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EDITORS

ANWARI DILMY

(Herbarium Bogoriense)

AND

C. G. G. J. VAN STEENIS

(Flora Malesiana)

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NOTES ON INDONESIAN FRESHWATER ALGAE—I

Staurastrum wildemani Gutw. (Desmidiaceae)

ARTHUR M. SCOTT* and GERALD W. PRESCOTT**

At various times during the last four years Mr. M. Sachlan, of the Laboratory for Inland Fisheries at Bogor, Java, has sent us collections of freshwater algae from the larger islands of the Indonesian Archipelago, —Borneo, Java and Sumatra. To him we express our sincere thanks for his care and effort in obtaining this material, and for affording us the opportunity of studying it. A report on the algae is in course of preparation, and will be published on completion.

During our examination we have encountered some curious cases of dichotomy in a species of *Staurastrum*, involving four different forms, which, if considered separately, might be thought to belong to four different species. They throw a new light upon the relationship between *St. wildemani* Gutw. and *St. subtrifurcatum* var. *majus* West & West, whose similarity has been noted and commented upon by other authors. (Schmidle, 1902, p. 73; Gutwinski, 1902, p. 605; West & West, 1907, p. 215; Krieger, 1933, p. 209; Rich, 1935, p. 151; Fritsch & Rich, 1937, p. 213).

The description of these plants requires more space and more illustrations than would be appropriate in the general report; therefore we think it advisable to publish them in this preliminary paper.

Our illustrations were all drawn to a magnification of about 1200, and in printing were reduced by one-half, making the final magnification about 600. All dimensions are given in microns.

Because of some duplication in the numbering of Mr. Sachlan's samples, we found it necessary, in certain cases, to assign new numbers to them. In the following list, which includes only those collections mentioned in this paper, our number is given first, followed by Sachlan's in parentheses:

- BORNEO. Sachlan X. A lake in East Borneo, 1941. Coll. Dr. K. F. Vaas.
Sachlan 38. Lake Semedo, West Borneo, June 1949. Coll. Dr. K. F. Vaas.
JAVA. Sachlan T. A lake in the environs of Bogor.

*2824 Dante Street, New Orleans 18, La., U.S.A.

**Department of Botany, Michigan State University, East Lansing, Mich., U.S.A.

- SUMATRA. 108, 109. (Sachlan VIII, IX). Danau Teloko, near Palembang. August 1951.
110. (Sachlan M). Swamp near Menggala, South Sumatra, April 12 1954.
112. (Sachlan P-1). Swamp Pang-pangan, near Danau Teloko. 1954.

In addition to these Indonesian samples, we refer in the text to two African collections, also containing *St. wildemani*, which we have been privileged to examine through the courtesy of Dr. Rolf Grönblad and the collectors:

UGANDA 4. Dam near Soroti. Coll. Miss E. M. Lind.

SUDAN 1. Lake Ambadi, Bahr-el-Ghazal. Coll. Dr. Julian Rzoska.

1. STAURASTRUM WILDEMANI Gutwinski 1902.—Figs. 1—6

Syn. *Staurastrum subtrifurcatum* f. *bidens* Schmidle 1902.

Gutwinski described this species from a collection made by Dr. M. Raciborski in Sitve (Situ or Siteo = Lake) Tjibinong near Bogor, Java. He was aware of Schmidle's publication, earlier in the same year, of *St. subtrifurcatum* f. *bidens*, because he suggests a comparison with it. Since then *St. wildemani* has been reported from Java and Sumatra by Krieger (1933), and by the present authors from Arnhem Land in the Northern Territory of Australia in a paper now in press. In Sachlan's Indonesian material it occurs rather frequently, sometimes in association with *St. subtrifurcatum* var. *majus* West & West, and forms dichotypical cells with the latter, as will be described later. In 1927 Dr. Rolf Grönblad, of Karis, Finland, found at Sulkava, Finland, a *Staurastrum* which he identified as *St. wildemani*; it is somewhat larger than the Indonesian plants, but otherwise in agreement. He has kindly permitted us to use his unpublished drawings, one of which is reproduced here to our larger scale, as Figure 5. Note that this specimen possesses *three* spines on one angle of the upper semicell, and only two spines on all the others. His original notes on the drawings, made in 1927, show that he considered *St. wildemani* and *St. subtrifurcatum* var. *majus* as synonymous. Also through the courtesy of Dr. Grönblad we have recently had the opportunity of examining some material from Uganda in which both *St. wildemani* and *St. subtrifurcatum* var. *majus* occur in the same gathering; and another sample from Lake Ambadi in the Sudan in which a small form of *St. wildemani* occurs together with a correspondingly small form of *St. subtrifurcatum* var. *majus* and also dichotypical cells combining the two.

Rich (1935) reported *St. wildemani* and its zygosporangium from Southern Rhodesia, and Fritsch & Rich (1937) found *St. subtrifurcatum* var. *majus*

(*sic*) in material from Belfast Pan in the Transvaal. Incidentally, it may be noted that the remarks of Fritsch & Rich regarding 'granules' on Krieger's illustration (1933, pl. 19 f. 2) are based on a misinterpretation of the drawing; the black dots represent pores or small scrobiculation, not granules. We have shown such a group of larger pores in the center of the apical surface in some of our drawings, and it is to be understood that they occur in all the specimens that we have seen, where it was possible to distinguish the markings of the cell-wall; such groups are present in many other desmids.

2. *STAURASTRUM WILDEMANI* var. **majus** (West & West) Scott & Prescott,
comb. nov.—Figs. 8—12

Syn. *Staurastrum subtrifurcatum* Schm. 1898 (*non* West & West 1896).

Staurastrum subtrifurcatum f. *major* West & West 1900.

Staurastrum subtrifurcatum var. *majus* West & West 1907.

West & West (1896) applied the name *St. subtrifurcatum* to a new species which they found in a tube of material sent to them by the Rev. Francis Wolle, containing sediments from a number of tubes from various parts of the United States; the locality where this desmid occurred is therefore unknown. It must be quite rare, for it has not been found since then, to the best of our knowledge. The name *subtrifurcatum* was based on a supposed resemblance to *St. trifurcatum* Turn., found by Wallich in India and named by Turner (1892), who gave a Latin diagnosis but no illustration; he did, however, give an illustration of *St. trifurcatum* variety *reversum* Turn., in which the relative positions of the single and paired spines at each of the angles is reversed, the single spine being uppermost in variety *reversum*.

Schmidle (1898), evidently unaware of the previous publication by West & West, applied the name *St. subtrifurcatum* to a similar but different plant from Zanzibar, East Africa. Having noticed the error, West & West (1900) changed the name of Schmidle's plant to *St. subtrifurcatum* f. *major*, and a few years later (1907), having found the same plant in Burmese material, they raised it to varietal rank under the name *St. subtrifurcatum* var. *majus*. Some authors have cited it, incorrectly, as variety *major*.

For easier comparison, we give in Figure 7 a copy, enlarged to the same scale as our other figures, of West & West's 1896 illustration of *St. subtrifurcatum* from the United States, and because they showed only a semicell in front view we have added the lower semicell, by reversing the upper one, to give a better idea of what the whole cell probably looked

like. When Figure 7 is compared with Figures 8 and 9, which show typical examples of variety *majus*, it is seen that there are important differences, and if Schmidle had seen West & West's illustration it seems highly probable that he would have used some other name for this African specimens; had he done so the confusion in taxonomy would never have arisen. In the American plant the ventral margins of the semicells are concave outwards, an unusual feature, while in variety *majus*, no matter whether it comes from Burma, Indonesia, North Australia, East Africa or South Africa, the ventral margins are strongly convex. Also in front view of the American plant the spines extend out horizontally, forming an almost straight line with the apical margin of the semicell; in variety *majus* the upper paired spines are usually strongly curved upwards. In vertical view of the American plant the margins of the triangular semicell are deeply concave and merge imperceptibly into the line forming the outer edge of the spines, with no constriction at the point of junction, and the spines themselves are only slightly divergent. In vertical view of variety *majus* the margins of the semicell are somewhat concave in the center and convex near the angles, two adjacent sides meeting at the point where the single spine arises; the upper paired spines are more strongly divergent, and their slightly inflated bases are intramarginal.

Viewing the American plant as a whole, and taking account of these differences, we are impressed by its considerable resemblance to *St. trifidum* Nordst., as figured by West & West on the same plate (1896, pl. 5 fs. 20, 21), rather than to *St. trifurcatum* or *St. subtrifurcatum* var. *majus*. *A priori* it seems more likely that a plant known only from the United States may be related to one first found in Brazil (*St. trifidum*), than to another one known only from south-eastern Asia, North Australia and Africa. Other workers, besides ourselves, have found in the United States and Canada a number of desmid species formerly known only from South America.

The most potent argument against the supposed relationship between variety *majus* and the American species *St. subtrifurcatum* is that variety *majus* forms dichotypical cells with *St. wildemani*, and the latter, in turn, forms dichotypical cells with two new varieties to be described below, variety *horizontale* and variety *unispiniferum*. It is quite evident that this group of four different forms is closely inter-related; therefore we conclude that if there is any genetic relationship with the American plant it must be a much more remote one.

For these reasons we have transferred *St. subtrifurcatum* var. *majus* West & West to *St. wildemani* Gutw. as variety *majus* (West & West)

Scott & Prescott, *comb. nov.* The retention of the varietal name *majus* is required by the International Rules of Botanical Nomenclature, but the resulting trinomial is misleading, for the variety is not larger than the species to which it has been transferred.

As will be seen from the illustrations, there is considerable variation between the plants from different regions, in size of cell, and in the length, stoutness, and direction of the spines. At some future time, when more is known about their distribution, these different forms may perhaps be separated on a geographical basis. It is to be noted that for each of the forms of *St. wildemani* there is a corresponding form of variety *majus* and also a dichotypical form combining the two. For instance, the small cell of *St. wildemani* from the Sudan with slender and upstanding spines, shown in Figure 6, has its counterpart in variety *majus* shown in Figure 11, and a dichotypical form shown in Figure 14. The short-spined plant from Sumatra, Figure 4, is represented in variety *majus* by Figure 10, and its dichotypical form by Figure 15.

3. STAUSTRUM WILDEMANI Gutw. var. *horizontale* Scott & Prescott, var. *nov.*—Fig. 16.

Cellulae eis speciei magnitudine formaque subsimiles. Semicellulae a fronte visae cyathiformes, marginibus ventralibus valde convexis, margine apicali subconvexo, paululum elevato; omni angulo laterali superiore binis spinis longis eodem in plano horizontaliter extensis praedito. Semicellulae a vertice visae hexagonales, latera tria longa ac tria brevia, omnia valde concava praebentes; omnes sex anguli spina longa crassa subrecurvata praediti, spinis in paribus tribus late divergentibus, angulo divergentiae 90° vel paululo plus. Membrana punctata, poris aggregatis media in parte superficiei apicalis paulo maioribus. — Cellulae 45—48 μ long., 99—106 μ lat. cum spinis; 18—20 μ lat. isth.

Cells of about the same size and shape as in the species. In front view semicells cyathiform, the ventral margins strongly convex, the apical margin slightly convex and somewhat elevated; at each upper lateral angle two long, stout spines extending horizontally and paired in the horizontal plane. In vertical view hexagonal, with three long and three short sides, all strongly concave; at each of the six angles a long, stout, slightly recurved spine, forming three widely divergent pairs, angle of divergence 90° or slightly more. Wall punctate with a group of somewhat larger pores in the center of the apical surface. — Length 45—48 μ ; width with spines 99—106 μ ; isthmus 18—20 μ .

Habitats: Borneo X and 38; Sumatra 110.

Our figure 16 is designated as the type of this variety.

This variety should be compared with *St. bifidum* var. *hexagonum* Schaarschmidt (1882, p. 273, f. 19), which is similar in vertical view but

differs considerably in front view; also it appears to be much smaller than our plants, if our photocopy is a full-size reproduction of Schaar-schmidt's plate.

4. STAUSTRUM WILDEMANI Gutw. var. **unispiniferum** Scott & Prescott
var. nov.—Figs. 19, 20.

Cellulae eis speciei magnitudine formaque subsimiles. Semicellulae a fronte visae cyathiformes, marginibus ventralibus valde convexis, margine apicali subconvexo ac paululum elevato; omni angulo laterali superiore unica spina longa horizontaliter extensa praedito. Semicellulae a vertice visae triangulares, marginibus lateralibus media in parte paululum concavis atque ad angulos convexis, omni angulo in unicam spinam longam crassam producto. Membrana punctata, poris aggregatis media in parte superficiei apicalis paulo maioribus. — Cellulae 50—54 μ long., 98—102 μ lat. cum spinis; 18—21 μ lat. isth.

Cells of about the same size and shape as in the species. In front view semicells cyathiform, the ventral margins strongly convex, the apical margin slightly convex and somewhat elevated; at each upper lateral angle a single long spine extending horizontally. In vertical view triangular, the lateral margins slightly concave in the center and convex near each angle; each angle produced into a single long, stout spine. Length 50—54 μ ; width with spines 98—102 μ ; isthmus 18—21 μ .

Habitats: Sumatra 108 and 112.

Our figure 19 is designated as the type of this variety.

The dichotypical cells which form the basis for this paper fall into three different types, which may be designated as Type A, B, and C. Type A, shown in Figures 13-15, is a combination of *St. wildemani* with var. *majus*, and occurs in habitats Borneo X and 38, also in Sudan 1.

Type B, Figures 17, 18, combines *St. wildemani* with variety *horizontalis*, and was found in habitats Borneo X and 38, and Sumatra 110.

Type C, Figures 20, 22, combines *St. wildemani* with variety *unispiniferum*, found in habitat Sumatra 108.

Other combinations would seem to be possible and may be discovered in the future, for it is not to be supposed that we were lucky enough to find all of them in this one series of collections. It should be borne in mind that these are not isolated or single occurrences, as might be the case if merely local variant clones were involved; in each type we have seen a dozen or more examples of dichotomy, together with numerous specimens of the species and varieties concerned. Type A occurs in such widely separated places as Borneo and the Sudan, and Type B is found in East and West Borneo and South Sumatra.

In the Desmidiaceae the existence of 'combination forms' with differing semicells has long been known, and the phenomenon may be divided

into two classes. In the first and more frequent one the two semicells obviously belong to the same species, but exhibit differing degrees of radiation. Thus in a normally 3-radiate *Staurastrum*, one semicell will have the usual number of processes, while the other may have four or five or six. Such cases have been ably discussed by Teiling (1948, 1950, 1952), who has devised the name 'Janus-form' for them. In the other and much rarer class the individuals have semicells differing so much that they would appear to belong to different varieties or even species, as in the examples of *St. wildemani* described herein. For this class Teiling (1948) has coined the expressive and convenient terms 'dichotypical' and 'dichotypy.' Such dichotypical cells occur most frequently in the more highly elaborated species of *Euastrum*, *Micrasterias* and *Staurastrum*, and since they are usually found only as single individuals, or at best in very small numbers, they give rise to puzzling taxonomical problems, though occasionally, as with *St. wildemani* and with *Micrasterias floridensis* var. *subjohnsonii* (Prescott & Scott 1952), the chance find of dichotypical cells gives an insight into the true relationship between apparently different forms.

Concerning the cause which give rise to dichotypical cells not much is known at present. Desmid cells are normally quite symmetrical about both the vertical and horizontal axes, and heretofore it has been supposed that in vegetative division, which is far more common than sexual reproduction, each semicell could produce only an exact replica of itself. Recent discoveries prove that this is not correct in all cases; that under some circumstances, the conditions of which are not or only partially known, vegetative division of a dichotypical cell may result in two dichotypical cells, which means that each of the two different semicells has produced, not a replica of itself, but of the other and different semicell. Such a case is illustrated by the new Brazilian desmid *Amscottia mira* Grönbl. (Grönblad & Kallio 1954), in which the approximately 100 specimens seen were all dichotypical, and one individual was found that consisted of an adult semicell with an attached young and partially developed semicell of the opposite type. We now have under study a new *Ichthyocercus*-like desmid from one of Sachlan's collections (Sumatra 110), which also, apparently, shows inherited dichotypy. Because of certain puzzling features we are postponing publication of this plant pending receipt of additional material, which may, we hope, provide a solution of the problem.

Recent work on the cultivation of desmids and their subjection to artificial conditions of light, heat or cold, and centrifugal force, promise important increases in our knowledge concerning the cytological processes

of asexual reproduction and the morphogenetics of desmids (Waris 1950a, 1950b, 1951, 1953; Kallio 1951, 1953a, 1953b, 1954; Grönblad & Kallio 1954).

Another remarkable discovery was made by Starr (1954a, 1954b), who has isolated two strains of *Cosmarium botrytis* var. *tumidum* Wittr., "in which sexuality can be induced at will by mixing the two strains in a liquid medium," while other strains of the same plant, from the same habitat and collection, do not reproduce sexually, or only very seldom, even when mixed with either of the two fertile strains. In a personal communication Dr. Starr informs us that he has since succeeded in isolating sexual strains in other species of *Cosmarium* and *Closterium*. The results of further work in this investigation will be awaited with great interest.

We wish to thank Dr. Hannah Croasdale for providing the Latin diagnoses of the new varieties, and Scott also expresses his thanks to Mrs. Dorothy Perine for inking his pencil drawings.

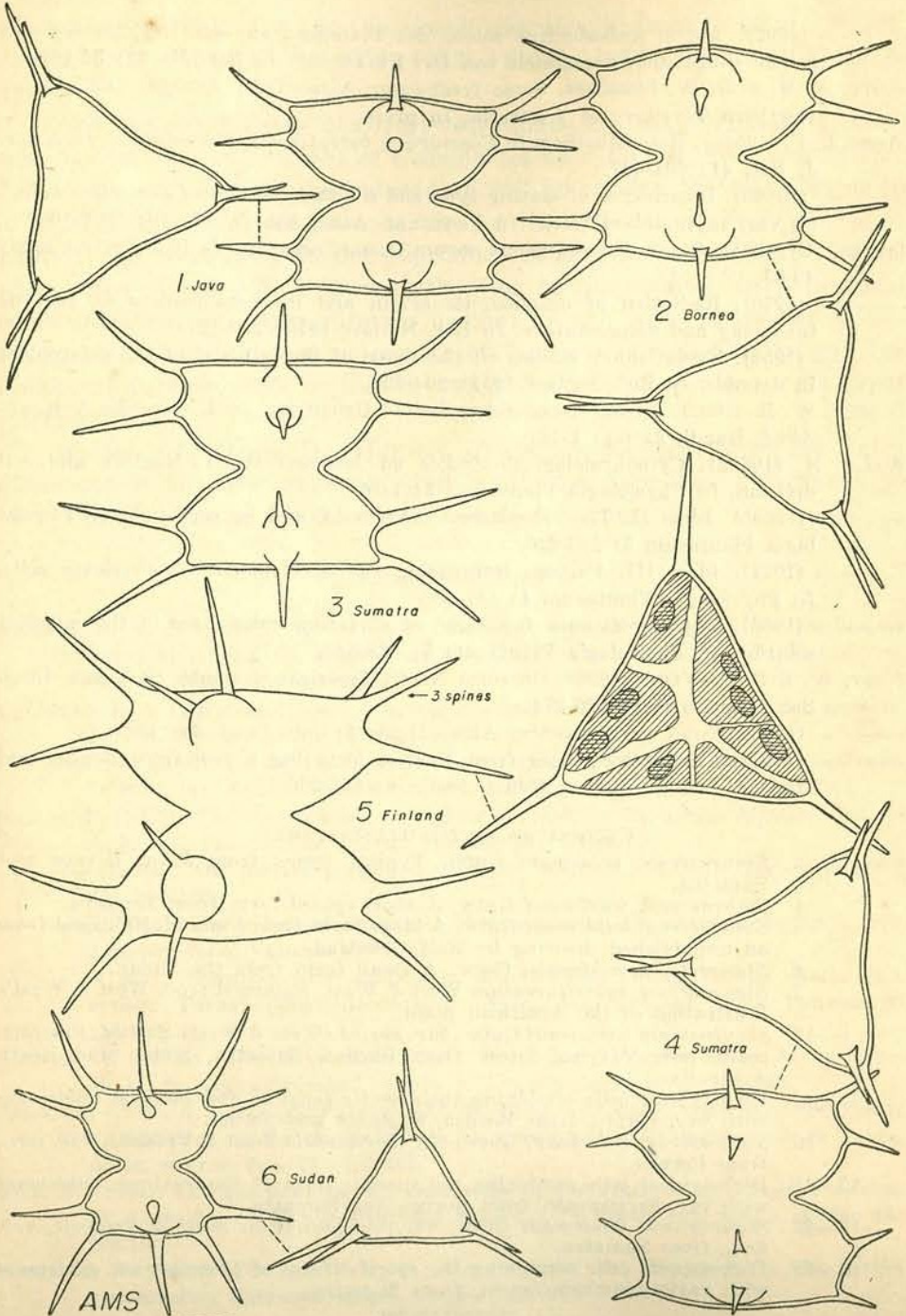
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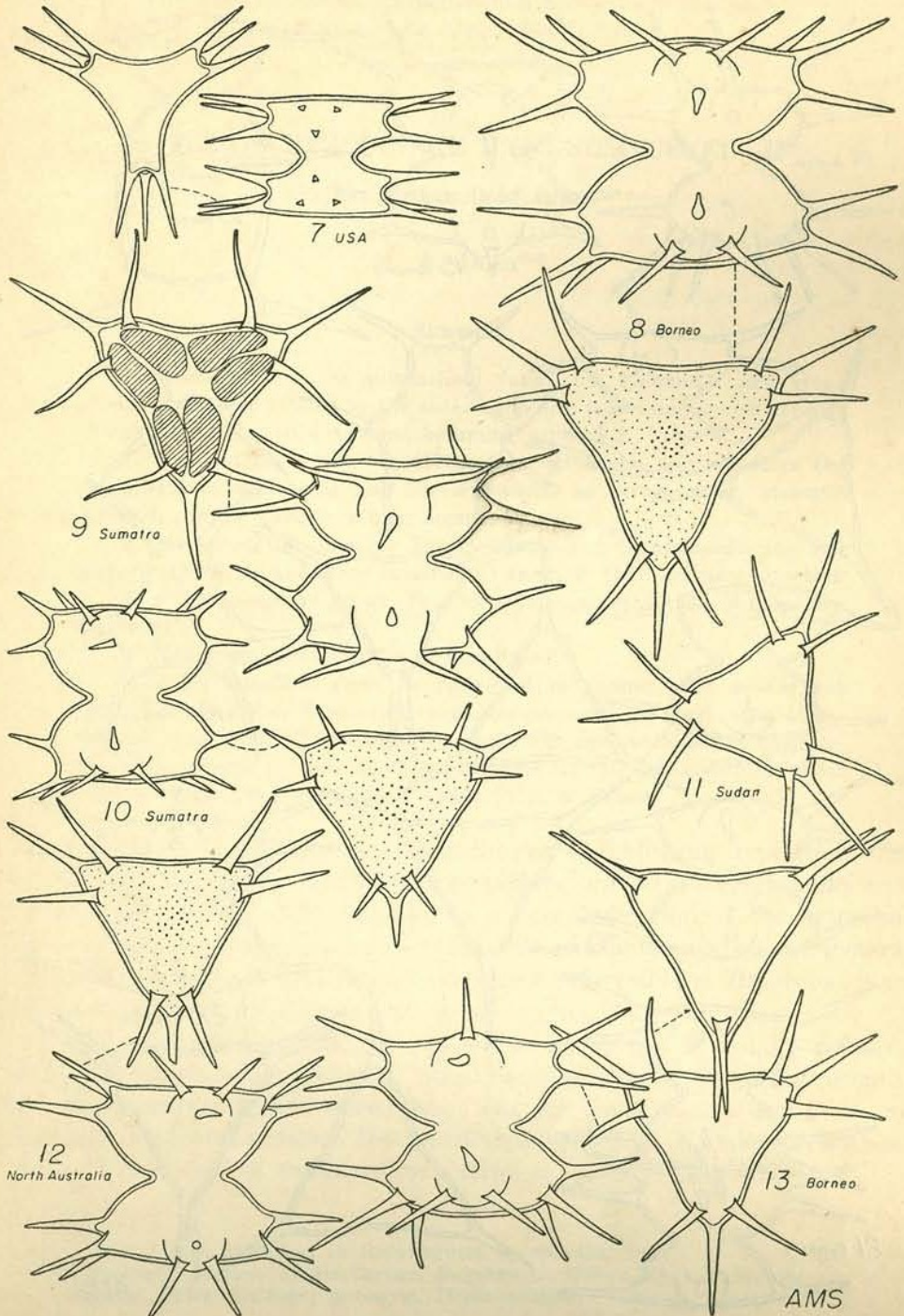
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EXPLANATION OF THE ILLUSTRATIONS.

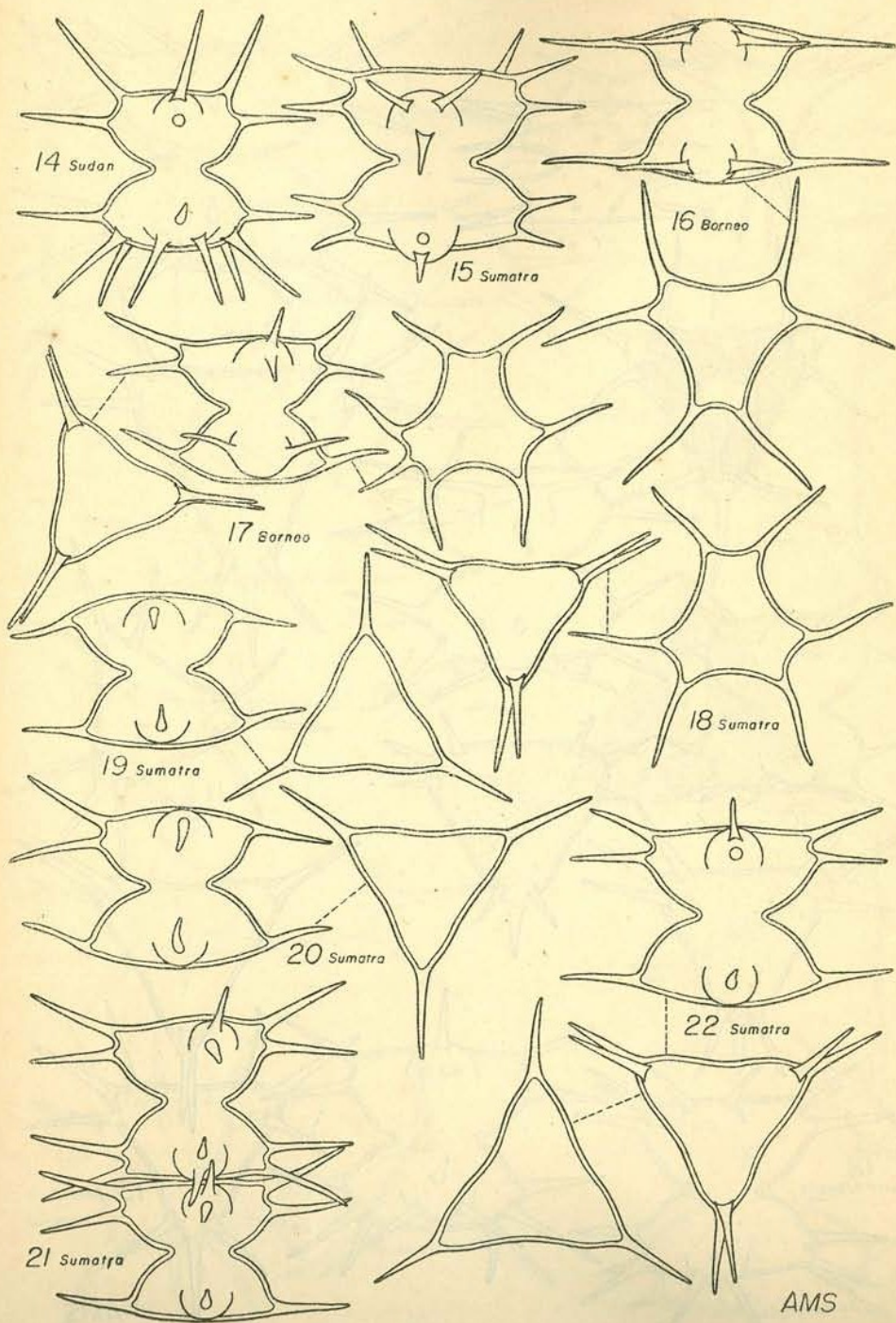
- Figs. 1—3. *Staurastrum wildemani* Gutw. Typical forms from Java, Borneo and Sumatra.
4. *Staurastrum wildemani* Gutw. A short-spined form from Sumatra.
5. *Staurastrum wildemani* Gutw. A large form from Finland. Enlarged from an unpublished drawing by Rolf Grönblad.
6. *Staurastrum wildemani* Gutw. A small form from the Sudan.
7. *Staurastrum subtrifurcatum* West & West. Enlarged from West & West's illustration of the American plant.
- 8—12. *Staurastrum wildemani* Gutw. var. *majus* (West & West) Scott & Prescott, comb. nov. Varying forms from Borneo, Sumatra, Sudan and North Australia.
- 13—15. Dichotypical cells combining the specific form of *Staurastrum wildemani* with var. *majus*, from Borneo, Sumatra and Sudan.
16. *Staurastrum wildemani* Gutw. var. *horizontale* Scott & Prescott, var. nov., from Borneo.
- 17—18. Dichotypical cells combining the specific form of *Staurastrum wildemani* with var. *horizontale*, from Borneo and Sumatra.
- 19—20. *Staurastrum wildemani* Gutw. var. *unispiniferum* Scott & Prescott, var. nov., from Sumatra.
- 21—22. Dichotypical cells combining the specific form of *Staurastrum wildemani* with variety *unispiniferum*, from Sumatra.



FIGS. 1—6



FIGS. 7-13



FIGS. 14—22