

NOTES ON INDONESIAN FRESHWATER ALGAE—IV.

Concerning *Euastrum moebii* (Borge) Scott & Prescott *comb. nov.*
and *Euastrum turgidum* Wallich.

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SUMMARY

The desmid presently known as *Mierasterias moebii* (Borge) West & West is transferred back to the genus *Euastrum* where it was originally placed by its discoverer, together with its several varieties, for reasons that are discussed in detail. There are described one new variety, var. *diplocanthyllum* from Australia, and one new form, var. *tetrachastriforme* fa. *latum* from Borneo. New illustrations are given for *Euastrum, turgidum* Wall., and criteria are suggested for differentiating this plant from the closely similar *E. moebii*.

Euastrum moebii (Borge) Scott & Prescott *comb. nov.*

This desmid was first described from Australia by M'ebius (1894) who identified it as a forma of *Euastrum verrucosum*. Borge (1896) named it *E. verrucosum* var. *moebii*. The assignment to *verrucosum* is obviously incorrect, as was noted by West & West (1897), who transferred it to *Mierasterias* and raised it to specific rank as *M. Moebii*. For a better understanding of our arguments which follow we quote in full West & West's remarks concerning this transfer:

"We do not consider that the var. *moebii* of *Euastrum verrucosum* belongs to that genus, much less to that species. The polar lobe is that of a *Mierasterias* and not that of an *Euastrum*. The characters of *M. moebii* are so different from those of *E. verrucosum* that we fail to see how it came to be placed under the latter species".

Our first acquaintance with actual specimens of this plant was in 1950—1951 during our examination of Arnhem Land collections, from which we described one new variety and one new form (Scott & Prescott 1958, but written in 1952). At that time we were impressed by its very considerable resemblance to *Euastrum*, also we noted West & West's remarks quoted above, and the comment by Krieger (1939, p. 43) that the systematic position of the species is questionable ("*strittig*") and that the wall-sculpture suggests

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the *verrucosum*-group of *Euastrum*. Because we had seen only a few specimens of the two new forms, and none of the previously recognized varieties nor the type species, we did not feel justified in publishing an opinion contrary to that of the old masters of desmidiology, West & West.

Since then we have seen, in the present Indonesian material, numerous examples of var. *burmense* and of the new *forma* of var. *tetrachastriforme* published herein, and a few specimens of a very similar plant that we have referred to *Euastrum turgidum*. Also in a new collection from the Northern Territory of Australia we have many specimens of the curious new variety, var. *diplocanthyllum*, which we are describing now because its structure has a bearing on the question of generic assignment, though it has not been found in Indonesia. All of these plants possess certain general features in common, and we have undertaken a review of them to see what could be learned from a detailed analysis.

It will be noted that West & West's objection to the *Euastrum* assignment is based principally, if not entirely, upon the polar lobe. Krieger (*loc. cit.*) also observes that the development ("*Ausbildung*") of the lateral and polar lobes justifies the assignment to *Micrasterias*. But Krieger himself must have been somewhat confused, because in his treatment of *E. turgidum* (1937, p. 624) he lists *M. moebii* var. *javanica* as one of its synonyms! As to the lateral lobes it is only necessary to look at Plates 92 and 93 of Krieger's Monograph (1937) to see no less than six species and a dozen varieties of *Euastrum* which have lateral lobes divided and/or extended in forms similar to those of *M. moebii* and its varieties, so that this feature belongs to *Euastrum* just as much as to *Micrasterias*.

The polar lobe is the feature that caused the difference of opinion in the past, and doubtless will do so again; in respect to the polar lobe it must be admitted that the plant occupies a position intermediate between *Micrasterias* and *Euastrum*. The most noticeable characteristic of this lobe, in front view, is its great width, which in the specific form and var. *tetrachastriforme* is almost equal to the width across the base of the semicell. There are several species of *Euastrum* in which the polar lobe is almost or quite as wide as the semicell base, such as *E. truncatum*, *truncatiforme*, *sympageum*, *pleсиocoralloides*, *geometricum*, *bimorsum*, *floridense*, etc., but perhaps these may not be admitted as valid comparisons because the plants are of a greatly different type from the one under consideration. However, there is one *Euastrum* of a quite comparable type, *divergens* var. *bifidum*, which has the polar lobe extended laterally.

In the vertical view of *M. moebii* the polar lobe is seen to be divided by two wide and deep incisions into four stout tapering lobules terminating

in a few (3 or 4) blunt conical teeth and also bearing large scrobiculae. In *Micrasterias* a divided polar lobe is known in four other species, *M. muricata*, *nordstedtiana*, *americana*, and *mahabuleshwariensis*, but in all of them the division is formed by true tubular processes that are not at all homologous with the lobules of *M. moebii*. The nearest approach that we have seen to the division of the polar lobe of *M. moebii* is in a new *Micrasterias* species (unpublished) from Brazil, somewhat similar in general appearance to *M. triangularis*, in which the polar lobe is sometimes entire but sometimes divided like that of *M. moebii*, the two conditions occasionally occurring in the two semicells of one individual.

In *Euastrum* the polar lobe divided into four tapering lobules is known in several species, e.g., *E. pinnatum*, *insigne*, *wollei*, etc., though again these are of different types from the one under discussion. But in *Euastra* that are strictly comparable with *M. moebii* we find indications of a quadrifid polar lobe in *E. gemmatum*, *bellum*, *divergens*, *turgidum* and *verrucosum* (Cf. *E. verrucosum* var. *alatum* fa. *extensum* Scott & Presc, 1952, PL 2, Fig. 6). It appears to us, therefore, that the divided polar lobe of *M. moebii* may be regarded as simply an exaggerated form of the quadrifid polar lobes of these *Euastrum* species.

In side view all the forms of *M. moebii* are alike. The cell is rectangular, with two large and very prominent protuberances on each side, the apical angles rounded and slightly projecting, and the apical margin between them usually somewhat retuse. The side view is where the resemblance to *Micrasterias* ceases completely, for there is no other *Micrasterias* (except perhaps *M. crux-africana* whose side view is not known) which has such large protuberances in side view, nor such a broad and retuse apex. On the other hand this side view is almost identical with that of several *Euastra*, such as *E. platycerum* var. *pulchrum*, *hypochondrum*, *divergens*, *spinulosum* var. *inermius*, and *verrucosum*.

There are several species of *Micrasterias* that have a small central facial swelling, usually armed with small teeth or spines. *M. tropica* var. *indivisa*, which we know only from the illustration, has a central rosette of verrucae, a typical *Euastrum* ornament. *M. crux-africana*, whose general structure is very much like that of *M. moebii*, has an extremely large central ornament, presumably a swelling, covered with triangular markings (probably pits) arranged in quite regular hexagons that seem to have been drawn in a stylized manner. Against these few examples, there are about 20 species of *Euastrum*, of types comparable with *M. moebii*, which have the large central tumour surrounded by one or two rings of simple or emarginate verrucae and sometimes with other large granules in the center. In *M. moebii*

var. *javanica* there is a similar rosette of verrucae, but in all the other varieties and in the species the tumour is ornamented with numerous large pits, circular to elliptical or triangular in shape and arranged in a hexagonal manner, with sometimes a low rounded granule in the center of each hexagon. This type of ornament occurs in many species of *Cosmarium*, three of *Xanthidium*, and one of *Arthrodesmus*, also in *Euastrum turgidum*, but is quite unknown in *Micrasterias*, except for the moebii-like *M. crux-africana*. In the new variety, var. *diplocanthyllum*, the strongly scrobiculate projections from the lower margin of the central tumour, almost meeting those of the opposite semicell, have no counterpart in *Micrasterias*, but are quite similar to those of *E. crassum*, *humerosum*, *ventricosum*, *ampullaceum* and *asperum*.

In *M. moebii* and most of its varieties there are one or two smaller swellings on each of the lateral lobes. This is a feature common to many *Euastrum* species, though something similar occurs in a few species of *Micrasterias*.

The specific form of *M. moebii* and some of its varieties have each lateral lobe divided into lower and upper lobules, though sometimes the upper one is represented merely by a swelling on the dorsal margin of the lower one. Frequently the upper lobule is doubled, as is easily seen in the side view. Except as a teratological phenomenon such a doubling of the upper lateral lobules is unknown in any other species of *Micrasterias* except *M. muricata*, in which the "lobules" are true processes. On the other hand, doubling of the upper lateral lobules occurs in several *Euastrum* species, such as *E. crassum*, *pinnatum*, *ventricosum*, *evolutum*, *pirassunungae*, *kolkwitzii*, though all of these differ considerably in structure from *M. moebii*.

All species of *Micrasterias* have porose walls, and in some the pores are quite conspicuous, but we have never seen and do not know of any in which the wall can be called scrobiculate. In *M. moebii* and all of its varieties the wall is scrobiculate, the pits being larger on the lobes where they have an apparent diameter of about 2μ , and in optical section they can be seen to be almost hemispherical excavations. This is a very common feature in *Euastrum*, being found in the groups that include *E. longicolle*, *obesum*, *crassum*, *oblongum*, *insigne* and *verrucosum*, among others.

Finally we come to the structure of the chloroplast, and here again the resemblance to *Micrasterias* breaks down. All the specimens that we have observed have been from preserved material, in which the chloroplasts are frequently so deteriorated that their structure is not determinable. We have been able to ascertain, however, that in the varieties *burmense*, *tetrachastri-forme* fa. *latum*, *diplocanthyllum* and *insolitum* the chloroplast is tetracentric. According to Teiling (1952) the tetracentric chloroplast is unknown in any

other *Micrasterias* species, but it occurs frequently in the larger species of *Euastrum*.

Summing up our arguments, and attempting to place a numerical value on the several features, we present the tabulation below. We have assigned an arbitrary value of 10 points to each of the features discussed, and have divided this number into two parts, each representing what we believe shows the relative resemblance to *Micrasterias* and to *Euastrum*. Other workers may doubtless disagree with some of our values, so we suggest that they assign their own values and add their figures.

	<i>Micrasterias.</i>	<i>Euastrum.</i>
General shape of cell in front view	4	6
Laterally extended polar lobe	7	3
Division of polar lobe	2	8
Side view of cell	1	9
Facial swelling and ornament	2	8
Doubling of upper lateral lobules	1	9
Scrobiculate cell wall	0	10
Tetracentric chloroplast	0	10
Total	<u>17</u>	<u>63</u>

While admitting that *M. moebii* is one of those peculiar desmids that do not fit satisfactorily into the artificially delimited generic classifications, and that can be assigned to one genus or another depending on personal opinion and subjective impressions, we think we have demonstrated that in this case the preponderance of evidence favors its assignment to *Euastrum*. Accordingly we now make the formal transfer back to the genus where it was originally placed by its discoverer, Möbius. The change, of course, affects all the varieties, and we have listed them below.

Euastrum moebii (Borge) Scott & Prescott *comb. nov.*

Syn. *E. verrucosum* forma Möbius (1894).

E. verrucosum var. *moebii* Borge (1896).

M. moebii (Borge) West & West (1897).

Euastrum moebii (Borge) Scott & Presc. var. *burmense* West & West

Syn- *M. moebii* (Borge) West & West var. *burmense* West & West (1907).

Euastrum moebii (Borge) Scott & Presc. var. *ridleyi* West & West.

Syn. *M. moebii* (Borge) West & West var. *ridleyi* West & West (1897).

Euastrum moebii (Borge) Scott & Presc. var. *javanicum* Gutw.

Syn. *AT. moebii* (Borge) West & West var. *javanica* Gutw. (1902).

Euastrum moebii (Borge) Scott & Presc. var. *tetrachastriforme* West & West.
Syn. *M. moebii* (Borge) West & West var. *tetrachastriformis* West & West (1901).

Euastrum moebii (Borge) Scott & Presc. var. *luzonense* Behre.
Syn. *M. moebii* (Borge) West var. *luzonensis* Behre (1956).

Euastrum moebii (Borge) Scott & Presc. fa. *extensum* Scott & Presc.
Syn. *M. moebii* (Borge) West & West fa. *extensa* Scott & Presc. (1958).

Euastrum moebii (Borge) Scott & Presc. var. *insolitum* Scott & Presc.
Syn. *M. moebii* (Borge) West & West var. *insolita* Scott & Presc. (1958).

Euastrum moebii (Borge) Scott & Presc. var. *diplocanthylum* var- nov. Fig. 1.

Cellulae magnitudine formaque quasi eadem atque in varietate javanico. Varietas differens praecipue proprietate tumoris medii cuius margo inferior in duas partes truncatas, deorsum eminentes, eis alterius semicellulae fere incidentes, dividitur, inflationibus lateralibus minoribus solitis, cellula a fronte visa non visibilibus. Lobuli superiores-laterales aut singulus aut duplices, interdum et singulus et duplices in ambabus semicellulis unici specimenis; extremitates omnis lobuli truncatae, tres vel quattuor dentes ferentes. Corpus a vertice visum late fusiforme, polis truncatis paululum angustis atque productis, ad partem mediam utriusque marginis protrusionem permagnum, apice retuso atque margine crenulato, ferens; lobuli superiores-laterales aut singulus aut duplices; lobus polaris in quattuor lobulos crassos, extremitatibus truncatis, duos vel tres dentes obtusos ferentibus, divisus. Semicellulae a latere visae trapezoideae, ad basim utroque in latere protuberantiam magnam, margine crenulato, parte in inferiore uncinatum et sinum partim claudentem praebentes, apex convexus, duas projectiones intra marginem enascentes, lobulos polares repraesentantes, habens; semicellulae admodum super basim media parte ellipsem magnam, lobum lateralem repraesentantem, praebentes; ellipsis una vel duabus projectionibus intra marginem ad partem superiorem enascentibus, lobulos superiores-laterales repraesentantibus, atque una projectione ad partem inferiorem, lobulum inferiorem-lateralem repraesentante, atque inflatione minore utroque in latere praedita. Scrobiculi per totam membranam cellulae, necnon per tumorem medium dispositi, hicque in hexagonis irregularibus elongatis, ut videtur, ordinati. Chloroplastus tetracentricus, tribus pyrenoideis in unoquoque quadrante praeditus. Long. 101—105; lat. ad basim 100—108; lat. ad lob. pol. 77—84; isth. 32—33; crass. 52—57. Habitat: N. Australia X-104, in caeno in loco OenPELLI, Arnhem Land, dicto. Coll. R. G. Gregson, m. Apr., an. 1954.

Cells of about the same size and shape as those of var. *javanicum*. Differs principally in the character of the central tumour, the lower margin of which is divided into two truncate parts which project downwardly and almost meet those of the opposite semicell; the usual smaller swellings not visible in front view. Upper lateral lobules either single or double, sometimes both in the two semicells of one individual; ends of all lobules truncate and bearing three or four blunt teeth. In vertical view a broadly fusiform body with slightly narrowed and produced truncate poles; centrally on each margin a very large protrusion with retuse apex and crenulate margin; upper lateral lobules either single or double; polar lobe divided into four stout lobules with truncate ends bearing two or three blunt teeth. In side view semicells trapezoidal; at the base on each side a large flattened protuberance with crenulate margin, uncinata at the bottom and partially closing the sinus; apex convex with two subapical projections arising intramarginally and representing the polar lobules; centered just above the base of the semicell a large ellipse representing the lateral lobe, with either one or two projections at the top representing the upper lateral lobules, and one projection at the bottom representing the lower lateral lobule, and a smaller swelling at each side. Cell-wall scrobiculate all over, including the central tumour, where the pits seem to be arranged in irregular elongated hexagons. Chloroplast tetracentric, with three pyrenoids in each quadrant.

Length 101—105; Width base 100—108; Width polar lobe 77—84; Isthmus 32—33; Thickness 52—57. Habitat, N. Australia X-104, Slough at Oenpelli, Arnhem Land. Coll. R. G. Gregson, April 29 1954.

From our illustrations it will be seen that the central tumour of this plant is quite unlike that of the species and the other varieties. The two downward protrusions are different from anything known in the genus *Micrasterias*, but are similar to those found in such *Euastra* as *E. crassum*, *giganteum*, *ampullaceum*, *insigne*, *ventricosum* and *asperum*. This gives additional force to our arguments, and is the reason for publishing this Australian desmid here, though it has not been found in Indonesia.

***Euastrum moebii* (Borge) Scott & Presc. var. *tetrachastriforme* West & West fa. *latum* fa. nov. Fig. 2.**

Cellula forma ornataque varietatis cellulae similis; paulo longior atque aliquante latior quam in varietate ita ut cellula a fronte visa quasi quadrata, non verticaliter elongato-rectangularis ut in varietate, videatur. Scrobiculi per totam membranam cellularum necnon per tumorem medium dispositi, hicque hexagonaliter ordinati. Chloroplastus tetracentricus, numero pyrenoideorum ignoto. Long. 126—131; lot. ad basim 133—135; lot. lob. pol. 102—105; isth- 37—39; crass. 74—75. Habitat: Borneo 404, in piscina in loco Sekadau on Kapuas River, W. Borneo, dicto. Coll. M. Sachlan, m. Aug., an. 1956.

Shape and ornamentation of the cell similar to those of the variety. Length a little more than in the variety, width considerably more, resulting in a more nearly "square" appearance of the cell in front view, as opposed to the elongated rectangular shape of the variety. Chloroplasts tetracentric, number of pyrenoids unknown.

Length 126—131; Width base 133—135; Width polar lobe 102—105; Isthmus 37—39; Thickness 74—75. Habitat: Borneo 404, Fishpond at Sekadau, on Kapuas River, W. Borneo. Coll. M. Sachlan.

EUASTRUM TURGIDUM Wallich (1860). Figs. 3, 4, 5.

No doubt many desmidiologists who have examined the illustration in Krieger's monograph (1937/39) of *Euastrum turgidum* and *Micrasterias moebii* have been impressed by the strong resemblance between these two plants, and may have wondered what were the reasons for their having been assigned not only to different species but to different genera. The question of the genus has been settled, we believe, by our transfer of *M. moebii* to *Euastrum*. The problem of the species, however, is more obscure, and must remain unsettled for the present. We think that our new illustrations and our comments will help toward an eventual solution of the problem, when more information is available concerning Indian forms of *E. turgidum*, and in the meantime we offer some criteria by which the two plants may be differentiated, which in some instance is not at all easy.

E. turgidum was first collected by G. C. Wallich in 1855, in the neighborhood of Raneegeunge, about 120 miles northwest of Calcutta, India, and published in his paper "Desmidiaceae of Lower Bengal" (1860). Because this paper is not well-known nor easily accessible, we give, in our Fig. 3, copies of his front and side views, which are all that he showed, enlarged to about the same scale as our own drawings, and we quote his description and comments in full:

"*E. turgidum*, n.s. Frond large. Segments broadly cuneate, truncate, with a large central inflation. Terminal margin straight".

"As seen in front view, the general outline of this species resembles that of the immature state of the large variety of *Xanthidium armatum*. It is distinguished from it, however, by the presence of the large central granulate inflation, the existence of a minute terminal notch, and by its not presenting the characteristic funnel-shaped processes which are distributed symmetrically upon the frond in that species".

"It also bears some resemblance to the species recently discovered in Ireland by the late Rev. R. N. Dixon, and described under the new generic name of *Tetrachastrum* in the Nat. Hist. Review (Vol. VI, No. 4, p. 464); but if a mature form, the entire absence of any inflated protuberance, or terminal notch, would seem sufficient to distinguish the latter from the present species, and to render it conformable, in all essential characters, to *Holocystis oscitans* Hassall."

"In the side view, the central inflated portion presents an irregular granulated outline, and the segments are pyriform. End view broadly elliptical, with the inflated portion granulated and the angles furnished with several stout conical projections".

"The lateral margins, in the front view, are sinuate, the prominent portions presenting the conical projections already referred to".

"Length .0050 inch; breadth .0038 inch [127 x 97 μ]. Lower Bengal 1855. Plate XIV, Fig. 17, front view. Fig. 18, side view".

The only other Indian record of the plant is that of Turner (1892), who listed var. *typicum* Wall.; var. *grunovii* Turn., (named for the plant described and illustrated by Grunow (1865) from Banka Island); and a forma *bitumida* of the latter variety, which different only in having two central tumours instead of one, and of which he saw only one specimen that may have been teratological. Turner added nothing to Wallich's description except some more complete dimensions. He notes that both var. *grunovii* and forma *bitumida* were found in the remnants of Wallich's gatherings; and that he found only three specimens of var. *typicum*, but does not state their source.

The species and some named varieties (none of which seems very safe except var. *simplex* Borge) have also been recorded from Java, Sumatra, Malaya, Japan, New South Wales, Queensland, and New Guinea.

To anyone who is well acquainted with the genus *Euastrum*, Wallich's drawings are not convincing, and that doubtless is the reason why Krieger disregarded them in his monograph (1937) and selected an illustration by Okada to represent the species. Wallich's figures of other known desmid species, e.g. *M. alata*, are correct as to outline, so that his figure of *E. turgidum* is probably correct in this respect, but the size of the central tumour seems disproportionately large, and the fact that the tumours of the upper and lower semicells touch each other and seem even to be slightly flattened at the line of contact is highly unusual and is not confirmed by his side view. Further, the irregular distribution of the granules on the tumour, if they are really granules and not pits, differs from that of all other *Euastra* that have granulate or verrucose central swellings, e.g. *E. verrucosum*, where the granules or verrucae are regularly arranged in concentric circles or ellipses. His description refers to a minute terminal notch, which we think was an optical illusion caused by two closely opposed granules immediately below the center of the apical margin. In his side view there is no doubling of the upper lateral or polar lobules, and the polar lobe is very much thinner than in the illustrations of most subsequent authors.

Turner's illustrations of *E. turgidum* are quite similar to those of Wallich, and may perhaps have been influenced by them. In his front view

(1892, Pl. 10, Fig. 28a) the central tumours are proportionately somewhat smaller, though with the same irregular disposition of the granules; and on the body of the cell he has shown numerous small semicircular markings that are the conventional way of representing granules, but which he may have intended for scrobiculae. His side view, Fig. 28b, clearly shows the upper lateral lobules and the polar lobe as single, while his vertical view, Fig. 28c, just as clearly shows the upper lateral lobules and the polar lobules as doubled. His drawing of var. *grunovii*, Fig. 29, shows a smaller central tumour with verrucae arranged in two concentric circles with a few scattered ones in the center, more nearly in accordance with other *Euastra* such as *E. verrucosum*. It should be remembered that var. *grunovii* was found in the remnant of Wallich's material. Dr. Rolf Grønblad has sent us a photocopy of a sketch that he made many years ago, showing a specimen of *E. turgidum* from Rabenhorst's Exs. No. 1727, which contains the original material from Insel Banka described by Grunow (1865). This sketch does not differ in any important respect from our Fig. 4, which depicts a specimen from the vicinity of Djakarta. In particular the central tumour is covered with triangular pits arranged in hexagons with a small granule in the center. This central granule is not shown in our Fig. 4, but is shown in Fig. 5 of a specimen from Bogor; the granule is not always visible, especially in cells that retain the chloroplast. Therefore Turner's Fig. 29 with a verrucose central tumour is not identical with Grunow's plant, and Krieger was correct in excluding Turner's var. *typicum*, var. *grunovii* and fa. *bitumida*.

Despite all these peculiarities and inconsistencies, the possibility cannot be excluded that there *may* exist in India an *Euastrum* whose shape and ornamentation would be more or less correctly represented by Wallich's and Turner's drawings. If and when such a plant does turn up, a revision of *E. turgidum* will be necessary, for it is evident that the plants assigned to this species by subsequent authors, including ourselves, differ considerably from Wallich's illustration. For the present, however, and until more evidence and exact drawings of such a plant are available, we think it best to exclude Wallich's and Turner's illustrations from consideration, as Krieger did.

In the illustration by Okada (1936) which he referred to var. *grunovii*, but which Krieger selected to represent the species, the outline of the cell agrees very well with Grønblad's and our drawings, and he shows some triangular markings in the center but does not say whether they represent granules or pits; he remarks that he determined his specimens after Bernard's descriptions and figures. Bernard's illustrations from Java (1908) and Malaya (1909), which he ascribed to var. *grunovii*, must actually be referred

to *E. moebii*, because of the greater development of the upper lateral lobules, the deeper incision of the polar lobes, and the narrower ellipse of the vertical view. In Bernard's figure (1908, Fig. 219), he shows triangular markings on the central swelling, but refers to them, incorrectly, as "tubercules disposés en hexagone"; they really are pits. He also notes the brown coloration of the central tumour in older specimens, which is caused by iron compounds (Cf. Krieger, 1937, p. 6, and p. 10, Fig. 6F).

The plants from Centennial Park, Sydney, Australia, described by Raciborski (1892) as *E. verrucosum* var. *crux-australis*, do not belong to *E. verrucosum*, of course, but must be referred to *E. turgidum*, as shown by their tumid vertical view. The illustrations are not good enough for more precise determination, and since the three forms apparently came from the same habitat the small differences would seem to be merely incidental variations.

EUASTRUM TURGIDUM Wall. var. SIMPLEX Borge (1896).

This variety was described by Borge (1896) from New South Wales, Australia. His description merely states that the apical margin is nearly straight and that the lateral lobes are rotund instead of undulate; he compares his plant with the Sumatran specimens that Schmidle (1895) referred to var. *grunovii*. Borge's figure is poor and gives no information about the ornament on the central tumour.

Krieger (1937) relegated to synonymy with var. *simplex* the plants from Sumatra described by Schmidle (1895) as var. *grunovii*, and this is undoubtedly correct because of the simpler outline of the cell, and particularly the rotund dorsal margin of the lateral lobes. Schmidle was the first to describe accurately the ornamentation of the cell-wall, stating that the granules or warts are confined to the upper and lower angles and the central tumour, the remainder of the surface being rough with small "dimples" (*Grübchen*). He discussed at some length the triangular markings on the tumour, describing the changes in light and shade and in the apparent shape of the markings that are caused by slight upward or downward changes in the focussing of the microscope. These changes are the result of different amounts of refraction of light rays passing through the differing thickness of the cell-wall. The phenomenon is quite complicated in the case of these triangular pits that are arranged in hexagons with a raised granule in the center, but a simple hypothetical case can be more easily understood. Consider a thin membrane, such as the cell-wall of a desmid, flattened and placed on a microscope slide and illuminated from below by parallel light rays. On the upper or outer surface of the membrane there is a small hemispherical

depression or pit, and on the under surface a corresponding depression but of larger radius. These two curved surfaces constitute a negative meniscus lens that converts the parallel light rays into an inverted cone of rays that diverge upwards. Consequently when the focus of the microscope is raised, the apparent diameter of the circular depression appears somewhat larger, and as the same amount of light is spread over the larger area, the surface appears darker. When the focus is lowered the opposite change takes place and the surface appears to become lighter. In the reverse case the membrane has a raised hemispherical granule on the upper or outer surface, and a corresponding hollow of larger radius on the under surface. These act as a positive meniscus lens that changes the parallel light rays into a cone that converges upwards. When the focus is raised the apparent diameter of the granule decreases, and the same amount of light is spread over a smaller area that consequently appears brighter. In actual practice, of course, these simple conditions do not obtain, but the principle holds good and it usually affords a reliable method of differentiating between pits and granules; pits become darker as the focus is raised, while granules become lighter. In some instances there can be seen, at a certain focus, a tiny black spot in the center of the circular marking; such spots have been interpreted as pores through the cell-wall. Whether they are always pores is open to question, for such a black spot that disappears upon change of focus could be caused by a refractive effect, *e.g.*, if one of the curved surfaces were spheroidal instead of truly spherical, which could easily be true.

Playfair (1908) transferred *M. moebii* to *E. turgidum*, as *E. turgidum* Wall. var. *moebii* Playf., but the transfer has not been accepted by subsequent authors. Krieger (1937) rejected it, and G. S. West (1912) merely remarked that Playfair had confused the two plants. But West continues thus: "It would appear that *E. turgidum* is a desmid of the Indo-Malay region, probably very rare, which requires further investigation. I have not yet seen it, but I judge that such a species exists, not only from Wallich's original account, but also from the somewhat poor figure published by Schmidle of a specimen from Sumatra." If West had actually seen Schmidle's plant, or those that other authors have called *E. turgidum*, he might not have dismissed the matter so summarily, for actually some forms of the two species are quite difficult to differentiate. Prior to the writing of this paper we gave serious consideration to the advisability of combining the two species and reviving Playfair's nomenclature. We finally decided to keep them separate because some of the recently discovered varieties, such as *E. moebii* var. *insolitum* Scott & Presc. and var. *diplocanthylum* Scott & Presc. differ so greatly from the basic form of *E. turgidum* that they cannot

be included in one species. In this connection Lektor Einar Teiling has made the interesting suggestion (*in litt.*) that the two species may be the present stages in two slightly divergent lines of evolution from a common ancestor, which appears not implausible.

Playfair (1908) created the name *E. turgidum* var. *simplex* n. var., but the varietal epithet is illegitimate because it had already been used by Borge (1896). No illustration accompanied Playfair's description, but he compared his plant with *E. verrucosum* var. *simplex* Josh, (in Turner 1892, PL 11, Fig. 9*). The systematic position of Joshua's plant is doubtful because of inadequate information; Krieger (1937) excluded it on the ground that it is a *Cosmarium*, but this also is doubtful because the side view with its wide and retuse apex is that of an *Euastrum*. It does not belong to *E. turgidum* because of the lack of a central tumour, i.e. Its narrow polar lobe in front view, and much smaller size.

Krieger (1933) recorded var. *grunovii* from Java, but later (1937) revised it to var. *simplex* Borge. In his comments (1933) he states that his specimens agree best with Schmidle's illustration (1895, PL. 4, Fig. 12), but notes that the sculpture of the central part is generally irregular, and his illustration (1933, PL. 21, Fig. 3) which he used again in his monograph (1937) as typical of var. *simplex*, shows a number of circular granules of varying sizes connected by short lines in what seems to be an incomplete network. This figure should be compared with another in his monograph (1937, p. 10, Fig. 6F) showing a specimen of similar shape to var. *simplex* that has been chemically treated to bring out the ornament. In the latter figure the network of lines is complete, and they enclose triangular spaces that we believe are triangular pits, similar to those shown in Schmidle's illustration cited above. With due respect to the late Dr. Krieger we think that his 1933 illustration does not correctly represent the central ornament.

EUASTRUM TURGIDUM Wall. var. AUBURNENSE Playf. (1908).

Krieger (1937, p. 658) excluded this variety as being a *Micrasterias*. The only species of *Micrasterias* that it could be assigned to would be *M. moebii*, which we have transferred to *Euastrum*. Playfair's front view does indeed resemble *E. moebii*, but his side and vertical views show a very narrow and undivided polar lobe which is unknown in *E. moebii* or any of its varieties, but apparently does occur in *E. turgidum* though we have not seen any ourselves. Playfair's vertical view is also too tumid for *E. moebii*, and in this respect also is closer to *E. turgidum*. For the present, therefore, we are inclined to allow var. *auburnense* to remain as a good variety.

Our illustrations Figs. 4 and 5 show two different forms, both of which we refer to the species and not to any of the varieties of *E. turgidum*. Fig. 4 represents a specimen from a swamp near Djakarta, Java, and is quite similar to the drawing by Grönblad, mentioned above, of a specimen from Banka Island, except that in the latter there is faint suggestion of a very small notch in the outer margin of the lateral lobes, similar to but even smaller than those shown in our Fig. 5. We have also seen a single example of this form from collection *Borneo 403*, from Danau Panggang, near Amuntai, S. Borneo. The dimensions of our Djakarta specimen are: Length 124; Width 102; Width polar lobe 72; Isthmus 39; Thickness 66. Those of Grönblad's are: Length 118; Width 100; Isthmus 40; Thickness 49.

Our Fig. 5 depicts one of several specimens from a pond at the Laboratory for Inland Fisheries at Bogor, Java, collected in May 1942. These are noteworthy for the large size of the central tumour, which in most cases is elliptical in shape with the longer axis horizontal, another unusual feature, and its especially distinct ornamentation. Dimensions of some of these specimens are: Length 122—132; Width 100—107; Width polar lobe 72—83; Isthmus 36—40; Thickness 64—69.

The criteria that we have used for differentiating *E. turgidum* from *E. moebii* are as follows: The length, width and thickness of *E. turgidum* and especially of var. *simplex* are sometimes much greater than those of *E. moebii*, according to Krieger (1937), though we have not seen any of the extremely large sizes listed by him. The neck below the polar lobe is relatively wider in *turgidum*, resulting in a smaller lateral extension of the polar lobules; the upper lateral lobules, where they exist, can be seen to be doubled only in the side and vertical views. Because of the relatively greater thickness of the cell, the vertical view is more broadly elliptical, or tumid, in *turgidum* than in *moebii*. The central tumour in *turgidum* is sometimes larger in *turgidum* than in *moebii* and the ornament of pits and granules is usually more easily seen; the smaller tumours usually present on the lateral lobes of *moebii* are lacking in *turgidum*. In both species the ornament of the tumour consists of pits arranged in more or less regular hexagons with a raised granule in the center of each hexagon. In old and well-developed semicells the pits are triangular and separated by costae which extend between the raised granules; in younger semicells the pits are frequently circular or nearly so, and then careful examination is required to determine that they actually are pits. The only plants in either species that have verrucae on the central tumour are *E. moebii* var. *javanica* Gutw., and the unknown plant shown in Turner's illustration (1892, Pl. 10, Fig. 29)

The one collection from North Australia was made by Mr. R. G. Gregson, and sent to us by Dr. Ray L. Specht of the University of Adelaide. The Indonesian material was collected by Mr. M. Sachlan, of the Laboratory for Inland Fisheries at Bogor, and sent to us by him. To these gentlemen we extend our thanks for the opportunity of studying these desmids. Portions of all collections have been deposited in the Farlow Herbarium of Harvard University.

We wish also to thank Dr. Hannah Croasdale for translating the diagnoses into Latin, and Mrs. Dorothy Perine for inking the senior author's pencil drawings.

All dimensions are given in microns, and all illustrations are reproduced to a magnification of about $\times 460$. The types of the new taxa are designated as the illustrations and descriptions accompanying each of them.

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EXPLANATION OF THE ILLUSTRATIONS.

- Fig. 1. *Euastrum moebii* (Borge) Scott & Presc. var. *diplocanthylum* Scott & Presc.
2. *E. moebii* (Borge) Scott & Presc. var. *tetrachastriforme* West & West fa. *latum* Scott & Presc.
- j 3. *E. turgidum* Wall. Enlarged from Wallich's original illustration. . 7
4. *E. turgidum* Wall. Fa. Specimen from Djakarta.
- ;- .5. *E. turgidum* Wall. Fa. Specimen from Bogor.

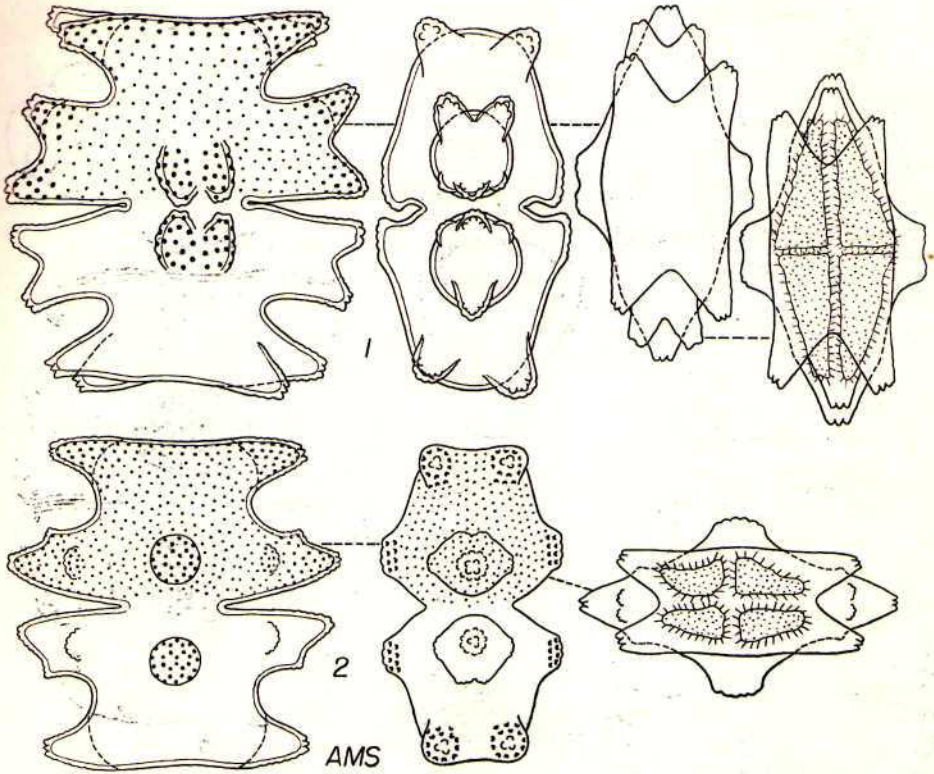


Fig. 1, 2.

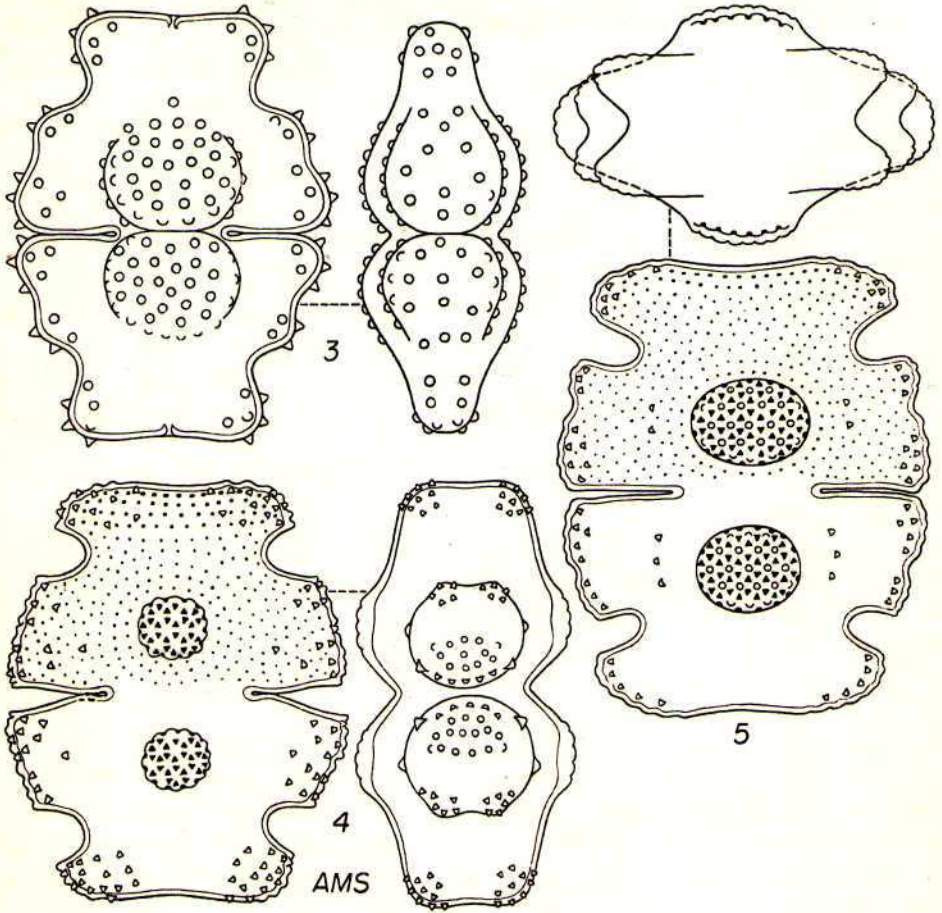


Fig. 3, 4, 5.