical" species of *Cosmarium* by NEUHAUS & KIERMAYER (1982).

Once form (a) is referred to *Euastrum*, the best fitting taxon is without doubt *E. binale* var. *groenbladii*. The satisfactory identification of form (b) with any described species of *Cosmarium* is not such a simple matter, however. Taking the overall morphology (basal lobes usually retuse, apical lobes mostly somewhat dilated and the lenght: breadth ratio (1.25–1.45) into account, the previously assigned name of *C. quadratulum* (var. *boldtii*) is upon second thought not at all satisfactory. This form agrees closely with *C. regnelli* var. *chondrophorum* Skuja, as illustrated in FÖRSTER (1965, p. 148, t. 5: 31), but since this figure does not resemble SKUJA's (1949, p. 139, t. 29: 4) original drawing very much (compare *figs. 1n* and *o*) this form had better be left unnamed for the time being.

A much better correspondence with "typical" *C. quadratulum* is shown by a form recently discovered in preserved material collected by the late Professor J. Heimans in the early 'twenties (*fig. 5f, g*). According to expectation (the form in question is manifestly a *Cosmarium*), the SEM micrographs indicate that the

Fig. 2. SEM micrographs. a–b. *Euastrum montanum*. c–d. *Cosmarium subreinschii*. e. *Euastrum insulare* var. *insulare*. f. *E. insulare* var. *basichondrum*. g–h. *E. lacustre* (syn.: *E. insulare* var. *lacustre*). Scale bar in a–g represents 10 μm, in h 1 μm.

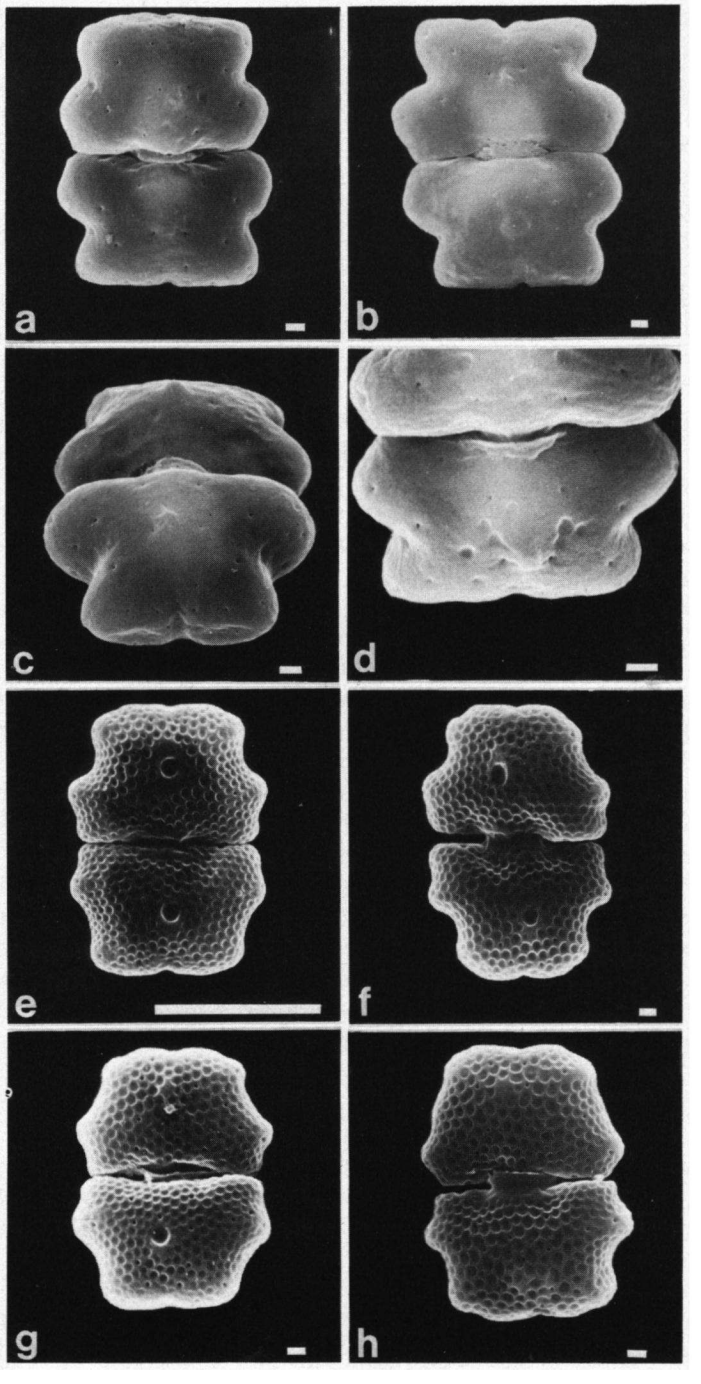
cell wall is of the scrobiculate type (*fig. 4b, c*). If this form is indeed referable to *C. quadratulum* (Gay) De Toni (which, in view of the confusion around this taxon, can only be decided after type material has been studied), this species may conceivably be characterised by a group of strikingly larger (albeit not very deep) scrobicles at the lateral flanks of the apical lobes.

Euastrum insulare (Wittr.) Roy var. *lacustre* (Messik.) W. Krieg.
The original diagnosis of this taxon by MESSIKOMMER (1927, p. 98, t, 1: 16) (as *E. binale* var. *lacustre*) is as follows:
"Parvum circiter 1,5 – plo longius quam latum medio profondissime constrictum, incisura lineari. Semicellulae trapezicae basi recta, angulis inferioribus subacutis, lateribus convergentibus biundulatis, ante apicem perpendiculari – ascendentibus, lobo polari abrupte truncato medio leniter retuso utroque angulo dente parvo armatis. Semicellulae ab latere visae elongato – ellipticae sine prominentiis, a vertice visae elongato – ellipticae punctis in series transversas dispositis, punctis medianis maxmimis; membrana punctata, apicem versus punctis seriatis, in area suprabasali punctis nullis. – Long. cell. 25-26 μ; fossile in creta lacustri'. See our *fig. 1p.*

In a subsequent paper MESSIKOMMER (1938, p. 168) stated that several features of this variety are rather inconstant, such as the dimensions, the shape of the basal angles (rounded or acute), the shape of the apical lobe (parallel-sided or slightly broadening) and the rate of development of the central papilla (not rarely minute to totally absent), see *fig. 1q*. Whereas MESSIKOMMER thought the shape of the basal part of the semi-cell (viz. trapezoid) to be the most important differential characteristic against the var. *insulare* (with a rectangular basal part), compare RŮŽIČKA (1981, p. 441), the latter states that the shape of the basal part of the semicell is highly variable in the species *E. insulare* as a whole, so that at best the linearly arranged apical pores may have any diagnostic significance to segregate a var. *lacustre*. When, however, such an arrangement can also be shown indubitably to be present in var. *insulare*, the latter author would consider the distinction of a var. *lacustre* meaningless unless other sharply differentiating characteristics come to light. As already mentioned in the present paper, such an arrangement of the apical pores in shorter or longer rows is a feature presumably common among the species of *Euastrum*. It has also been established with certainty in *E. insulare* var. *basichondrum* (COESEL 1984). Up to now this had not been cleared up in the case of *E. insulare* var. *insulare*. *Figs. 2e* and *4e* show SEM micrographs of this taxon. A comparison with the var. *basichondrum* (*fig. 2f*) shows that although in the var. *insulare* the pores are slightly more distant and the apical rows are restricted to the immediate vicinity of the apical notch, the two forms have essentially the same wall sculpturing (barring the isthmal hump in the var. *basichondrum*), viz., one or a few manifest scrobicles in the centre of the semicell and in addition two oblique and distally converging grooves on the semicell (short ones in the var. *insulare* and longer ones in var. *basichondrum*); the remainder of the cell wall is smooth.

As regards the original description of the var. *lacustre* by MESSIKOMMER

Fig. 3. SEM micrographs. a–d. *Euastrum groenbladii* (syn.: *E. binale* var. *groenbladii*). e–h. *Cosmarium spec.* cf. *regnelli* var. *chondrophorum*. Scale bar in a–d, f–h represents 1 μm, in e 10 μm.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(1927), one may consider why this author emphasised the wall punctation so explicitly. Most probably he did so because this feature was markedly pronounced. He did not include this in his diagnosis but his original illustration of the var. *lacustre* (*fig. 1p*) shows a strikingly coarse punctation drawn in the form of small circles rather than dots and attaining an appreciable diameter especially near the apex. On the basis of more recent information in the form of SEM micrographs of desmids it may be concluded with a great deal of probability that the circles do not indicate pores but shallow pits. It is of interest in this connection that MESSIKOMMER (1927) on the same plate gives illustrations of *Cosmarium impressulum, C. laeve, C. meneghinii formae* (= *C. subgranatum?*) and *C. variolatum* likewise showing a pattern of smaller or larger circles on the cell wall. All these taxa appeared to have a scrobiculate cell wall according to recent SEM studies by the present author! The presence of a superficial scrobicular sculpturing in *E. insulare* var. *lacustre* may well be a much better differential feature in respect of the var. *insulare* than the arrangement of the apical pores in more or less distinct apical rows. *E. insulare* var. *lacustre* had hitherto been mentioned by only a few workers, the most detailed illustrations being those in FÖRSTER (1965, p. 130. t. 1: 23–26; 1972, p. 415, t. 1: 3–6), which are curious in that, apart from more or less clear apical rows of punctae, most of them show a relatively coarse punctation of the central field of the semicells (*figs. 1s, t*). This is also manifestly indicative of the presence of scrobicles in that area. The somewhat larger black dots slightly below the apical margin (*fig. 1s*) are almost certainly larger and deeper pits, but these are likely to be interpreted as granules, especially so when cells with a protoplasmic content seemingly have no other light microscopically discernible wall sculpturing. A suggestion of such an interpretation can be found in a figure of *E. insulare* collected in the Dutch island Schiermonnikoog (*fig. 1r*). A more detailed study of empty cells of this same material showed that also in this case the central area is blotchily punctate and that in apical view rows of punctations are clearly discernible (*fig. 5a–c*). SEM micrographs of this sample (*figs. 2g, h* and *4f*) indeed show the anticipated image: cells for the most part densely scrobiculate (and in this respect markedly differing from *E. insulare* var. *insulare* and the var. *basichondrum*. The identification of the material in question as *E. insulare* var *lacustre* seems to be fully warranted on the ground of these observations.

4. DISCUSSION

The examination of the above-mentioned taxa by SEM reveals that the cells of individuals of the same species collected in geographically sometimes far-apart localities consistently exhibit the same scrobiculation pattern of the cell wall.

It follows that ultrastructural cell wall characteristics provide a welcome addition to our arsenal of diagnostic features, especially for the distinction of light microscopically hardly distinguishable and frequently confused taxa. In these cases in which between two forms described as varieties of the same species there

are conspicuous differences in their scrobiculation patterns without showing any transition one may well consider the raising of such forms or varieties to the species level. There is, for that matter, no reason to attribute a less cogent taxonomic significance to essentially different wall sculpturings than to, for instance, differences in the sites and/or arrangements of granules, tubercles and spinules. On account of the results of this investigation, the present author, therefore, proposed to assign a specific rank to *E. insulare* var. *lacustre*:

Euastrum lacustre (Messik.) Coesel stat. nov.

Basionym: *E. binale* var. *lacustre* MESSIKOMMER 1927, p. 98, t. 1: 16.

N.B. Type material of this taxon is unfortunately not available because I learned from correspondence that Dr. E. Messikommer, who died in 1983, did not leave any collected material.

The fact that *E. lacustre* differs morphologically from *E. insulare* and *E. binale* in a densely scrobiculate cell wall (and deserves a species status) is substantiated by an ecological difference. Whereas *E. insulare* and *E. binale* like so many other desmids, decidedly prefer an acid to at most neutral environment, the recorded habitats of *E. lacustre* indicate a preference for an alkaline environment. MESSIKOMMER (1938) recorded the latter taxon from (sub)fossil deposits of white marl and calcareous mud in the Tyrole and characterised it as a benthic form of more lime-rich lakes and pools. FÖRSTER's (1965) collection from a *Sphagnum* pool in Torne-Lappmark seems to be in glaring contrast but one must always bear in mind that the usual pH preference of plants often is not upheld in arctic environments. Also in the case under discussion the species is, according to Förster, accompanied by several desmid species that are decidedly not known to be acidophilous in Central Europe, such as *Closterium parvulum, Cosmarium granatum, C. holmiense* var. *integrum, C. hornavanense* var. *dubovianum, C. punctulatum, C. regnellii, C. speciosum, Micrasterias crux-melitensis, Staurastrum furcigerum* and *Hyalotheca dissiliens* (compare COESEL 1979a, b). FÖRSTER's (1972) record of *E. lacustre* from Venezuela agrees much better with MESSIKOMMER's ecological characterisation: in Lake Valencia with water rich in electrolytes (conductivity 1800 μS cm^{-1}), with a high sulphate content (SO_4^{2-} 333 mg l^{-1}) and a fairly high hardness MgO 56 mg l^{-1}; CaO 45 mg l^{-1}) FÖRSTER recorded fifteen desmid species from this relatively extreme environment, mainly representatives of the genus *Cosmarium*, with *E. lacustre* as the only species of this genus. In The Netherlands *E. lacustre* has so far only been found in the North Sea Islands of Terschelling and Schiermonnikoog where it is fairly common in dune lakes with a pH 7–9, a conductivity of 300–950 μS cm^{-1}, a calcium content of 45–75 mgl^{-1} and a magnesium content of 15–25 mgl^{-1}, a likewise alcaline and rather electrolyte-rich habitat.

The present author also proposes a change in rank for the other *Euastrum* variety amply discussed above, viz. *E. binale* var. *groenbladii*; this not on account of SEM revealed fine wall structures but on its essentially different gross morphology. *E. binale* var. *groenbladii* is characterised by an almost straight apex line and rounded apical angles which renders its habit cosmarioid (thus confusion with *Cosmarium quadratulum* being possible, cf. *figs 5d, e* and *5f, g*), whereas

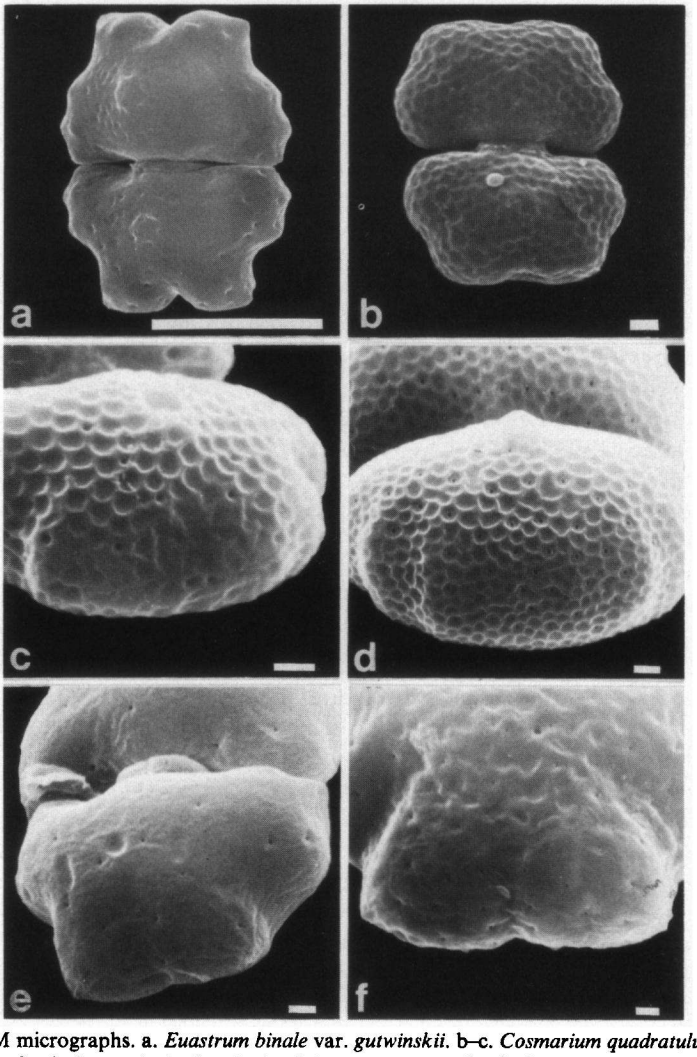

Fig. 4. SEM micrographs. a. *Euastrum binale* var. *gutwinskii*. b–c. *Cosmarium quadratulum?* (c. arrangement of apical pores). d. *C. subreinschii*, arrangement of apical pores. e. *Euastrum insulare* var. *insulare* arrangement of apical pores. f. *E. lacustre* (syn.: *E. insulare* var. *lacustre*), arrangement of apical pores. Scale-bar in a represents 10 μm, in b–f 1 μm.

in all other varieties of *E. binale* the apical lobe has a characteristic, wide V-notch connected at either side with the acute apical angles through a usually conspicuously arched apex line. To my mind the typically euastroid morphology of the apical lobe is such an essential feature of *E. binale* that for this reason the var. *groenbladii* ought to be excluded from this species:

Euastrum groenbladii (Messik.) Coesel stat. nov.

Basionym: *E. binale* forma *groenbladii* MESSIKOMMER 1927, p. 98, t. 1: 17, 3: 9.

N.B. Of this taxon no type material could be examined either; see above under

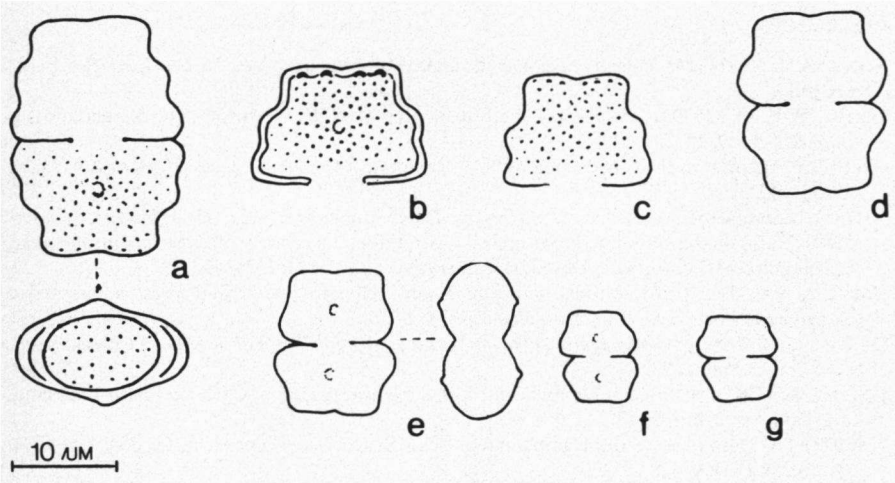

Fig. 5. Illustrations of Dutch material of: a–c. *Euastrum lacustre* (syn.: *E. insulare* var. *lacustre*), d–e. *E. groenbladii* (syn.: *E. binale* var. *groenbladii*), f–g, *Cosmarium quadratulum* (?). In all three taxa the rate of development of a central protuberance (papilla) is a variable feature.

E. lacustre. The earlier homonym *E. groenbladii* Scott & Groasd. (SCOTT et al. 1965, p. 33, f. 62) does not prevent the use of the later combination because the first was not validly published (Art. 37, ICBN).

E. groenbladii differs from *E. binale* in its cosmarioid habit form (with almost straight apex line and rounded apical angles) but can be distinguished from superficially similar species of *Cosmarium* by the altogether different scrobiculation pattern of the cell wall and by the conspicuous apical rows of pores on either side of the (shallow) median notch. As far as its ecology is concerned, there are indications that *E. groenbladii* in comparison with *E. binale* prefers not so pronouncedly acid habitats. MESSIKOMMER (1927) described the taxon from a Caricetum rostratae with pH 6.9–7.1. In a later publication (MESSIKOMMER 1929) it is recorded from a peat pit with *Typha minima* and *Potamogeton* but especially from hydrosere vegetations in association with the moss *Scorpidium scorpioides* and various species of *Utricularia* with pH 6.2–7.0. The present author found it in a very similar habitat in shallow fen hollows in the holocenic broads area of N.W. Overijssel (The Netherlands) with pH 6.6–6.8 (COESEL 1981, as *Cosmarium quadratulum*). Now that *E. groenbladii* can be distinguished from *E. binale* and from small species of *Cosmarium* the species under discussion appears to be of fairly common occurrence in The Netherlands, also in mesotrophic, slightly acid pleistocenic moorland pools. Up to now it has not been recorded from more pronouncedly acid peat bog pools (pH $< 5{,}5$), which habitat is precisely the preferred environment of *E. binale*, in particular, of its most common infraspecific taxon, the var. *gutwinskii* (compare RŮŽIČKA 1981).

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