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Some Planktic Staurastra from New Zealand

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During the last years my attention has been directed upon the plankters in the lakes situated in the temperate zone of southern hemisphere. These studies have mainly considered South American lakes. But in this connection some studies have also been made on the plankton in the lakes of New Zealand. The lakes mentioned in the present note are all situated on the North Island. Samples from the following lakes have been studied: —

Lake	Approximate height m a. s.-l.	Approximate depth ft.
Taupo	300	546
Rotorua	300	80
Tarawera	300	280
Rotomahana	300	450
Roto-iti	300	180
Waikaremoana	600	800

From the recent review published by Chapman & Thompson, 1957, it is evident that the phytoplankton of this area has been rather neglected during the last decades. In contrary there have recently been published several papers on zooplankters, e.g. those by Jolly and Russell. Considering the freshwater algal flora of New Zealand the papers of the former publisher and editor of this journal, C. F. O. Nordstedt, are still one of the main sources.

It is surprising to note that such a familiar plankter as *Ceratium hirundinella* has been recorded for the first time for New Zealand as

late as in the above mentioned paper by Chapman & Thompson. I have noted this plant, represented by forma *furcoides* as dominating in the plankton of Lake Tarawera. Apart from *Ceratium hirundinella*, the occurrence of the following plants is characteristic for the prevailing facies of plankton-community in November, 1955: —

Cyanophyta.
Anabaena circinalis Rabenh.
Aphanizomenon flos-aquae (L.) Ralfs

Chrysophyta.
Dinobryon divergens Imh.
D. sociale Ehrenb.
Melosira granulata (Ehrenb.) Ralfs
Synedra ulna (Nitzsch) Ehrenb.

Chlorophyta.
Botryococcus braunii Kütz.
Closterium aciculare T. West
Staurastrum johnsonii v. altius Fritsch & Rich
S. pingue Teiling
S. smithii (G. M. Smith) Teiling

In the following note I am going to make some comments on a few of the planktic *Staurastrum*-species occurring in the lakes. Most of these plants can also be found in the plankton of the northern hemispheric lakes. Some of them belong to the taxa recently treated by Brook in a series of important papers.

Staurastrum longiradiatum fo. *majus* West & West

Let us first consider the long-armed plants depicted on figs. 1, 2, 4—7, 13, and 16. The size of these plants is: length 50—56 µ, breadth 131—183.7 µ. They are rather frequent in the plankton of Lake Taupo. The composition of the phytoplankton in Lake Taupo in October, 1955, is evident from the following list: —

Cyanophyta.
Anabaena circinalis Rabenh.
Oscillatoria lacustris (Kleb.) Geitler

Chrysophyta.
Dinobryon divergens Imh.
Salpingoeca frequentissima (Zach.) Lemm.
"Trachelomonas furcata Dol." — Deflandre, 1926, figs. 621 & 622.
Asterionella formosa Hass.
Cyclotella stelligera Cleve & Grun.
Melosira granulata (Ehrenb.) Ralfs — dom.
M. undulata (Ehrenb.) Kütz.
Nitzschia holsatica Hustedt
N. vermicularis (Kütz.) Grun.
Synedra ulna (Nitzsch.) Ehrenb.

Chlorophyta.
Eudorina elegans Ehrenb.
Botryococcus braunii Kütz.
B. protuberans West & West
Lagerheimia citriformis (Snow) G. M. Smith
Closterium aciculare T. West
Staurastrum johnsonii v. altius Fritsch & Rich
S. longiradiatum f. majus West & West — subdom.
S. planctonicum Teiling

Phycomycophyta.
Tetracladium setigerum (Grove) Ing.

In June, 1956, the following plankters occurred in the plankton of the same lake: —

Cyanophyta.
Anabaena circinalis Rabenh.

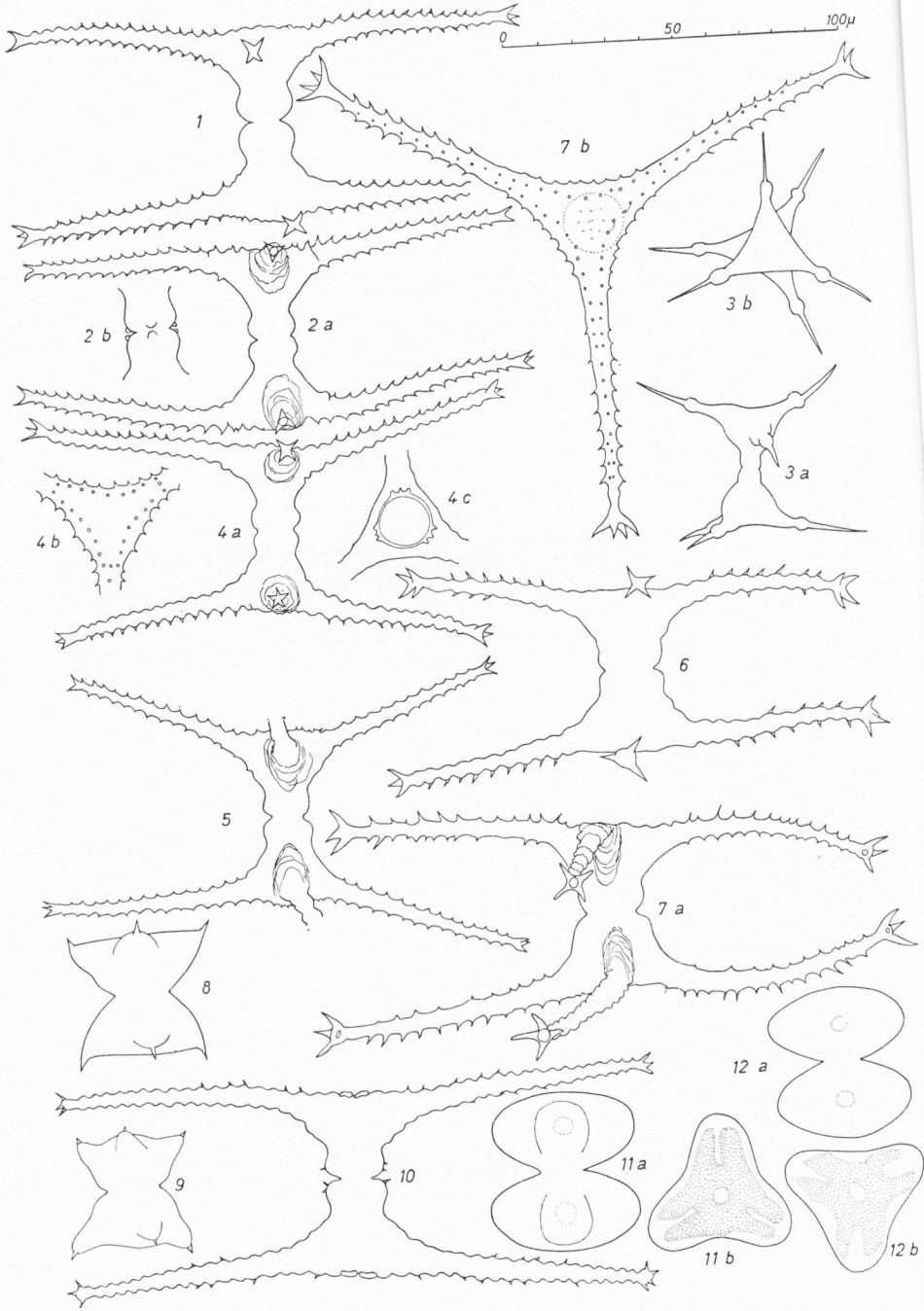
Chrysophyta.
Salpingoeca frequentissima (Zach.) Lemm.
Asterionella formosa Hass.
Melosira granulata (Ehrenb.) Ralfs — dom.

Chlorophyta.
Eudorina elegans Ehrenb.
Botryococcus braunii Kütz.
B. protuberans West & West
Staurastrum johnsonii v. altius Fritsch & Rich
S. longiradiatum f. majus West & West — subdom.

The question is, do the above mentioned plants represent one taxon or several taxa. At first glance it looks as if there may be two taxa present, e.g. the first one illustrated by figs. 2, 4 & 5, characterized by narrow semicells, and the second one, figs. 6, 7, 13, characterized by its stout semicells. But considering the whole population which might be arranged in the following series: 2, 4, 5→1→16→6, 7, 13 we can admit that all these plants may very well belong to just one varying taxon. The conspicuous, long and horizontal or slightly diverging processes point to such a suggestive name as *S. longiradiatum* West & West. There are many figures of *S. longiradiatum* to be found in the literature, e.g.

S. longiradiatum West & West in West & West, 1896, pl. 17, fig. 23.
— in Smith, 1924, pl. 74, fig. 6.
— in Skuja, 1948, pl. 18, fig. 11.
— in Nygaard, 1949, fig. 51.
— in Grönblad, 1956, fig. 22.
— in Irénée-Marie, 1957, pl. 1, fig. 16.
S. cf. longiradiatum West & West fo. in Thomasson, 1957, fig. 27.
S. gracile v. elongatum Scott & Prescott in Scott & Prescott, 1958, fig. 17: 9.

From the description given by West & West (1896) we note that their plants were considerably smaller than mine, length only 25—30 µ, and breadth 67—77 µ. Their plants have long processes, which according to the drawings which may be considered as type, terminate in two divergent spines. Of about the same size are the plants reported by Irénée-Marie (1957) from Canada. In the above mentioned paper West & West described a fo. *majus,* this one also from North America. It has trifurcate processes and is considerably broader than the type form of the species. The breadth of fo. *majus* is 119 µ. No other measurements are given, nor any drawings.


0
50
100µ
1
7 b
3 b
2 b
2 a
3 a
4 c
4 b
4 a
6
5
7 a
8
12 a
9
10
11 a
11 b
12 b

In 1909 G. S. West added a biradiate variety to *S. longiradiatum,* the var. *subnudum* (length 30—31 μ) which according to his report occurred together with the type form in the Yan-Yean reservoir, Australia. A figure of var. *subnudum* accompanies the description, but considering the type form, only a reference to the original figure from 1896 has been made. In 1924 Smith, who had studied West's collection from Australia, points out (p. 90) that the specimens from Australia show a greater variability in the divergence of the processes than is given in the original description. Moreover, the dimensions of the Australian specimens which West referred to the type, are according to Smith (op. cit.) those of the fo. *majus,* which according to him should consequently not be recognized. It is a pity that Smith has neglected to give a drawing of the plants studied by him. But since he has identified his plants from North America with West's, he probably saw something like the plants depicted by him. By comparing his drawings with the original drawings by West, it is evident that there are great differences. The plants depicted by Smith have more in common with *S. planctonicum* (v. i.) than with *S. longiradiatum.* We know also that *S. planctonicum* has been reported by Prescott & Scott, 1952, as frequent in a similar Australian habitat, in Happy Valley reservoir. The problem could possibly be settled by a fresh study of West's collection, but the words of the experienced and eminent algologist F. Hustedt, cf. Hustedt, 1959, p. 34 & 62 et seqq., ought to be pointed out in connection with such a study.

There is described at least one more similar taxon from the region under consideration, viz. *S. gracile* var. *elongatum* Scott & Prescott from North Australia. It resembles in shape the plant depicted on fig. 6 in this note, but is smaller, only 30 μ long and 75 μ broad; thus the measurements agree very well with those of *S. longiradiatum.* The authors have also pointed out the affinity between their plant and *S. longiradiatum.* Considering the recent clean up within *S. gracile* by Brook, it is suitable to refer their plant to *S. longiradiatum.*

The plant described by W. West in 1892, pl. 23, fig. 11, under the name *S. gracile* ssp. *bulbosum,* resembles a great deal my plant on fig. 16, but it has shorter processes. The drawing given by W. West is somewhat sketchy; his plant belongs obviously to *S. planctonicum* and

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Figs. 1—12. — 1 & 2. *Staurastrum johnsonii* v. *altius.* — 3. *Staurodesmus unicornis* fo. — 4 & 5. *Staurastrum johnsonii* v. *altius.* — 6 & 7. *Staurastrum longiradiatum* f. *majus.* — 8 & 9. *Staurodesmus leptodermus* v. *corniculatus.* — 10. *Staurastrum johnsonii* v. *depauperatum.* — 11 & 12. *Staurastrum muticum.*

ought to be designated as *S. planctonicum* var. *bulbosum*. Synonymous names are *S. planctonicum* var. *bullosum* Teiling and *S. planctonicum* var. *bullatum* Teiling in Teiling, 1946 & 1947.

Returning to Smith's discutable interpretation of *S. longiradiatum* we note that in 1957 Florin emphazised, that the plants depicted by Smith, 1924, pl. 74, figs. 5—11 under the name of *S. longiradiatum,* in reality represents *S. planctonicum,* cf. also Thomasson, 1957. By comparing the figures given by Smith we see that the differences between the plants drawn by him are minimal, and that they may be considered as members of one taxon, viz. *S. planctonicum*. I can agree that fig. 7 undoubtedly represents *S. planctonicum*. The question is whether the fig. 6, which is closely related to the plants depicted on figs. 2, 4 & 5 in the present note, may represent something else. I think that this is the case. By comparing figs. 6 & 7 in Smith (op. cit.) we must admit that there are differences in the shape of cell-body. Of course they are very similar to each other, but I think they can be kept apart. The cell-body of *S. planctonicum* is conical, the fig. 5 in Smith also represents this taxon. Contraryly the semicell of the plant depicted on fig. 6 is of more cylindrical shape. I shall return to this plant further on.

The way out of the dilemma seems to be to refuse the interpretation of *S. longiradiatum* given by Smith, and to retain the description given by West & West. *S. longiradiatum* will then embrace the specimens with a length of cell-body of about 30 μ. The fo. *majus* is characterized by a considerably longer cell-body, about 50 μ. My plants from Lake Taupo, depicted on figs. 6, 7, 13, and 16, could then be designated as *S. longiradiatum* fo. *majus*. The direction of the processes is somewhat varying within the present population; in some plants they nearly touch each other. The length of my plants is about 50 μ, the breadth with processes 131—163—178.5—183.7 μ. The basal part of the semicells is relatively broader than in the plants discussed below, viz. the plants illustrated by figs. 1, 2, 4 & 5. *S. longiradiatum* seems to have some affinities to *S. pingue*. This relation is illustrated by fig. 51 in Nygaard, 1949, and fig. 18: 11 in Skuja, 1948. The plant described by Fritsch & Rich, 1937, fig. 23 c, under the name *S. longiradiatum* var. *elevatum* is probably not at all related to *S. longiradiatum*. The same could be stated about the above mentioned *S. longiradiatum* var *subnudum*.

Staurastrum johnsonii var. ***depauperatum*** G. M. Smith

Both of the varieties just mentioned are biradiate, and their dimensions are close to those of *S. longiradiatum*. Also in the plankton of

Lake Taupo a biradiate plant was noted, cf. fig. 10. The measurements of this plant are: length 56.3 µ, and breadth 178.5 µ, thus of about the same magnitude as those of *S. longiradiatum* fo. *majus*. The ornamentation on the swollen bases of the semicells occurs also in *S. longiradiatum*, cf. fig. 16. Only one specimen of this biradiate plant was noted; therefore it is ticklish to determine whether this plant represents just a biradiate facies of *S. longiradiatum*, or if it belongs to some other taxon. Among the similar biradiate taxa the following could be named: —

S. johnsonii v. depauperatum G. M. Smith in Smith, 1924, pl. 79, figs. 7—11.
— v. *bifurcatum* Scott & Grönbl. in Scott & Grönblad, 1957, pl. 22, figs. 1—3.
— v. *perpendiculatum* Grönbl. in Grönblad, 1920, pl. 2, fig. 33.

The first one is the taxon closest to my specimen from Lake Taupo. It is of about the same size as my plant. The var. *bifurcatum* is considerably smaller; on the other hand the var. *perpendiculatum* is 80—91 µ long. Until more material has been studied I have considered my plant preliminarily as *S. johnsonii* var. *depauperatum*, provided that it is not a biradiate facies of *S. longiradiatum*. Note that the proximal spines on the processes are delicate in my plant and stout in the present population of *S. longiradiatum* fo. *majus*, cf. fig. 7 b.

Staurastrum johnsonii var. ***altius*** Fritsch & Rich.

The next group of Staurastra are the plants already mentioned and illustrated by figs. 2, 4, and 5. The length of these plants is 50—56 µ, the breadth 131.2—147—157.5 µ. These plants resemble to a high degree the plant pictured on pl. 74, fig. 6 in Smith, 1924, which is already discussed above. I am not inclined to assume that they belong to *S. planctonicum*. They have considerably longer processes and there is not the faintest trace of the stout ventral end-spine on the processes which is usually, according to Teiling (1946) very characteristic of *S. planctonicum*, cf. figs. 30 & 31 in Teiling, 1946. The absence of stout ventral end-spine and the lack of prominent dorsal spines on the processes of my plants make their affinity to *S. planctonicum* hardly plausible. Actually there is one more taxon to be considered in this connection, viz. *S. johnsonii* var. *altius* Fritsch & Rich. Just compare fig. 2 in the present paper and fig. 22 A & B in Fritsch & Rich, 1937, cf. also Thomasson, 1957, p. 12. My plants are of the same magnitude as the African ones described by Fritsch & Rich. The supraisthmal ornamentation is in my plants usually reduced. In spite of these minor differences I am for the time being inclined to designate my plants from Lake Taupo as *S. johnsonii* var. *altius* Fritsch & Rich.

Staurastrum pingue Teiling and ***S. longipes*** (Nordst.) Teiling.

In the plankton of Lake Roto-iti the plants illustrated by figs. 14 & 18 were noted. Their measurements are: length without processes 31—37.5 µ, breadth with processes 95—112.5 µ. The phytoplankton of this lake was in February, 1956, composed mainly of the following plankters: —

Cyanophyta.

Chroococcus limneticus Lemm.

Pyrrophyta.

Ceratium hirundinella f. furcoides Schröder
Peridinium striolatum Playf.

Chrysophyta.

Dinobryon bavaricum Imh.
D. sertularia Ehrenb.
Asterionella formosa Hass.
Melosira granulata (Ehrenb.) Ralfs
Synedra acus Kütz.
S. ulna (Nitzsch.) Ehrenb.

Chlorophyta.

Eudorina elegans Kütz.
Closterium aciculare T. West
Cosmarium contractum v. ellipsoideum (Elfv.) G. S. West
Spondylosium panduriforme (Heimerl.) Teiling, 1957, p. 215
S. planum (Wolle) West & West
Staurastrum arctiscon v. glabrum West & West
S. denticulatum (Näg.) Arch.
S. floriferum West & West — fig. 29
S. leptocladum v. gracile G. S. West
S. longipes (Nordst.) Teiling
S. longipes v. contractum Teiling
S. muticum Bréb.
S. pseudosebaldii Wille fo. — fig. 28
S. sexangulare (Bulnh.) Lund.
S. smithii (G. M. Smith) Teiling
S. subgracillimum West & West
S. tangaroaii Thom.
Staurodesmus brevispinus (Bréb.) Florin
S. connatus (Lund.) n. comb.
S. leptodermus v. corniculatus (Lund.) Thom.
S. unicornis (Turner) Thom. fo.

The plants from Lake Roto-iti, figs. 14 & 18, are undoubtedly *Staurastrum longipes* (Nordst.) Teiling. Their shape is identical with the figure by Nordstedt, 1873, fig. 17. It ought to be mentioned that *S. paradoxum* var. *longipes* Nordst. in Borge, 1900, is probably *S. chaetoceras*. Considering the last mentioned taxon I can not agree with Brook, 1959, p. 601, that the plants figured in Nygaard, 1945, under the name of *S. tetracerum* var. *validum* belong to *S. chaetoceras*. These plants are to be considered as a biradiate facies of *S. cingulum* var. *obesum*, like *S. thunmarkii* Teiling, cf. Florin, 1957, p. 128. My plants from Roto-iti

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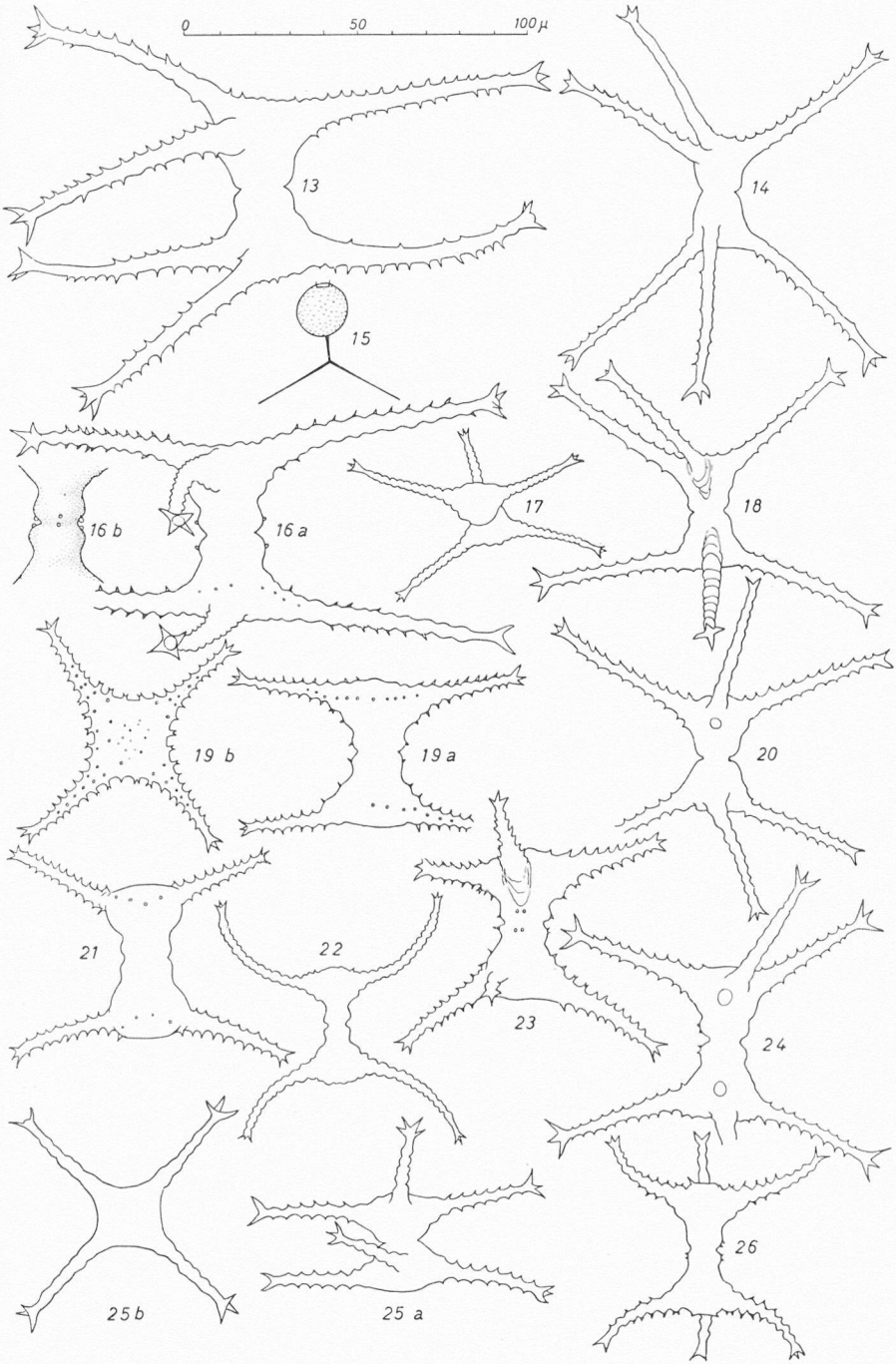
Figs. 13—26. — 13. *Staurastrum longiradiatum* f. *majus*. — 14. *Staurastrum longipes*. — 15. "*Trachelomonas furcata*", diam. 11 µ. — 16. *Staurastrum longiradiatum* f. *majus*. — 17. *Staurastrum smithii*, Janus-form. — 18. *Staurastrum longipes*. — 19. *Staurastrum pseudosebaldii* fo. — 20. *Staurastrum pingue*. — 21. *Staurastrum pseudosebaldii* fo. — 22. *Staurastrum leptocladum* v. *elegans*. — 23. *Staurastrum pseudosebaldii* fo. — 24. *Staurastrum pingue*. — 25. *Staurastrum platycerum*. — 26. *Staurastrum tangaroaii*.


0
50
100 µ
13
14
15
16 b
16 a
17
18
19 b
19 a
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24
25 b
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26

should also be compared with the fig. 23 in Teiling, 1946. Both of my plants have their processes crowned by a corona of strong and diverging bowed spines, a feature characteristic for *S. longipes* as pointed out by Teiling, 1946, p. 81. The plants occurring in the plankton of Lake Roto-iti are somewhat larger than the plant described by Nordstedt. Good illustrations of *S. longipes* are apart from those mentioned above also to be found in West & West, 1905, pl. 7, figs. 13 & 14, Smith, 1924, pl. 73, figs. 3—6, and Allorge, 1931, pl. 14, fig. 8 & 9.

Plants similar to the previous ones were also met in the plankton of Lake Rotorua. They are illustrated by figs. 20 & 24. The length of these plants is 35—45 µ, breadth 100 µ. The plankton-community of Lake Rotorua was in October, 1955, composed of: —

P y r r o p h y t a.

Cystodinium brevipes Geitler

C h r y s o p h y t a.

Dinobryon cylindricum Imh. — subdom.
D. divergens Imh. — subdom.
Salpingoeca frequentissima (Zach.) Lemm.
Asterionella formosa Hass. — subdom.
Melosira granulata (Ehrenb.) Ralfs — dom.
Synedra acus Kütz.

C h l o r o p h y t a.

Eudorina elegans Ehrenb.
Botryococcus braunii Kütz.
Closterium aciculare T. West
Cosmarium contractum v. ellipsoideum (Elfv.) G. S. West
C. pseudarctoum Nordst.
Spondylosium planum (Wolle) West & West
Staurastrum arctiscon v. glabrum West & West
S. clepsydra Nordst.
S. leptocladum v. elegans G. S. West
S. lunatum v. planctonicum West & West
S. muticum Bréb.
S. pingue Teiling
S. pseudosebaldii Wille fo.
S. smithii (G. M. Smith) Teiling
S. smithii fac. triradiatum Florin
S. sexangulare (Bulnh.) Lund. — 4-radiate
S. subnudibrachiatum West & West
S. tohopekaligense Wolle
Staurodesmus bieneanus (Rabenh.) Florin
S. cuspidatus (Bréb.) Teiling
S. dejectus (Bréb.) Teiling
S. dickiei (Ralfs) Lilljer.
S. glabrus f. limnophilus Teiling
S. leptodermus v. corniculatus (Lund.) Thom.
S. patens (Nordst.) Teiling—Taylor, 1935, fig. 33: 1
S. unicornis (Turner) Thom. fo.

It ought to be mentioned that the dominating *Melosira granulata* is in the present sample, like in the other samples mentioned here, of a curious type. It has large pores, but lacks the very characteristical terminal spines.

The two plants from Lake Rotorua, figs. 20 & 24, are difficult to classify. The first one which is similar to the plant designated by

Brook, 1959, as *S. pingue,* cf. Brook, 1959, pl. 17, fig. 2, is a little larger but could be accepted as *S. pingue*. The second plant, fig. 24, is also larger than *S. pingue*. The corona of terminal spines on the processes is of *S. longipes*-type, but the shape of semicells is similar to *S. pingue,* cf. Brook, 1959, pl. 18, figs. 10, 12 & 13. As Brook has pointed out, p. 602, these plants approach Teiling's *S. planctonicum*. Properly these plants have their taxonomic position somewhere between *S. pingue,* cf. Teiling, 1942, figs. 3—5, and *S. planctonicum* in Teiling, 1946, fig. 30. I think that there are good reasons to consider the plants under discussion, viz. fig. 24 in the present note, and figs. 10, 12 & 13 in Brook, 1959, as a variety of *S. pingue*. They differ from *S. pingue* by their larger size and cup-shaped semicells; in *S. pingue* the semicells are subcylindrical. Moreover the sinus in *S. pingue* is relatively deep and narrow, compare Teiling, op. cit., figs. 3—5. In the plants under consideration the sinus is a broad V-shaped notch. The magnitude is identical with *S. planctonicum,* but the ornamentation of the processes is of a divergent character, see above. Brook gives no measurements of his plants, but they seem to form a continuous series between my plant and *S. pingue*. In spite of obvious differences between the plants just discussed and the plant drawn by Teiling I am inclined to accept the delimitation of *S. pingue* given by Brook, and to consider my plants with some hesitation as belonging to *S. pingue*.

S. pingue has been also reported from Australia, cf. Prescott & Scott, 1952, fig. 5: 2, here under the name *S. gracile* fo. *minimum,* which is similar to the small forms of *S. pingue* depicted by Brook (op. cit.) on pl. 18. The plant depicted by Grönblad, 1938, fig. 2: 5, under the name *S. sublongipes* G. M. Smith is not identical with the plant described by Smith, but has its proper place among the plants grouped under *S. pingue*.

The plant from Lake Waikaremoana depicted on fig. 30 forms a transitional link between the plants discussed under *S. longipes* and the plants figured on fig. 31—33. The conspicuous corona of terminal spines on the processes indicates its relationship to *S. longipes*. It is smaller than the specimens of this taxon discussed above, but I think it could well be labelled as *S. longipes*. It was noted in the sample collected in February, 1957. The plankton community was on the date of sampling composed of: —

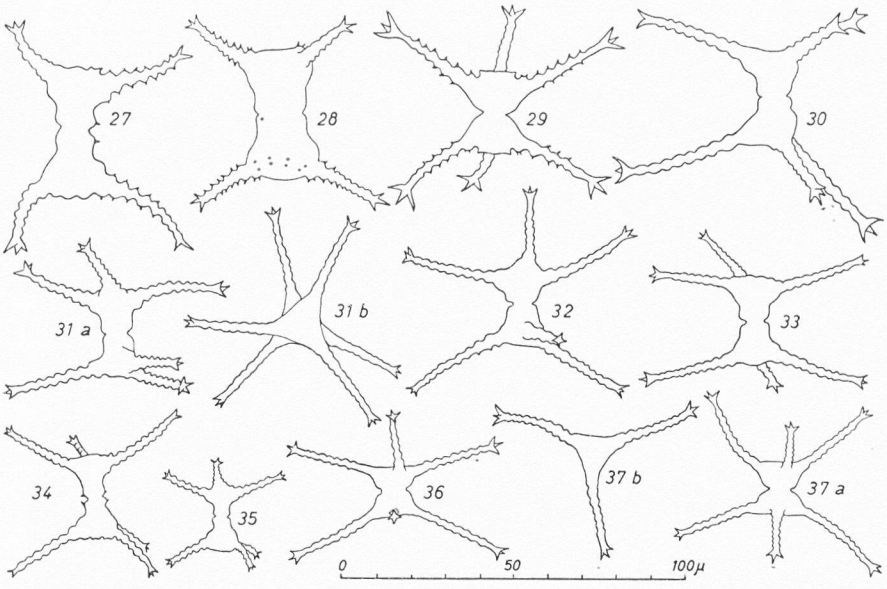
Chrysophyta.
Dinobryon cylindricum Imh. — dom.
D. divergens Imh. — subdom.
Mallomonas sp.
Melosira granulata (Ehrenb.) Ralfs
Synedra ulna v. danica (Kütz.) Grun.

Chlorophyta.
Eudorina elegans Ehrenb.
Closterium aciculare T. West
C. kuetzingii Bréb.
Cosmarium contractum v. ellipsoideum (Elfv.) G. S. West
C. depressum v. achondrum (Boldt) West & West
Staurastrum arctiscon v. glabrum West & West
S. longipes (Nordst.) Teiling
S. pingue Teiling
S. platycerum Playf.
S. smithii fac. triradiatum Florin
S. tangaroaii Thom.
Staurodesmus dickiei (Ralfs) Lilljer.
S. leptodermus v. corniculatus (Lund.) Thom.

Staurastrum smithii fac. ***triradiatum*** Florin.

In the sample from Lake Waikaremoana, plants of the shape shown by the plant depicted on fig. 31 occurred. They are small, length 25 µ, breadth 65 µ. Similar specimens were noted in the plankton of Lake Rotomahana, cf. figs. 32 & 33. The length of these plants is 22.5—29 µ, breadth 69 µ. Also in Lake Rotorua similar plants occurred, see the drawing of a Janus-form fig. 17. To find a suitable taxon for these plants is a ticklish problem. Similar plants are often classified as *S. paradoxum* var. *parvum* W. West, cf. figs. 12—15 in Smith, 1924. His plants are, however, more gracile in their shape than those drawn by W. West, but this may be due to the way of drawing. The plants grouped by Smith (op. cit.) under the name *S. paradoxum* var. *parvum* consist of two types, viz. figs. 7—11 and 12—15. The later, however, with concave sides in top-view, has also been classified by Smith as *S. tetracerum* var. *evolutum* West & West in the same book, cf. pl. 76, figs. 11—14.

My plants from New Zealand may be considered as forms representing the lowest limit of the magnitude within *S. longipes*. However, the spines at the end of the processes are not forming a corona. They also resemble the plants considered by Brook, 1959, pl. 25 as *S. pendulum* var. *pinguiforme* Croasdale. Brook has here also cogitated about *S. paradoxum* var. *evolutum*. The fig. 8 on pl. 145 in West's Monograph of *S. paradoxum* var. *evolutum* resembles the plants grouped under *S. longipes*, and in 1955 I considered this variety as belonging to *S. longipes*-group, and later, in Willén (1959), as *S. tetracerum* var. *evolutum*. It ought to be pointed out that the plant drawn by West shows convex sides of the semicells. In the plants figured on figs. 17 and 31—33 they are concave like in *S. longipes*. The plant on fig. 33 in the present note should be compared also with *S. pingue* on pl. 1, fig. 6 in Messikommer, 1954. For the time being I have labelled my plants with some hesitation as *S. smi-*



Figs 27—37. — 27. *Staurastrum tangaroaii.* — 28. *Staurastrum pseudosebaldii* fo. — 29. *Staurastrum floriferum* fo. — 30. *Staurastrum longipes.* 31—33. *Staurastrum smithii* fac. *triradiatum.* — 34 & 35. *Staurastrum tangaroaii.* — 36 & 37. *Staurastrum subgracillimum.*

thii fac. *triradiatum,* according to the interpretation given by Florin, 1957, figs. 29: 2—4.

The plants figured on figs. 32 & 33 in the present paper were noted in the plankton of Lake Rotomahana. The net-plankton of this lake was in September, 1955, composed of: —

Euglenophyta.

Phacus caudata Hübner

Chrysophyta.

Asterionella formosa Hass.
Cyclotella meneghiniana Kütz.
Melosira italica (Ehrenb.) Kütz.
M. italica v. tenuissima (Grun.) O. Müller
M. varians Agardh
Nitzschia acicularis W. Sm.
Synedra acus Kütz.
S. ulna v. danica (Kütz.) Grun.
S. ulna v. spathulifera Grun.
S. ulna v. tenuirostris Hustedt

Chlorophyta.

Gonium pectorale O. F. M.
Actinastrum hantzschii Lagerh.
Ankistodesmus falcatus v. mirabilis f. longiseta Nyg.
Coelastrum microporum Näg.
Crucigenia minima Brunnth.
Dictyosphaerium pulchellum Wood.
Oocystis lacustris Chodat
Selenastrum westii Smith
Closterium aciculare T. West
C. cornu Ehrenb.
Staurastrum pingue Teiling—Brook, 1959, figs. 8, 10 & 12
S. smithii fac. triradiatum Florin

In April, 1957, the following plankters occurred in the plankton of the same lake: —

Cyanophyta.
Coelosphaerium kuetzingianum Näg.
Lyngbya hieronymusii Lemm.

Chrysophyta.
Asterionella formosa Hass.
Melosira granulata (Ehrenb.) Ralfs
M. italica (Ehrenb.) Kütz.
M. varians Agardh
Synedra acus Kütz.
S. ulna (Nitzsch.) Ehrenb.

Chlorophyta.
Actinastrum hantzschii Lagerh.
Botryococcus braunii Kütz.
Crucigenia minima Brunnth.
Scenedesmus ecornis (Ralfs) Chodat
Closterium acutum v. variabile Krieger
C. polystichum Nyg.
Desmidium asymmetricum Grönbl.
Staurastrum smithii fac. triradiatum Florin
Mougeottia sp. ster. — dom.

Staurastrum subgracillimum West & West.

We have now considered a series of plants similar in shape, but of different size, viz. figs. 5→14, 18→20, 24→30→31, 32, 33. The following two taxa could both be considered as related to these plants.

The first one, figs. 36 & 37, is a little plant, only 13—15μ long and 57—64—67.5 μ broad. I was of common occurrence in the plankton of Lake Roto-iti. I have earlier classified similar plants as *S. longipes* var. *evolutum,* see Thomasson, 1955, p. 220, fig. 3: 5. I can not agree with Brook, 1959, p. 603, considering the identity of *S. paradoxum* var. *evolutum* West & West and *S. pingue* Teiling. The small size of the first taxon leads me to suppose that it belongs to some other group.

There are many figures published of plants which have some similarity to my plants from Lake Roto-iti, v.g.: —

Staurastrum subgracillimum West & West, 1896, pl. 17, figs. 3 & 4.
— subgracillimum West & West fo. in West & West, 1902, pl. 1, figs. 21 & 22.
— tenuissimum West & West in West & West, 1895, pl. 8, fig. 43.
— paradoxum var. osceolense fo. minor West & West in West & West, 1896, pl. 17, fig. 9.
— subgracillimum West & West in Brook, 1958, fig. 61.
— subgracillimum West & West in Scott & Grönblad, 1957, pl. 31, fig. 20.
— subgracillimum West & West fo. in Scott & Prescott, 1958, fig. 15: 14.

The similarity between fig. 36 in this note and the drawing of *S. subgracillimum* in West's Monograph, pl. 144, fig. 1, a specimen from Ireland, is conspicuous. But the plant from Ireland represents probably not the taxon occurring in Ceylon and United States. On the other hand fig. 37 is in side view very similar to *S. paradoxum* var. *evolutum* in Monograph, pl. 145, fig. 8, but in vertical view it has concave sides. All

these plants lack the crown of large spreading spines on the apices of the processes characteristic of *S. subgracillimum* described from North America, and also of *S. longipes*. *S. longipes* var. *contractum* Teiling, 1946, fig. 37, and figs. 31: 1 & 2 in Florin, 1957, is also a plant which resembles a great deal the plant on fig. 37 in the present paper.

The matter of classifying my plants from Lake Roto-iti seems in high degree to be just an affaire de goût. Against the original var. *evolutum* sensu West points the concave sides of the semicells; against the original *longipes* sensu Teiling the lack of conspicuous corona formed by terminal spines; against the original *subgracillimum* sensu West the lack of corona and the diverging processes. Nor is the apex noticeably concave. Until more populations have been studied I am inclined to label my plants as *S. subgracillimum,* with regard to West's interpretation of his Irish specimens.

Staurastrum tangaroaii Thom.

While the plants just discussed could be derived from the form shown in figs. 31—33 by shortening the longitudinal axes, the shape of the plant shown in fig. 34 seems to be a result of elongation of the longitudinal axes. The noticeable variation amplitude of the size within the population, illustrated by figs. 26, 27, 34 & 35, points to quite another taxonomic connection.

The plants on figs. 26 & 27 were observed in the plankton of Roto-iti and Waikaremoana. Their measurements are: length 39—44 µ, breadth 60 µ. The smaller ones on figs. 34 & 35 occurred in the plankton of the same lakes. Their size is: length 19—26 µ, breadth 52.5 µ. The smaller plants may be considered as fo. *minus* of the larger taxon as they seem to be well separated from each other as regards the size. The small plants on figs. 34 & 35 resemble a little *S. gracile* var. *nyansae* G. S. West figured in Thomasson, 1957. But the differences are too great for identication. The upward curvature of the processes resembles another *Staurastrum* species noted in the plankton of Lake Rotorua, viz. *S. leptocladum* var. *elegans* G. S. West, fig. 22. The length of its cell-body is 34 µ, total length 75 µ, breadth with processes 64—66 µ. It is closely related to *S. leptocladum* var. *insigne* West & West which, however, has a row of granules around the basal inflation of the body of the semicells. But Smith, 1924, p. 103, and Grönblad, 1945, p. 26, have both seen specimens of *S. leptocladum* without the transverse row of granules on the basal swelling of the semicells; consequently it is a doubtful character. Probably the var. *elegans* may be united with var. *insigne*.

One might feel tempted to consider the above mentioned triradiate plants as a facies of *S. leptocladum* var. *elegans,* but no Janus-forms have been observed, and I am not very satisfied with that idea. In 1896 Borge described *S. rectangulare* from Australia which has a vague similarity to my plants on figs. 26 & 27 in its upward curvature of the processes. It may be related to these plants, but it is probably not, cf. also its var. *verrucosum* in Scott & Prescott, 1958, fig. 17: 11.

If I remember right, I have seen a figure, similar to the large plants discussed above somewhere in the literature, but I have failed to find it. One ought to consider that according to the estimation of Ružička, 1958, p. 135, there have been published more than 5,000 papers on desmids. Of course a considerable part of them is of less account for taxonomic work.

Preliminarily I have designated the plants on figs. 26, 27, 34, and 35 as *S. tangaroaii* Thom.[1] They are characterized by the processes which are curved upward. The lower part of the semicells is campanulate with cyathiform bases and the sinus is widely open. The cells are of small to medium size: length 19—26—32—39—44 μ breadth 52.5—66 μ.

Staurastrum platycerum Joshua.

In the plankton of Lake Waikaremoana an interesting *Staurastrum* species was observed, cf. fig. 25. The measurements of this plant are: length 29 μ, breadth 87.5 μ. It resembles to some extent *S. heimerlianum,* but is larger and the ornamentation is less spinous. I have considered this plant as *S. platycerum* Josh., cf. figs. 3: 5 b & c in Grönblad, 1938. Of course the original drawing given by Joshua, 1886, pl. 24, fig. 1, is, to say the least, confusing, see also the discussion in Grönblad, 1938, p. 62. My plants should also be compared with *S. longipes* var. *parallelum* Grönblad, 1948, fig. 46 which shows a tri-radiate plant with some affinity to the plant under discussion. In 1910 Playfair published a paper in which he stringed together a "Formenkreis" around *S. sexangulare,* including *S. platycerum.* It is a very interesting study, but its taxonomical consequences require additional analysis. Due to the rare occurrence of the plant under discussion I prefer to retain *S. platycerum.* Also Grönblad (op. cit.) is cautious about the ideas of Playfair considering the Playfair's *S. sexangulare* var. *dentatum* as a variety of

[1] *Staurastrum tangaroaii* n.sp. Cellulae mediocres, semicellulae cyatiformes, parte basali valde elongata, angulis apicalibus in processus longos valde sursum curvatos protractis.

S. platycerum. So far as I can judge this plant belongs to *S. rotula*, cf. Thomasson, 1957, p. 14, fig. 19, and 1959, p. 72, figs. 22: 1—3.

Staurastrum floriferum West & West fo.

In the plankton of Lake Roto-iti an interesting *Staurastrum* was noted, see fig. 29. The length of this plant is 25 µ, and the breadth 75 µ. Of the many pictures published of similar plants just compare the following ones: —

Staurastrum bullardii G. M. Smith in Smith, 1924, pl. 74 & 75.
— floriferum West & West in Smith, 1924, pl. 74.
— bullardii G. M. Smith in Krieger, 1932, pl. 20, fig. 1.
— floriferum West & West in Grönblad, 1938, fig. 2: 3.
— bullardii G. M. Smith fo. in Skuja, 1948, pl. 20, fig. 5.

Skuja (op. cit.) has pointed out the relationship between his plants and *S. floriferum*. My plant could very likely be considered as belonging to *S. bullardii*, but the semicells of *S. bullardii* are obsemicircular in side view. In my plants they are obversely trapeziform like in *S. floriferum*. I think it is necessary make a strong point of the shape of the semicells in *S. bullardii*, and to avoid too spacious an interpretation of this taxon. On the other hand the plant labelled as *S. floriferum* in Smith, 1924, may represent just a variety of *S. anatinum*. Among the plants figured by Smith, the one on pl. 74, fig. 17 is very similar to my fig. 29. For the relations between *anatinum* and *floriferum* see Florin, 1957, p. 129. I have designated my plant as *S. floriferum* fo. but with hesitation since its shape has great affinities to *S. bullardii* in Smith, 1924, pl. 75, figs. 1—3. Also in the long and divergent terminal spines it resembles *S. bullardii*.

Staurastrum pseudosebaldii Wille fo.

The plants depicted on figs. 19, 21, 23 & 28 are all quadri-radiate. The length is 38.4—45 µ, and the breadth 84 µ. The represent obviously the intricate *S. planctonicum*-group. The interpretation of my plants is difficult, due to the fact that most of the plants studied, viz. those occurring in Roto-iti and Rotorua, were quadri-radiate. The open sinus points to the relationship to *S. sebaldii*, but the cylindrical basal part of semicells resembles greatly *S. manfeldtii*. In top view the extramarginal row of forked spines indicate their affinity to *S. pseudosebaldii* Wille. Considering this species, cf. p. 229 in Teiling, 1947, and regarding the taxonomic value of this kind of ornamentation see Brook, 1959, p. 595. My quadri-radiate plants resemble somewhat the plant on fig. 22: 5 in

Thomasson, 1959, which has been labelled as *S. pseudosebaldii* fo. I think that for the time being it is better to designate also these plants from New Zealand as *S. pseudosebaldii* fo., instead of thrusting them in among the plants grouped around *S. sebaldii* or *S. manfeldtii*. This is with good reason, because even Teiling, (op. cit.) after his critical words about the taxonomic value of *S. pseudosebaldii,* adds a new variety to this discussable species.

Staurastrum muticum Bréb.

The *Staurastrum* from Lake Rotorua, reproduced on figs. 11 & 12 in this note resembles *S. muticum* in its shape, but is considerably larger. The dimensions of my plants are: length 45—47.5—50—52.5 µ, and breadth 42.5—46 µ. On the other hand *S. grande* var. *parvum* W. West which is similar, is considerably larger than my specimen, viz. length above 60 µ. But even though the average length of *S. muticum* as a rule lies far below 40 µ, there occur, according to West's Monograph, specimens which have a length exceeding 40 µ Consequently my large plants seem to represent the upper limit of magnitude.

Staurodesmus leptodermus var. ***corniculatus*** (Lund.) Thom. n. comb.

In the plankton of Lake Rotorua and Roto-iti a *Staurodesmus* species was noted, cf. fig. 8 & 9, which is only slightly smaller than the *Staurastrum* (=*Staurodesmus*) *corniculatum* var. *variabile* described by Nordstedt in 1888 from New Zealand. The dimensions of my plant are: length 37.5 µ, breadth 37.5 µ.

Staurodesmus corniculatus seems to be a taxon of rather varying shape. This was obviously also the impression of Nordstedt when he designated his variety as *variabile*. It is a question whether the very similar, but larger *Staurodesmus leptodermus* var. *subcorniculatus* (Rich.) Thom., also belongs to *S. corniculatus*. Related to my plants seem to be also *Staurastrum* (=*Staurodesmus*) *corniculatum* var. *spinigerum* fo. *maior* Grönblad, 1936, figs. 37 & 38, which is, however, somewhat larger. It is possibly synonymous to the above-mentioned plant described by Rich. Compare also *Staurastrum* (=*Staurodesmus*) *leptodermum* Lund. in Brook, 1958, figs. 1—3.

The differences between *S. corniculatus* and *S. leptodermus* are small, and the first one had better be linked up with the second one as a variety. Therefore I have designated my plants as *S. leptodermus* var. *corniculatus* (Lund.) Thom. n. comb.

Staurodesmus unicornis (Turner) Thom. fo.

Another interesting *Staurodesmus* species is depicted on fig. 3 in the present note. It was observed in the plankton of Lake Rotorua. I have considered it as a forma of *Staurodesmus unicornis*. It is closely related to the plant figured by Scott & Prescott, 1958, fig. 15: 8, but has an elongated isthmus part. The length of my plants is 36—40 µ. The plant described by Turner under the name of *Staurastrum scolopacinum* should probably be united with the *Staurodesmus unicornis*. So far as one can judge from the drawing it could be just a forma or variety of *S. unicornis*. *S. unicornis* var. *longicollis* (Grönbl. & Scott) Thom. has longer and more slender processes than my plant from New Zealand. There has been described one more plant, which belongs to *S. unicornis*-group, viz. *S. subscolopacinum* West & West, which, however, is considerably smaller than the plants under consideration.

I think it is evident from the discussion above considering some taxa of *Staurastrum* and *Staurodesmus* that the taxonomic work on these genera is to a large extent depending on the personal interpretation of the shape of the plants. The study of published figures and investigations on different populations are of great help for identification. The comparison of drawings published by various authors gives some idea of variation of the taxa under consideration. Moreover it gives some information of the way and exactitude of drawing of the authors. Dealing with earlier papers, the interpretation is complicated by the fact that the illustrations are often reproduced from the original drawings by an engraver. In the recent time there may occur some inaccuracy depending on the fact that the author's original pencil-drawings are transferred into the Indian ink by a draughtsman. It must not be forgotten that the specimens figured very often represent an arbitarily chosen plant, which may not be at all representative of the population under consideration. The ideal would be if every population were illustrated by a number of figures. These are some of the grounds why the interpretation of some taxa is very often afflicted with some uncertainty and calls forth discussion. It is to be hoped for that such discussions gradually help us to encircle the taxonomic units, and to settle the range of variation within these units. The just mentioned sources of errors together with some others make it often very hazardous to make use of phycological literature for plant geographical purposes. It is often a matter of discernmant and experience. The same could be said about the applicability of ecological data found in phycological papers.

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Studies in the Genus Juncus II

Observation on Juncus articulatus L. × bulbosus L.

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Description

Rhizome weakly developed, thin, ascending, with internodes 0—2 mm long, richly branched. Culms very variable in size, as a rule rather weak, part of them having well developed bulb-like swellings at their bases. Branching also by way of forming numerous adventitious shoots and roots from the stem nodes, some of the adventitious shoots giving rise to new rhizomes at different levels. Floating branches not observed in nature. Leaves distinctly septate.

Inflorescence with primary branches emanating at an angle of 60°—90° to the main axis. Length of inflorescence and number of branches and heads very variable. Size and shape of the heads varying with growth conditions. As a rule, under natural conditions, each head containing 2—5 flowers only, under good watering and favourable light conditions sometimes elongated, more or less spike-like, containing 10—25 flowers. Adventitious shoots formed in the inflorescence in extremely moist conditions.

Outer perianth segments boat-shaped, scarious at the margin, ± abruptly ending in a mucro. Mucro in most flowers placed at the margin. Inner perianth segments oblong-lanceolate, obtuse, with a broad scarious margin. The margin almost always folded or frayed, the segment thus giving an appearance of being more narrowly lanceolate and ± acute. Inner segments at mature state considerably (c. 0.5 mm) longer than the outer ones. Anthers 0.6—0.8 mm, filaments 0.45—0.6 mm. Style 0.5 mm, stigmata 2—3 mm.

Capsule never maturing. Ovary degenerating at flowering time, becoming dry and flattened. Degenerated capsule 1.2—1.7 mm, reaching

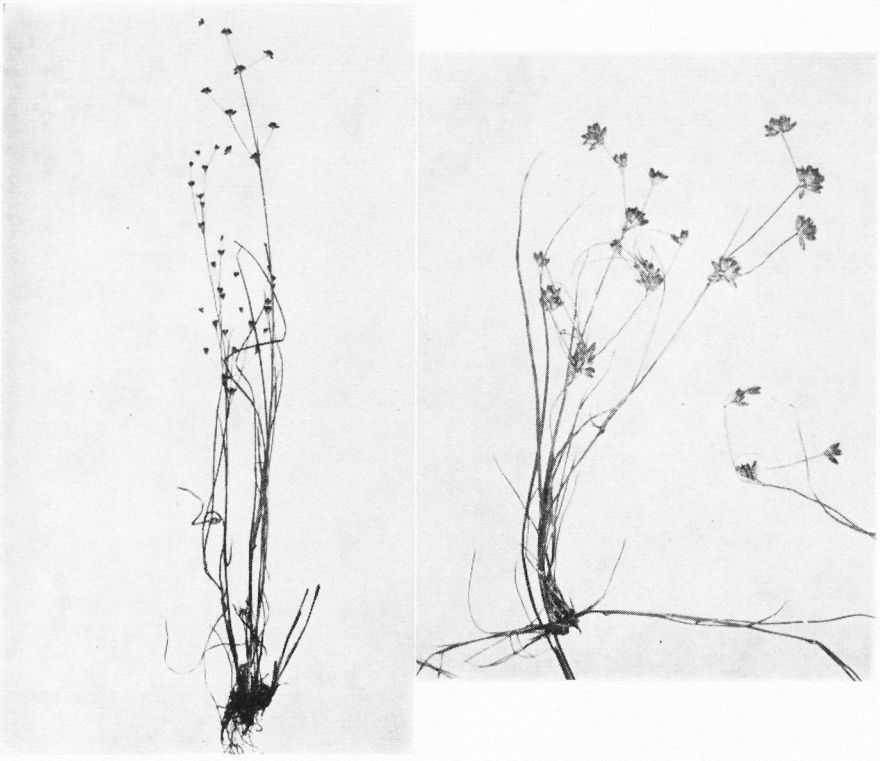

Fig. 1. *J. articulatus* L.×*bulbosus* L. To the left plant no. 1851, from lake Skeingesjön. To the right part of plant no. 633 from Arkelstorp, cultivated in submersed pot.

two thirds of the length of the perianth, light-brown. Style not dehiscing in any regular way, remaining at the capsule and later irregularly falling into pieces. Seeds never formed.

Finds of the hybrid

This hybrid has not been reported previously, as far as known to the present author. The number of localities detected is at present only three, but the plant may be much more common than is known today, since it is very easily overlooked. Juncus hybrids have as a rule been recognized by means of their empty capsules with concave sides, but this one never develops any capsules at all. Thus the flower first looks like being in bud stage only and then immediately changes into a stage where it appears to have been dried out or otherwise killed at the bud stage.

Fig. 2. 1. Normal inflorescence of plant no. 3077, from Sibbarp, Osby. 2. Another twig from the same plant, cultivated in greenhouse, forming adventitious shoots in the heads. 3. Abnormal inflorescense of plant no. 647, from Arkelstorp. Cultivated in submersed pot.

The first specimens were found at Arkelstorp in the northeastern part of Scania, at the northern end of lake Oppmannasjön, on the 25th of June, 1957. During collection of material for cytological investigation of *J. articulatus* and *J. bulbosus,* the only septate species present at the locality, some specimens were observed which could not be determined. Those dubious specimens were of course taken home for cultivation in the Botanical Garden in Lund and later on they proved to have the somatic chromosome number of 60. In specimens from this locality and from several others the number 2n=80 has been determined for *J. articulatus* and 2n=40 for *J. bulbosus.* In the 60-chromosome hybrid it has been possible in some cases to recognize one constituent of the satellite chromosome pair of *J. articulatus.* This chromosome consists of one arm equivalent to the other intermediate-sized pairs and one small body. The link between them often appears rather long in weakly shrunk mitotic plates, the satellite thus being easily mistaken for a chromosome of its own, being about half as big as the smallest pair of J. articulatus. Its true nature is best seen in prophase nuclei. The satellite chromosome of *J. bulbosus,* on the other hand, has a very small satellite and a short link and in most cases it is impossible to recognize.

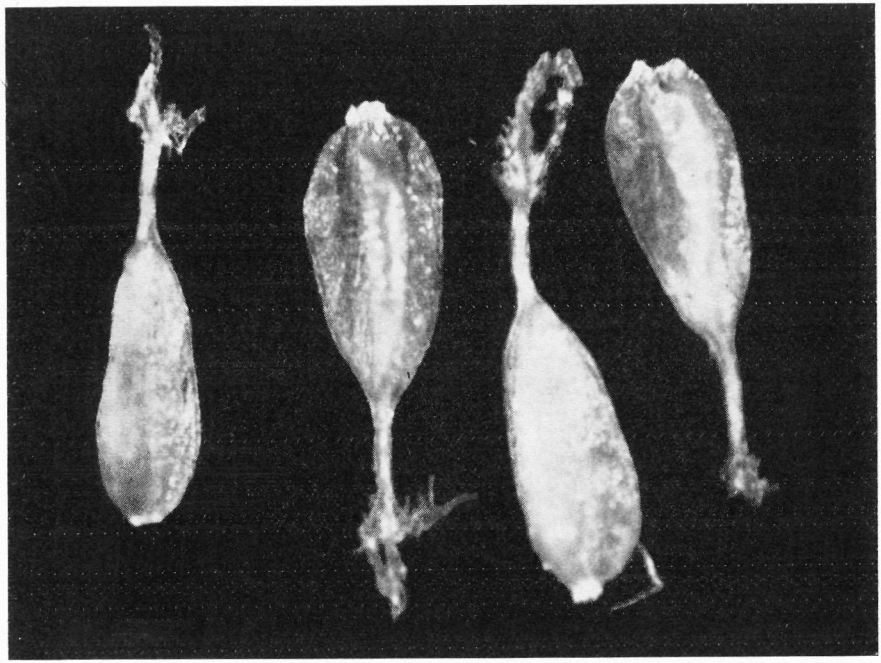

Fig. 3. Degenerated capsules of plant no. 633, from Arkelstorp. ×c. 30.

The 5 hybrid specimens collected at this locality had an almost identical habit, and they have probably arisen by vegetative propagation from one original individual. They grew on very moist ground, themselves being the stabilizing agent in small c. 10 cm high tussocks on almost naked mud. The locality is situated just in the boundary zone between the grazed pasture and the broad belt of reed and tall *Carex* species. It is submerged several times a year and trampled by cattle. The surrounding vegetation is very rich, containing some 200 species of flowering plants.

The habit of the hybrid was intermediate between the races of the parent species present. *J. bulbosus* was represented by a low, 1—10 cm high form. It had a rather well developed rhizome with 0—1 mm long internodes and distinctly marked bulbs at the straw bases. Most culms and leaves were strictly upright, the leaves indistinctly septate. The inflorescence was composed of 1—4 heads only, each containing 4—5 flowers. The *J. articulatus* type on the locality was also low, 10—20 cm high. It had a well developed rhizome with internodes 1—5 mm long and showed tendencies of bulb-like swellings at the straw bases. Its inflorescence was composed of c. 10 heads only, each containing 6—8 flowers.

After the first find had been clearly understood, the hybrid has been searched for in various other places. The parent species are growing together in almost every moist spot in southern Sweden, thus having good possibilities of hybridization. On September 3rd, 1958, the hybrid was found in northern Scania, in the parish of Osby, just were the river Helgeå leaves lake Skeingesjön. In that locality it was growing at the waterline on a gravely shore without close vegetation. Two specimens were collected, very identical in habit as well as in flower characteristics. They are, however, somewhat different in habit from the Arkelstorp form, being much taller and having a longer inflorescence. The races of the parent species present in the vicinity are also different from those at the Arkelstorp locality, especially that of *J. articulatus,* which is here represented by tall, many-flowered forms. The locality is submerged for 4—6 months every year, as the water-content of the river is much greater during the winter.

On July 17th, 1959, a new specimen of the same plant was found, having exactly the same habit as those from lake Skeingesjön. This one was also growing on the shore of the river Helgeå, 6 km further down if measured along the stream. The locality is at the rapids 500 m NW of the railway bridge at Sibbarp, parish Osby.

The striking resemblance between this plant and the ones from lake Skeingesjön leads to the supposition that they might possibly be members of the same clone, spread by means of growth and floatation along the river. In order to test their possibility of such vegetative propagation, hybrid plants as well as other septate *Junci* have been deprived of all earth and kept floating in water for a week. In no case did such a treatment affect their viability. In that way one single individual of a hybrid may become spread over a large area, thus giving a false appearance of being often and easily formed.

At the last-mentioned locality the hybrid was growing at the waterline, forming a dense tussock. The shore here was steep and the vegetation densely closed. The hybrid tussock, however, was at the outside of the vegetation, partly floating in the river. It did not form floating branches, as J. bulbosus often does under similar conditions, but only erect culms.

Vivipary

The hybrids have now been cultivated for three years under various conditions, in the greenhouses as well as in the open, but under no conditions have there been produced any seeds or mature capsules. Under extremely moist conditions, however, shoots are formed in the

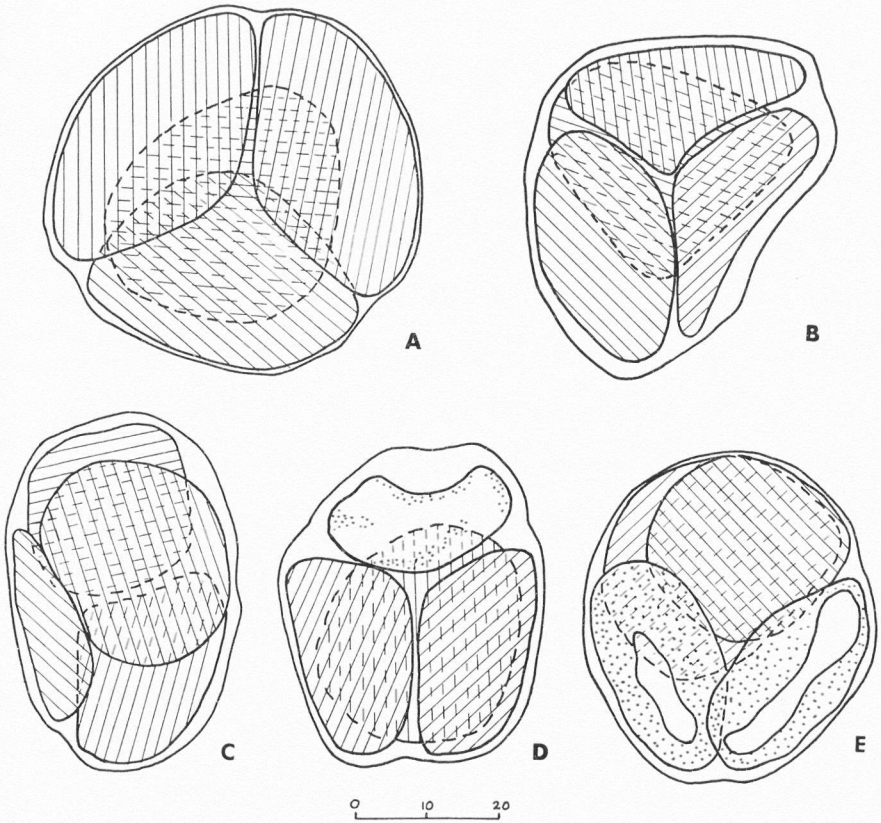

Fig. 4. Pollen grains of plant no. 633. A. Morphologically normal grain. B, C. Grains which have taken the stain normally, but show abnormal form and size. D, E. Grains with one respectively two of the four parts degenerated. Cotton blue preparation. Scale in μ.

heads of the inflorescence, giving the appearance of vivipary. A closer examination of many cases has shown that the shoots are formed in the axils of bracts in exactly the same manner as the other adventitious shoots formed from stem nodes.

Pollen fertility and pollen formation

The determination of the percentage of good pollen meets with certain difficulties. The pollen grain consists of all four parts of the tetrad, in the way normal for Juncaceae. Five to ten per cent of the tetrads are quite degenerated. Some of them have all four parts normally formed,

though empty, others are quite irregularly formed. In 1—5 % of the grains 1, 2 or 3 of the units are normally filled, whereas the other ones are degenerated. In such cases all the four parts must be considered unbalanced, the four units of a pollen tetrad having arisen from the same meiotic division; even these grains must thus be included among the morphologically bad ones. The greatest difficulty is represented by those 40—50 % of the grains, which take staining normally but have one or more of their parts irregularly formed, small or abnormally vacuolized. In many cases they are quite distinctly defective, but in other cases there are only slight disturbances in shape or size. It is impossible to judge from their appearance which of them are functional and which are not. A few grains have been found containing only 1 or 2 parts instead of the normal four, the ones with two parts being most common. If all these grains with visible abnormalities are considered bad, there still remain 30—50 %, which must be considered morphologically good. It must also be pointed out, that the same plant may give rather different figures for pollen fertility on different occasions. In a few cases some grains have been found germinating in the anthers; thus it is evident that part of them may function. That does not, however, prove that they can give rise to any viable zygote.

In order to get a better view of the pollen formation smear preparations have been made. It has been found that there are always lagging chromosomes both in anaphase I and in anaphase II. With respect to the somatic number 60 there would be expected pollen grains with 30 chromosomes after a normal meiosis. Countings from pollen mitoses show, however, a great variety of irregular numbers. The highest number observed is 29 and the lowest 17, but most pollen units have 20—28 chromosomes. The behaviour of the chromosomes in metaphase I has not yet been sufficiently interpreted, but the frequence of pairing seems to be low.

Leaf anatomy

One of the main reasons for placing *J. bulbosus* and *J. articulatus* in separate groups within the septate *Junci* is the widely different organization of their leaves. The leaf of *J. articulatus* has a single longitudinal cavity, filled up with a delicate aerenchymatous tissue with large intercellular lacunes. The surrounding parenchymatous layer is almost uniformly thick and contains as a rule c. 20 vascular bundles. The epidermis consists of large cells with strongly thickened walls. The leaf is somewhat flattened and has distinct external longitudinal ridges. *J. bul-*

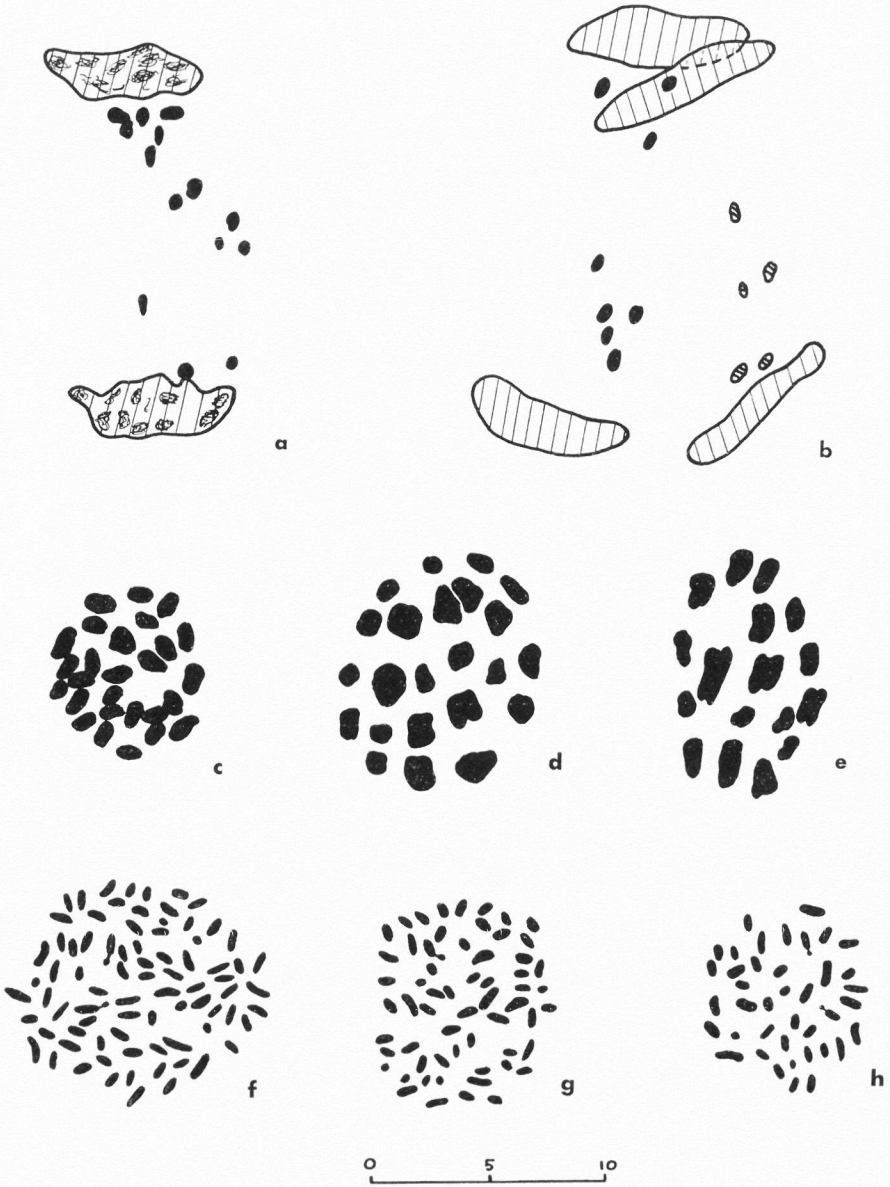

Fig. 5. a—e, pollen divisions from plant no. 633. Aceto-orcein smear preparations. a. First anaphase of meiotic division. b. Second anaphase of meiotic division. c—e, Pollen mitoses, showing the chromosome numbers 27, 23 and 17, f—h, Mitotic divisions from root tips. f. *J. articulatus* L. 2n=80. Plant no. 644 from Arkelstorp. g. *J. articulatus* L.×*bulbosus* L., somatic number 60. Plant no. 633 from Arkelstorp. h. *J. bulbosus* L. 2n=40. Plant no. 942 from Granvin, Norway. Scale in μ.

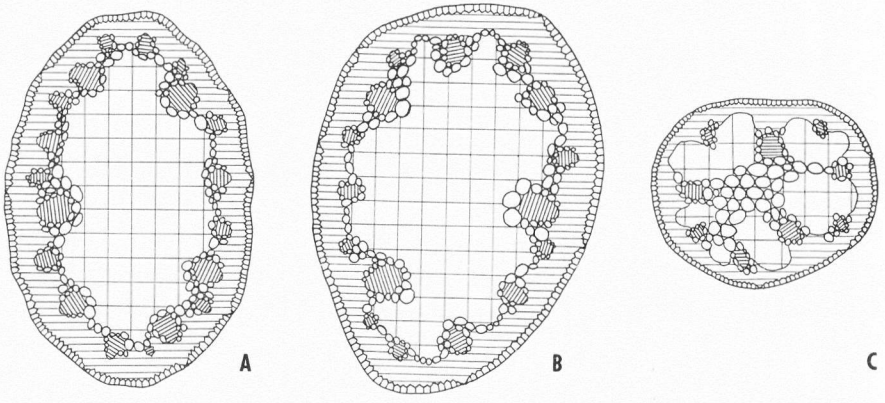

Fig. 6. Transverse sections of leaves. A. *J. articulatus* L. No. 1139, from Kvarnby, Scania. B. *J. articulatus* L.×*bulbosus* L.. No. 633 from Arkelstorp. C. *J. bulbosus* L. No. 3148 from lake N. Vixen, Småland.

bosus has its central cavity divided into several parts by lamellae of large-celled parenchyma. The vascular bundles are as a rule only c. 10, the largest of them lying in the lamellae. The epidermis consists of rather small cells with only slightly thickened walls. The leaf is approximately circular in transverse section, with a distinct dorsal flattening in its middle portion and a dorsal furrow at its base. The leaves of the hybrid have most in common with those of *J. articulatus,* but show some easily determinable influences from *J. bulbosus.* The epidermis consists of more thin-walled cells than that of *J. articulatus.* The larger vascular bundles lie in ridges protruding into the central cavity. In the outer and median parts the leaf is somewhat flattened in the manner of *J. articulatus.* There is no obvious external ridging. In the basal part there is a tendency of dorsal flattening in the manner of *J. bulbosus* and a short little furrow may be observed at the base of the leaf.

Differences from J. alpinus Vill. × articulatus L.

In the field it will sometimes be difficult to distinguish between the two hybrids. In cultivation there will not be any difficulties, since *J. alpinus*×*articulatus* will always form mature capsules, despite of what race of *J. alpinus* was involved in the crossing. *J. articulatus*×*bulbosus,* on the contrary, never shows any mature capsules. There are, however, also some other floral characteristics. In *J. articulatus*×*bulbosus* the inner perianth segments become longer than the outer ones, which have

their mucro placed at the very margin. In *J. alpinus*×*articulatus* the perianth segments are equal in length or the outer ones a little longer, and the outer segments have their mucro placed a short distance below the margin. *J. articulatus*×*bulbosus* may also be recognized by its tendency of dorsal flattening of the leaf, the feeble furrow at the leaf base and the tendency of bulb-like swellings at the straw bases.

Determinations of the chromosome numbers for the hybrid and its parents species

All countings made from sections of root tips. The numbers in the first column refer to preparations and herbarium specimens kept at the Botanical Museum, Lund.

Nr.	2n	Species	Locality	Coll.
642	40	J. bulbosus L.	Scania, par. Oppmanna, at the northern end of lake Oppmannasjön.	25.6.1957 S. Snogerup
742	40	J. bulbosus L.	Scania, par. Glimåkra, Häggeryda.	1.7.1957 S. Snogerup
740	40	J. bulbosus L. constant dwarf form.	Scania, par. Glimåkra, southern margin of lake Rolstorpssjön.	1.7.1957 S. Snogerup
1835	40	J. bulbosus L.	Scania, par. Oderljunga, eastern margin of lake Bälingesjön.	9.8.1958 S. Snogerup
1848-49	40	J. bulbosus L.	Scania, par. Osby, ditch in a small mire 300 m W of lake Svanshalssjön.	2.9.1958 S. Snogerup
3148	40	J. bulbosus L.	Sweden, Småland, north-eastern margin of lake N. Vixen, NW of Eksjö.	5.8.1959 S. Snogerup
923-25	40	J. bulbosus L.	Norway, Hordaland, Fana, southern margin of lake Söyla.	.8.1957 S. O. Strandhede
928-29	40	J. bulbosus L.	Norway, Sogn, Vinje, Framnes, at lake Opheimsvatn.	8.1957 S. O. Strandhede
940	40	J. bulbosus L.	Norway, Nordfjord og Sunnmöre, at the river between Björkelo and V. Egge.	8.1957 S. O. Strandhede
941-44	40	J. bulbosus L.	Norway, Granvin, at the lake 100 m NE of the church.	8.1957 S. O. Strandhede
960	40	J. bulbosus L.	Norway, Möre og Romdal, southeastern margin of lake Hangavatn.	8.1957 S. O. Strandhede
644-48	80	J. articulatus L.	Scania, par. Oppmanna, at the northern end of lake Oppmannasjön.	25.6.1957 S. Snogerup
750	80	J. articulatus L.	Scania, par. Oppmanna, Arkelstorp, fen 400 m SE of the school.	25.6.1957 S. Snogerup
634-35	80	J. articulatus L.	Scania, par. Österslöv, fen 200 m WSW of the island Husön.	24.6.1957 S. Snogerup
622	80	J. articulatus L.	Scania, Ivön, on the shore at the northern end of the island.	28.6.1959 S. Snogerup

Nr.	2n	Species	Locality	Coll.
946 948 1642	80	J. articulatus L.	Scania, at lake Ringsjön, NE of Råröd.	29.8.1957 S. Snogerup
1139	80	J. articulatus L.	Scania, par. S. Sallerup, chalk quarry 1.5 km NNE of the church.	10.8.1957 S. Snogerup
906	80	J. articulatus L.	Scania, par. Lomma, 500 m NE of the church.	14.8.1957 S. Snogerup
904-05	80	J. articulatus L.	Scania, Lund, spontaneous at a pond in the Botanical Garden.	12.8.1957 S. Snogerup
753-54	80	J. articulatus L.	Sweden, Uppland, par. Älvkarleby, 2 km ESE of Gårdskär at the narrow bay.	12.7.1957 S. Snogerup
761	80	J. articulatus L.	Sweden, Uppland, par. Älvkarleby, 2 km E of Gårdskär.	12.7.1957 S. Snogerup
771	80	J. articulatus	Sweden, Uppland, par. Älvkarleby, east of the highway 2500 m N of the church.	16.7.1957 S. Snogerup
2911 2918	80	J. articulatus L.	Sweden, Öland, at the lake between Lenstad and Ekelunda.	6.6.1959 S. Snogerup
2867 2869-70	80	J. articulatus L.	Sweden, Öland, at the lagoon 4 km SW of the northern end of the island.	4.6.1959 S. Snogerup
2873	80	J. articulatus L.	Sweden, Öland, small fen 3 km N of Böda station.	4.6.1959 S. Snogerup
2878	80	J. articulatus L.	Sweden, Öland, par. Böda, Byerums raukar.	4.6.1959 S. Snogerup
3131	80	J. articulatus L.	Sweden, Västergötland, Billingen.	31.7.1959 S. Snogerup
436 898	80	J. articulatus L.	Sweden, Dalsland, par. Frändefors, at the north-eastern margin of Hästefjorden.	25.7.1952 Josef Sjögren
1845	80	J. articulatus L.	Denmark, Jylland, Gaansager, at the river Suså.	16.8.1958 S. A. Björse
1146	80	J. articulatus L.	Sweden, Dalsland, par. Bäcke, Ödebyn.	1.8.1956 S. O. Strandhede
362	80	J. articulatus L.	France, Var. at the rivulet 2500 m WSW of Cavalaire, 14 km SW of St. Tropez.	14.5.1957 S. Snogerup
2209-10 2213	80	J. articulatus L.	Greece, Naxos, at the road between Komiaki and Apollona, c. 100 m s m.	4.6.1957 H. Runemark
633 649 645-47	60	J. articulatus L. ×bulbosus L.	Scania, par. Oppmanna, at the northern end of lake Oppmannasjön.	25.6.1957 S. Snogerup
1850-51	60	J. articulatus L. ×bulbosus L.	Scania, par. Osby, at the outflow of the river Helgeå from lake Skeingesjön.	3.9.1958 S. Snogerup
3077	60	J. articulatus L. ×bulbosus L.	Scania, par. Osby, at the river Helgeå, 500 m NW of the railway bridge at Sibbarp.	17.7.1959 S. Snogerup

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A new Hypocyrta from Ecuador

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Numerous members of the family Gesneriaceae, of which African Violets and Gloxinias are the best known, are presently enjoying immense popularity in both public and private collections. This interest started more than a century ago when representatives of the genera *Alloplectus, Achimenes, Hypocyrta, Kohleria, Columnea, Trichantha, Rechsteineria,* etc. were introduced into European botanical gardens from Tropical America and popularized through the descriptions and the beautiful coloured plates in *L'Illustration Horticole,* Curtis's *Botanical Magazine,* or *La Flore des Serres et des Jardins de l'Europe.*

It was revived in America by the sudden upsurge of African Violet fever and has now widened to include other genera, such as *Columnea,* though some of the handsomest species were already known abroad. Such species as *Columnea Oerstediana* Klotsch, *C. gloriosa* Sprague, *C. magnifica* Klotsch., *C. Schiedeana* Schlech. and probably others, were popular at one time or another, having even been used freely for hybridization purposes. Apparently the first species mentioned does not seem to be in cultivation any longer, while some old hybrids persisting in collections are not easy to name.

Botanically, with its 140 genera and approximately 1800 species, the family as a whole is in sore need of a monograph. On one hand, the correct names, the value and the limits of the genera are far from being uniformly accepted by the various specialists. On the other, there is still a large number of species to describe or rediscover, types to be located, names to be clarified or applied correctly.

In a series of scholarly papers, Dr. B. L. Burtt (Edinburg) has begun to clear the numerous problems relating to the Old World representatives of the family; numerous small and large taxonomical imbroglios have already been elucidated. Mr. C. V. Morton (Smithsonian Institute,

Washington) has contributed various regional treatments of the West Indian and American group; he has monographed the large and difficult genus *Besleria* and is still active in revising other critical genera. Dr. A. J. M. Leeuwenberg (Utrecht) has dealt in great detail with the various representatives of the family in the Guianas and some of their relatives from neighbouring countries. Finally, Dr. H. E. Moore (Ithaca, New York) has written an informative book on the cultivated Gesneriads, bringing together the results of all the taxonomical revisions scattered in specialized periodicals here and abroad, so as to help the amateurs and the professional alike find their way through the intricate synonymy and the chaos of wrong determinations which, through exchange or purchase, have travelled from one collection to another.

Old authors of the past century, such as Oersted (1858) have overlabored the creation of genera. Nowadays, we seem to have gone to the other extreme and even if genera like *Alloplectus* and *Columnea* are difficult to define, making of them such an heterogeneous assemblage as is done now, does not seem to clear the picture. In the *Columneae* tribe, the genera apparently "are based rather on convenient characters than on conspicuous discontinuities of features . . . A consequence of this state of affairs is the presence of what may be called 'borderline species', i.e. species that have some characters of one and some of an other genus. Nevertheless they can be assigned to one of the genera as certain characters may be considered as more important than others." (Leeuwenberg, l.c. p. 293.)

For instance, representatives of *Collandra* (leaves strongly unequal; corolla nearly actinomorphic), *Trichantha* (fringed calyx; corolla usually of two colours, mostly yellow and brown, symmetrically distributed; presence of an appendage in each sinus of the corolla) are perfectly recognizable and quite distinct from all the *Columnea* sect. *Columnea,* which have the corolla strongly two-lipped, the upper one helmet-like. If *Collandra* and *Trichantha* are kept separate, the picture of *Columnea* gains in sharper focus and is a more coherent one.

It appears that within each "genus" the species-making process through free hybridization — humming-birds apparently playing a part — results in the shuffling of various small characters in endless combinations, so that it is difficult, in a dichotomic key, for example, to "earmark" a species by mentioning one character only. At the same time, each genus has a sector of its area with a high concentration of different species and apparently being still an active center of evolution. *Columnea,* for instance, has 160 species scattered through the West

Indies, Mexico, Central and South America to Peru, Bolivia and southern Brazil. But Colombia alone has 70 species, Costa Rica 32 and the West Indies 18, Jamaica accounting for 12 while Cuba has only 2. On the other hand, the genus *Gesneria* is essentially West Indian with 28 species in Cuba, 20 in Hispaniola, 16 in Jamaica. The genus *Rechsteineria* extends from Mexico to northern Argentina and Uruguay, but the greatest concentration of species is in Brazil. The same apparently applies to the much smaller genus *Hypocyrta*. Colombia seems to be the area with the highest number of species in many genera: *Alloplectus, Besleria, Episcia, Kohleria,* etc., Costa Rica running second in several cases.

In the Old World, Burma, Thailand, the Malay Peninsula, Indo-China and adjacent tropical China are the homes of several species in the genera *Chirita, Didymocarpus, Beccarinda, Briggsia,* the two first mentioned having presumably their centre of evolution in Thailand.

The 20 species of *Saintpaulia* are restricted to barely 25,000 sq. miles in Tropical East Africa, the Eastern Usambara Mountains alone totalling 10 species (Burtt, 1958). The 90-odd species of *Streptocarpus* are predominantly Middle and South African. Finally, the small genera *Haberlea, Jankaea* and *Ramonda* are the only ones that have reached the mountains of southern Europe. A perfect example of narrow endemism is provided by the genus *Cyrtandra,* the largest in the family with over 500 species, specially abundant in the Pacific Islands. Hawaii alone has several dozens of them, each moist valley, wether wide or small, has its own species.

At the Montreal Botanical Garden, we have over a number of years assembled a considerable collection of Gesneriaceae through the exporation-work of some members of the staff, exchange or purchase. Several species obtained in this manner have turned out to be either little-known or new. The purpose of this paper, the first of a series devoted to cultivated Gesneriads, is to describe a new species of *Hypocyrta* from Ecuador. I fully realize the perils of bringing something new in such a difficult family, but having failed to match this unusual plant in the literature available, I do not hesitate to name it after its discoverer Mr. Henry Teuscher, our present Curator. He has introduced into cultivation several rarities, thanks to his own travels and his contacts with various collectors, a fact which has made the Montreal Botanical Garden an important center for rare or seldom-seen plants.

Hypocyrta Teuscheri Raymond, n. sp.
Sect. *Dichroae* Raymond, sectio nova

Char. sect.: Suffrutices foliis dichrois, supra viridibus aut vittatis, subtus vinaceis, nervis reticulatis, rugosis, setulis basi tuberculatis investis; sepalis amplis cinnabarinis; corolla dichroa tubo citrino lobis cinnabarinis. Species 2 in Ecuador et Columbia incolunt: H. pulchra N. E. Brown et H. Teuscheri Raymond.

Descr. spec.: Affinis H. pulchra N. E. Brown, sed foliis vittatis, basi decurrentibus, corolla valde ventricosa, habitu, etc. ample distincta.

Suffrutex metralis et ultra ramis numerosis flexuosis, tetragonis (diam. 5 mm.) hornotinis viridibus rubromaculatis, dense sed breve hispidulis, demum griseis; folia fere aequalia, petiolata (petiolo vinaceo, griseo-hispidulo 4—5 cm. longo, diam. 4—5 mm.); lamina ovato-acuminata (12—15 cm. longa, 5—7.5 cm. lata), undulato-serrata, utrinque dense hispido-rugosa, bullata, pilis basi tuberculatis dense investa, basi paulum inaequaliter decurrentia, venis primariis 10—12-jugis, secundariis numerosis reticulatis, supra atro-viridis vitta centrali argentea longitudinali percursa, subtus vinacea; flores axillares numerosi, singuli, bracteis lanceolatis rubris (1 cm. longis, 2 mm. latis) praediti, pedunculo rubro 1—2 cm. longo); sepalis cinnabarinis (10—12 mm. longis, 8 mm. latis), late ovatis, nervatis, utrinque pilosis, margine dentato-ciliatis et undulatis, basi solum connexis et lateribus sese tegentibus; corolla 2 cm. longa, citrina, externe minute hirsutella, in calyce obliqua, basi postice gibba (diam. 8 mm.), supra basin leviter constricta, versus faucem antice ventricosa (diam. 12 mm.), fauce constricta, lobis quinque cinnabarinis, ciliatis, subobliquis coronata; stamina 4 (1 cm. longa) filamentis basi dilatato-confluentibus, superne tortis; antheris suborbicularibus; ovarium pilosulum, glandula postice sola evoluta; stigma bilobum; fructus ignotus.

A weak shrub 1 m. high or more, straggling over other vegetation, with numerous branches; stem tetragonous (about 5 mm. in diam.), the young parts green with red markings, covered with hairs, greying with age; leaves of a pair practically equal, petiolate, the petioles wine-coloured, grey hispidulous, 4.5 cm. long, 4—5 mm. thick; blade ovate-acuminate, 12—15 cm. long, 5—7.5 cm. wide, finely undulate-serrate, hispid-rugose, bullate, the hairs tubercle-based, the base unequally decurrent, the upper surface deep green with a silvery wide band on both sides of the midvein, the under surface of a rich wine-colour; primary veins 10—12 pairs, the secondary numerous, in a reticulate pattern; flowers numerous at the axils of the leaves, each with a peduncle of its own, subtended by short red bracts (1 cm. long, 2 mm. wide), pedunculate, the peduncle 1—2 cm. long, also red; sepals red (10—12 mm. long, 8 mm. wide) largely ovate, finely pilose on both surfaces, with margins finely undulate and dentate-ciliate, united at base only, but their sides overlapping, nerved; corolla 2 cm. long, lemon-coloured,

externally minutely hirsute, oblique in the calyx, with a posterior gibbosity (8 mm. diam.), slightly constricted farther up, widening again in the frontal portion, this time (12 mm. diam.), then constricting anew below the five short, finely ciliate, crimson lobes; stamens 4, the filaments dilated and united at base, coiled above, the anthers suborbicular; ovary hirsute, the posterior gland only develops; stigma bilobed.

Grown in the Montreal Botanical Garden, under culture number 2137-56, from cuttings collected by Mr. Henry Teuscher in Ecuador, approximately half-way between Guayaquil and Cuenca, near a road-builders' camp, known as I.N.C.A. Camp, at an altitude of 3,500 feet. TYPE of the same number (leg. Raymond) in the Herbarium of the Montreal Botanical Garden.

According to the collector, the plant grew on the shady slope of a ravine, its lower parts devoid of leaves and without contact with the ground. It behaved like many other liana-like weak shrubs in the tropics that take new footholds, develop only short aerial roots and creep over the vegetation. The plant had just finished blooming at the time of the collection, which was in late April, 1956. Two years after the rooting of the cuttings in Montreal, they set up flower buds, but these failed to open and shrivelled. This year, several plants came to bloom at the end of June and the beginning of July (fig. 1). This period is the wettest and coldest part of the year in Ecuador where the seasons are reversed and where *Hypocyrta Teuscheri* flowers at the end of the dry season. The buds at the basal nodes are the first to open and the flowers do not last long. After a day, the lobes turn brownish.

In spite of its straggling habit, the species is an interesting one for collectors, its leaves displaying an unusual variegated pattern, which in color and texture remind one of *Episcia* or *Alloplectus*, the two-toned corolla and the red calyx being an additional attraction. When stripped of its sepals, the dorsally saccate and ventrally inflated corolla resembles a yellow miniature slipper (fig. 2).

Apparently, large tracts of Ecuador are still botanically unknown. This Gesneriad comes from a small area that yielded in barely three hours' collecting such unusual and even new species as *Rodriguezia Teuscheri* Garay, *Guzmannia gloriosa* André, *G. Teuscheri* L. B. Smith, *Trichantha minor* Hook. among others, not to mention several Aroids, some of which we have not been able to identify with certainty as yet and may presumable be undescribed.

The mainly Brazilian genus *Hypocyrta* Mart. (1829) comprises about a dozen species, mostly erect or weak shrubs. A more northern one,

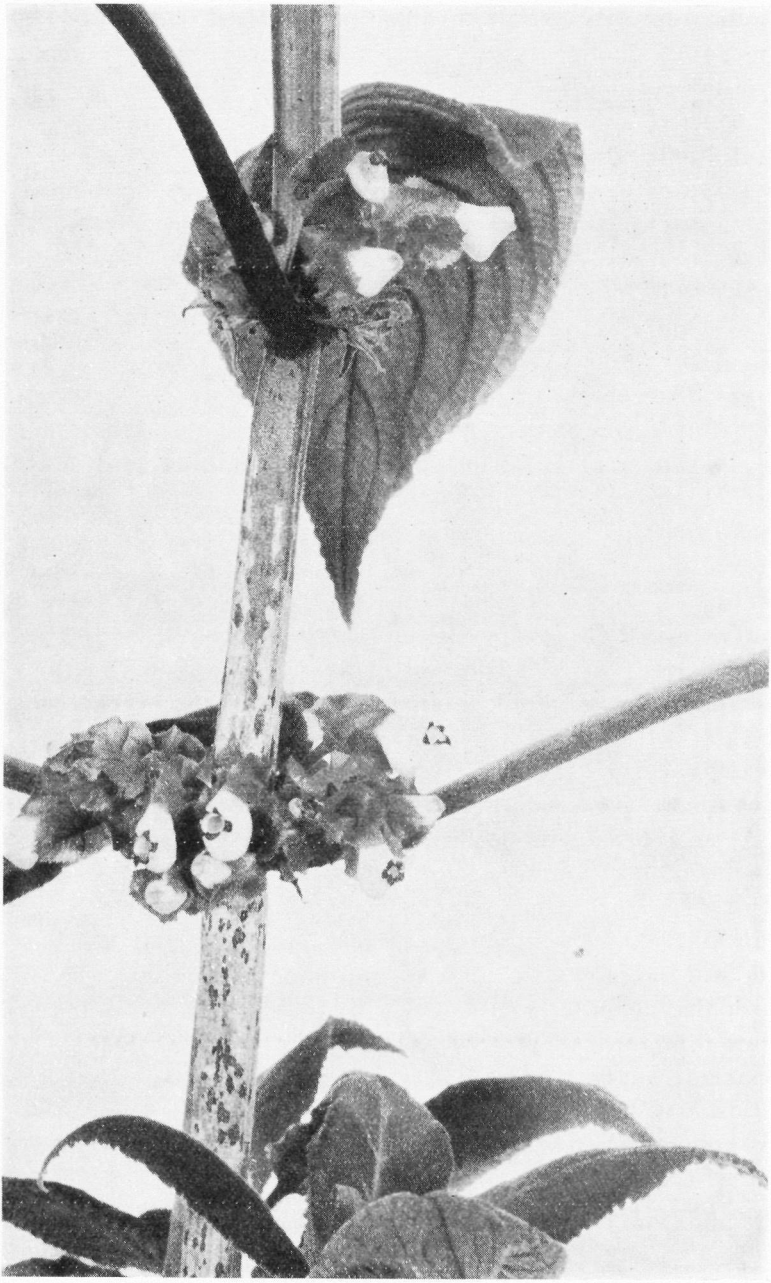

Fig. 1. — *Hypocyrta Teuscheri* Raymond — View of the lower nodes with flowers in the axils. Photog. F. Charbonneau.

Fig. 2. — *Hypocyrta Teuscheri* Raymond — Close-up of the flowers with (right) and without (left) sepals. Photogr. F. Charbonneau.

H. Nummularia Hanst., of trailing habit, a native of southern Mexico and Central America, becomes more and more popular in collections as a basket-plant. Coloured illustrations can be found of *H. strigillosa* Mart. (Bot. Mag. tab. 4047), *H. glabra* Hook. (Bot. Mag. tab. 4346) and *H. scabrida* Lemaire (Fl. des Serres, tab. 238), not mentioning *H. pulchra* N. E. Brown (Bot. Mag. tab. 7468). Some other species, first described as *Hypocyrta,* had to be transferred to *Codonanthe* and *Codonanthopsis.*

Though sometimes confluent with *Alloplectus,* genus *Hypocyrta* stands apart through the following characters: corolla strongly swollen in front, filaments of the stamens dilated and united at base, coiled at the summit. The fruit is said to be a capsule not a berry.

In most species, the foliage is green, the corolla either of a single color, usually vermilion, or the body vermilion and the lobes yellow, whereas the usually narrow sepals are green. In *Hypocyrta pulchra,* as well as in the present one, the leaves are green or vittate on the upper surface, and wine-coloured beneath. Furthermore, they are bullate, reticulate, rough to the touch, because of the presence of tubercle-based stiff hairs. The red calyx and the largely ovate sepals simulate *Allo-*

plectus. The corolla has its tube yellow and the short lobes scarlet. As they both stand apart in the genus, section *Dichroae* was created to accommodate them. Both can be recognized with the following key:

Low erect shrub; leaves ovate, subcordate at base, dull green on the upper surface, wine-coloured beneath; corolla a little swollen and slightly saccate, hirsute except at base. Colombia. . . . . *H. pulchra* N. E. Brown

Weak straggling shrub; leaves narrowly ovate, decurrent at base, green with silver midrib on the under surface, wine-coloured beneath; corolla strongly swollen and saccate, hirsute throughout. Ecuador. *H. Teuscheri* Raymond

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The author wishes to thank Dr. H. E. MOORE, Mr. C. V. MORTON, Mr. Henry TEUSCHER, Mr. James KUCYNIAK and Mr. Florent CHARBONNEAU, for assistance and suggestions.

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Neue Vertreter der Gattung Characiopsis

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Die Gattung *Characiopsis* Borzi gehört zu den artenreichsten Gattungen der Xanthophyceen (Heterokonten). Trotzdem scheint die Formenfülle noch nicht erschöpft zu sein. Man kann bei eingehenden Untersuchungen der auf verschiedenen Fadenalgen und anderen Substraten festhaftenden Algen immer wieder neue, von den bislang bekannten *Characiopsis*-Arten abweichende Formen auffinden. Da die Variabilität der einzelnen Arten völlig unbekannt oder nur unvollkommen aufgeklärt ist, kann schwer entschieden werden, welche Formen den bekannten Taxa beizureihen, und welche Formen wiederum als selbständige Taxa aufzufassen sind. So wird eine Einreihung durch den subjektiven Standpunkt stark beeinflusst. Formen mit wenig veränderten Merkmalen, die nicht merklich von den bekannten Arten abweichen, werden als Varietäten betrachtet, wogegen Formen mit deutlich unterschiedlichen Merkmalen als selbständige Arten aufgestellt werden. Dabei wird nicht berücksichtigt, dass ein rein subjektiv betrachteter kleiner Unterschied von höherem taxonomischen Wert sein kann als ein subjektiv auffallender. Das ist eine Kinderkrankheit, die noch fast bei allen Algengruppen zu spüren ist. Umso mehr bei den Heterokonten, von denen wir vorläufig nur einen Bruchteil gründlich kennen. Bei der Gattung *Characiopsis* liegt vorläufig wenig Material vor, die einzelnen Funde sind zerstreut und die meisten Arten wurden nur einmal beobachtet. Dabei gibt es heute noch keine Möglichkeit *Characiopsis*-Arten in Reinkulturen eingehender zu untersuchen. Deshalb wird man, wenn auch unvollkommen, die Variabilität rein statistisch nach reichlichem Freiland-Material bestimmen können. Dazu muss reichlichst Material gesammelt, untersucht und verglichen werden. Sollte eine geeignete Methode einer Kultivation und Bestimmung der Variabilität nach Reinkulturen gefunden werden, würde

das die Arbeit sehr erleichtert. Bis dahin ist man gezwungen alle Formen, die subjektiv betrachtet deutlich von den bekannten Formen abweichen, als selbständige Taxa zu bezeichnen.

Nach diesem Standpunkt wurden auch die in diesem Artikel angeführten Taxa bearbeitet. Bei der Untersuchung einzelliger, festsitzender Algen habe ich Formen gefunden, die mit keiner der bislang bekannten identisch waren. Sie sollen daher als selbständige Taxa folgend beschrieben werden.

Characiopsis aculeata var. ***obtusa*** nov. var.

A typo differt cellulis longioribus, pediculo breviore, calyptra membranacea in vertice cellulae.

Dimensiones: cellulae 15—32 μ longae, 5—8 μ latae. Typus figura nostra 1.

Zellen gestreckt ellipsoidisch, schief oder unregelmässig spindelförmig, meistens unregelmässig gebogen oder gekrümmt. Nach vorne sind die Zellen kürzer, basal allmählich verschmälert, in einen zarten, kürzeren Stiel übergehend. Stiel nur ein Viertel der Zelle messend, mit einer breiteren, mit Eisenhydroxyd stark inkrustierten Haftscheibe. Membran etwas derb, vorne mit einer deutlichen, geschichteten, kegelförmigen Verdickung versehen. Diese Verdickung ist oft gekrümmt, nach unten gebogen. Chromatophoren 2—4, verhältnismässig gross, scheibenförmig, wandständig. Im Plasma gelegentlich grosse Öltropfen. Fortpflanzung wurde nicht beobachtet. Wahrscheinlich vollzieht sie sich durch Zoo-

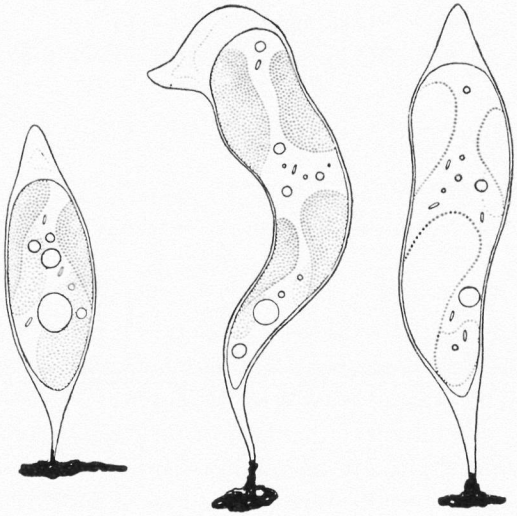

Abb. 1. *Characiopsis aculeata* var. *obtusa* nov. var. Links eine junge Zelle.

sporen wie bei allen übrigen *Characiopsis*-Arten, da leere Membranen beobachtet wurden. Junge Zellen sind mehr gestreckt elliptisch-spindelförmig, sie sind auch nicht gebogen.

Ausmasse: Zellen 15—32 μ lang, 5—8 μ breit.

Vorkommen: In wenigen Exemplaren auf *Oedogonium*-Fäden in alten Torfstichen (pH 6,3) bei Boskowitz, Mähren.

Ursprünglich wollte ich diese Form als eine selbständige Art auffassen. Doch konnte ich dann bestimmte massgebende Zusammenhänge mit *Ch. aculeata* (Pascher 1939) auffinden. Von *Ch. aculeata* var. *aculeata* unterscheidet sich die oben beschriebene Varietät durch die längeren und schlankeren Zellen, wobei die Krümmungen dieselben sind wie beim Typus. Der Stiel dagegen ist kürzer. Zum Unterschied von var. *aculeata* hat unsere Varietät anstatt eines Membranstachels eine kegelförmige Membrankappe, die stark verquollen ist und eine deutliche Schichtung aufweist.

Characiopsis sublinearis var. ***praeacuta*** nov. var.

A typo vertice cellulae acuto, minoribus chromatophoris compluribus differt. Dimensiones: cellulae 32—50 μ longae, 6—10 μ latae. Typus figura nostra 2.

Zellen sehr gross, gestreckt spindelförmig bis fast zylindrisch, jedoch immer unregelmässig. Vorne kurz zugespitzt und rasch verschmälert, nach hinten fast allmählich in einen schmalen, kurzen Stiel auslaufend. Der Stiel endet mit einer stark inkrustierten Haftscheibe. Oft ist bei den erwachsenen Zellen die vordere Hälfte mächtiger und dicker, was den Zellen das unregelmässige Aussehen verleiht. Zellen manchmal unregelmässig gebogen, mit welligen Flanken. Membran ziemlich derb, leicht gelblich gefärbt. Chromatophoren mehrere bis viele, scheibenförmig, wandständig. Öltropfen reichlich vorhanden. Fortpflanzung nicht beobachtet.

Ausmasse: Zellen 32—50 μ lang, 6—10 μ breit.

Vorkommen: Auf *Microspora pachyderma* in einer sumpfigen Bucht des Stadtteiches bei Zwittau, Mähren.

Ich konnte mich zuerst nicht entscheiden, ob diese Form zu *Ch. sublinearis* Pascher oder *Ch. polychloris* Pascher zu reihen. Die genannte Varietät besitzt gewisse Ähnlichkeit mit beiden Arten. Wie *Ch. polychloris* hat auch unsere Varietät ein zugespitztes Vorderende und mehrere kleinere Chromatophoren. Doch sind die Zellen von *Ch. polychloris* kleiner, regelmässiger (zylindrisch), nicht gekrümmt und mit einem anders gestalteten Basalende versehen (s. Pascher 1939). Unsere Varietät

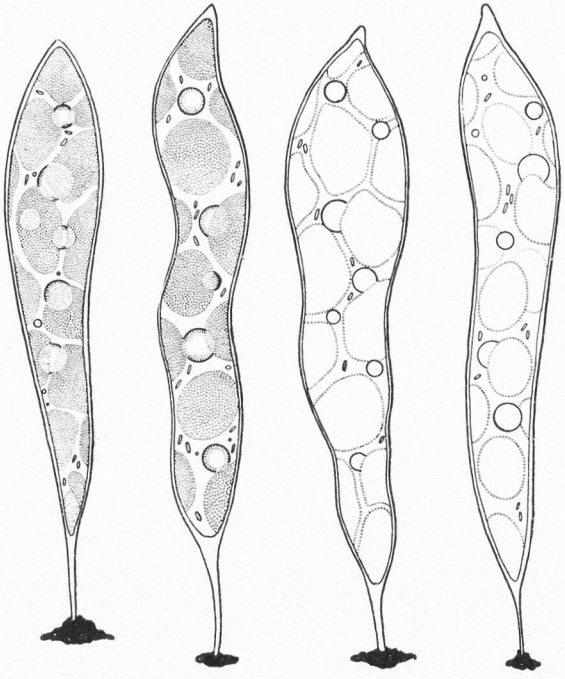

Abb. 2. *Characiopsis sublinearis* var. *praeacuta* nov. var.

hat mit *Ch. sublinearis* die geschlängelte Gestalt und das allmählich verschmälerte Basalstück gemeinsam. Das hat mich zur oben erwähnten Einreihung veranlasst.

Characiopsis incurva nov. spec.

Cellulae varie figuratae, principio claviformes, incurvae, sine pediculo, parte basali ad substratum directe destinatae, polo anteriore acutae; membrana delicatissima; 2—3 chromatophoribus parietalibus. Propagatio zoosporis quaterni formantibus. Aplanosporae cognitae.

Dimensiones: Cellulae 13—20 μ longae, 4—6 μ latae. Typus figura nostra 3.

Zellen verschieden geförmt, im Prinzip keulenförmig, ohne Stiel, also direkt mittels einer Haftscheibe festsitzend. Immer deutlich, einseitig buckelig bekrümmt, mit einer einseitig vorgewölbten Flanke. Das Vorderende rasch verschmälert und zugespitzt, nach hinten allmählich verjüngt und stumpf endend. Das gekrümmte Vorderende stets mächtiger als das Hinterende. Membran sehr zart, ohne Verdickungen. Chromatophoren meistens zwei oder drei vorhanden, rinnenförmig, wandständig. Bei jungen Zellen ist manchmal auch nur ein einziger Chromatophor

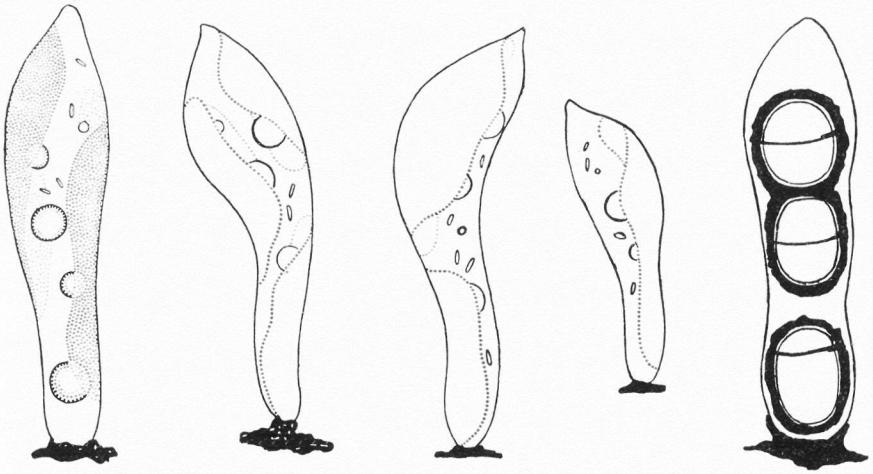

Abb. 3. *Characiopsis incurva* nov. spec. Rechts Zelle mit Aplanosporen.

vorhanden. Reichliche Öltropfen bei erwachsenen Zellen. Fortpflanzung durch 4 Zoosporen ohne Augenfleck. In einer Zelle wurden Aplanosporen beobachtet. Diese sind zweiteiling, derbwandig, mit dicken Eisenauflagerungen (s. Abb. 3).

Ausmasse: Zellen 13—20 μ lang, 4—6 μ breit.

Vorkommen: Auf verschiedenen Fadenalgen in einem Torfgraben (pH 5,7) des Pavlover-Moores bei Boskowitz, Mähren.

Diese Art unterscheidet sich deutlich von allen bislang bekannten Arten. Vielleicht könnte sie bei oberflächlicher Beobachtung mit *Ch. subulata* Borzi verwechselt werden. *Ch. incurva* unterscheidet sich jedoch deutlich durch ihre bogig keulenförmige Gestalt mit deutlich vorgewölbten, buckeligen Flanken.

Characiopsis subulata var. ***ventricosa*** nov. var.

A typo incurvis cellulis undulatis, parte basali ventricose turgida differt.
Dimensiones: Cellulae 17—22 μ longae, 5—7 μ latae. Typus figura nostra 4.

Zellen recht verschieden gestaltet, im Prinzip lanzettförmig, unregelmässig zugespitzt eiförmig, vorne immer in eine deutliche Spitze auslaufend, basal breit abgerundet. Die vordere Spitze kann jedoch manchmal auch leicht abgestumpft sein. Die Zellen sind stets gekrümmt, manche sogar sichelförmig; die meisten mit welligen Flanken. Gegen die Basis sind die Zellen deutlich verdickt, fast bauchig aufgetrieben, breit abgerundet. Ohne Stiel, daher direkt am Substrat festsitzend. Haft-

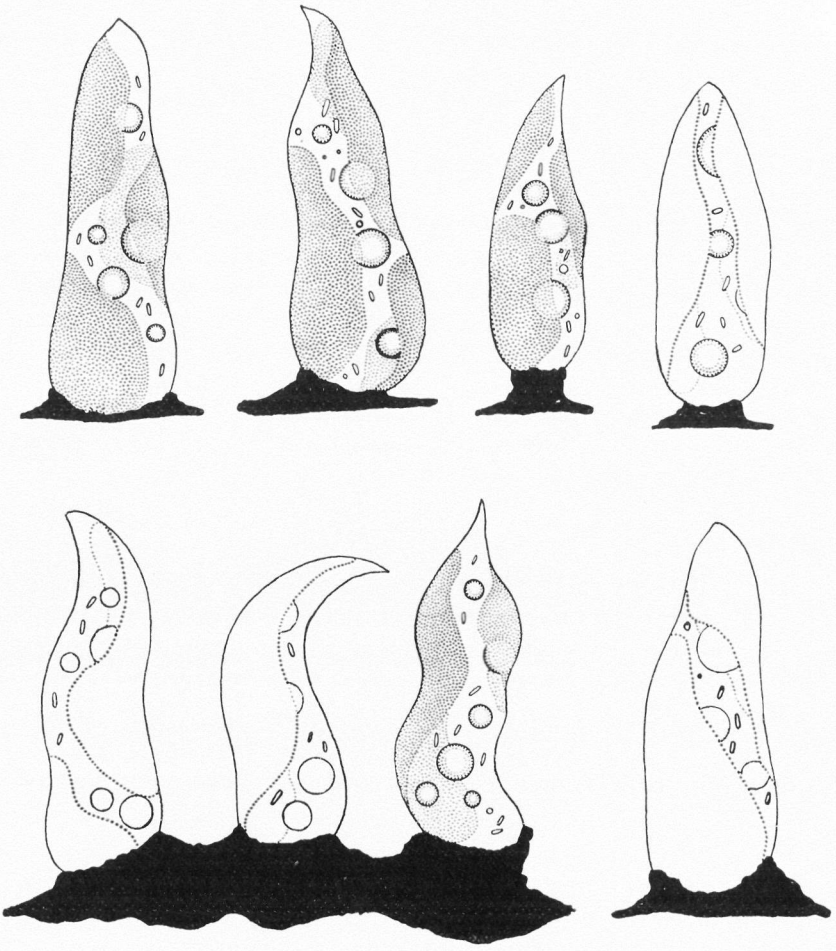

Abb. 4. *Characiopsis subulata* var. *ventricosa* nov. var.

scheiben mächtig, mit Eisenhydroxyd stark inkrustiert, oft dunkelbraune Massen bildend, die dann eine Grundplatte für mehrere Zellen bilden (s. Abb. 4). Membran sehr zart. Chromatophoren in der Einzahl vorhanden. Reichliche Öltropfen. Fortpflanzung durch 2—4 Zoosporen mit einem Chromatophoren und körperlanger Hauptgeissel.

Ausmasse: Zellen 17—22 μ lang, 5—7 μ breit.

Vorkommen: Auf *Oedogonium*-Fäden in alten Torfstichen (pH 6,3) bei Zwittau, Mähren.

Vielleicht eine selbständige Art. Die genannte Varietät ist zwar in

mancher Hinsicht mit *Ch. subulata* var. *subulata* identisch, unterscheidet sich jedoch durch die welligen Flanken und den bauchigen Basalteil.

Zellen mit einem Chromatophoren erinnern an *Ch. elegans* Ettl (1956), doch kommen bei der letztgenannten Art ausschliesslich Zellen mit einem Chromatophoren vor, wobei *Ch. subulata* nur in Ausnahmsfällen einen einzigen Chromatophoren führt. *Ch. subulata* var. *subulata* bildet gelegentlich auch mächtige, inkrustierte Haftscheiben.

Characiopsis callosa nov. spec.

Cellulae oblique ellipsoideae usque ad claviformes, parte anteriore late rotundatae, parte basali pediculo crasso excurrentes; cellulae seneces irregulariter undulatae; membrana valde crassa, evidente striata; parietalibus chromatophoris compluribus. Propagatio non observata.

Dimensiones: cellulae 16—22 µ longae, 8—12 µ latae. Typus figura nostra 5.

Zellen im Prinzip schief ellipsoidisch bis keulenartig. Vorne breit abgerundet, basal leicht verschmälert, und in kurzen aber dicken Stiel mit grosser Haftscheibe auslaufend. Alte Zellen sind in der Regel gewellt. Membran sehr dick und derb, häufig mit deutlicher Schichtung; bei alten Zellen mit unregelmässigen Verdickungen versehen, gelb gefärbt.

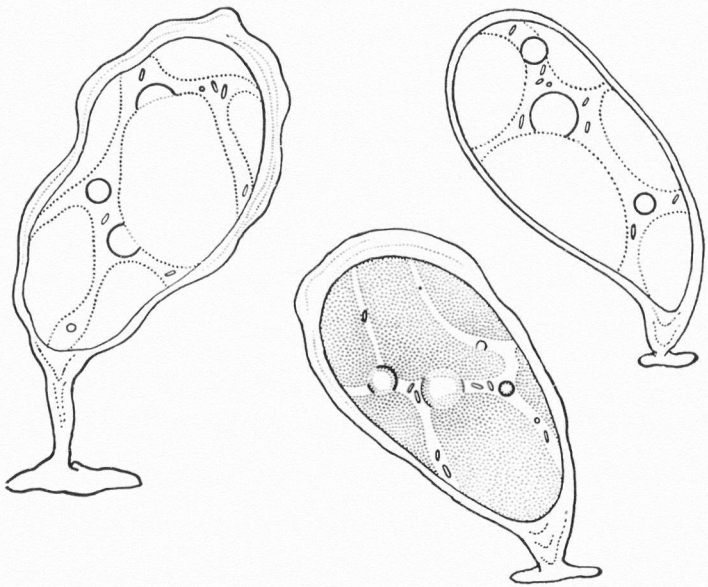

Abb. 5. *Characiopsis callosa* nov spec. Links eine alte Zelle.

Chromatophoren mehrere, wandständig und scheibenförmig. Fortpflanzung nicht beobachtet.

Ausmasse: Zellen 16—22 μ lang, 8—12 μ breit.

Vorkommen: Auf verschiedenen Fadenalgen (*Rhizoclonium sp.*, *Oedogonium sp.*) im Stadtteich bei Zwittau, Mähren.

Ch. callosa sieht keiner bekannten Art ähnlich. Sie ist durch die Gestalt und derbe geschichtete Membran charakterisiert.

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Embryo Sac Development and Polyembryony in Syzygium cumini (Linn.) Skeels[1]

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The genus *Syzygium* (=Old World *Eugenia*) is widely distributed in the southern and northern parts of India. With regard to the observations made about polyembryony in several *Eugenia* species an investigation was made of the embryology of *Syzygium cumini* (Linn.) Skeels.

Tiwary (1926) was the first to report on the occurrence of polyembryony in *Eugenia jambolana* and who compared the results with those obtained in *E. jambos, E. grandis, E. formosana* and *E. caryophyllata*. He has further observed that the genus showed all gradations of polyembryony in the several species, from a condition of predominance to one of comparative obscurity.

Pijl (1934) has published an account of his investigations on a few species of *Eugenia* from Java from the point of view of the occurrence of polyembryony, apogamy, parthenogenesis, apospory, polyspermy, etc. For instance, *Eugenia jambos* and *E. malaccensis* are highly polyembryonic. In the first one the adventive embryos arise from the nucellar tissue at the micropylar end while in the latter they originate from the integument. Pijl's examination of specimens from four different localities and fruits obtained from the local market, showed absence of polyembryony in *E. cumini* Merr. (=*E. jambolana* Lamk.), contrary to the report of Tiwary.

Johnson (1936) has recorded the high polyembryonic nature of *Eugenia hookeri*. The number of embryos found in a seed ranged from two to twenty-two.

An account of the structure of the ovule of *Eugenia paniculata, E. capensis* and *E. ventenatii* has been given by Mauritzon (1939) in his

[1] Work done at the Dept. of Botany, Delhi University, Delhi, India.

voluminous treatise entitled "Contributions to the embryology of the orders Rosales and Myrtales". He has commented upon the occurrence of a single integument in *E. paniculata* as the product of fusion of two.

Roy's (1953, 1955) investigation on *Eugenia jambos* and *E. bracteata* showed the embryo sac development to be of the Normal type. He also traced the origin of adventive embryos in the former and development of the zygotic embryo in the latter species.

Material and Methods

The material for investigation was collected mainly from the trees growing in the University campus, Banaras, as well as from Delhi, Agra and Calcutta. Collections were made in the months of April and May during the years 1954—1957. Flower buds and ripe ovaries were fixed in F.A.A. after trimming off the ovary wall from the sides so as to facilitate penetration of the fixing fluid. The stamens were fixed in Nawashin's fluid.

The customary procedures of infiltration and imbedding were followed. Sections were cut between 10—20 μ thick depending upon the stage of development. The anthers were sectioned at 5—6 μ thick. Haidenhain's iron haematoxylin, and safranin and fast green combination, were used for staining.

Observations

Ovary and ovule: The ovary is inferior and conical in shape. It is bilocular containing numerous ovules borne on axile placentae. The style is strong and slightly longer than the length of the ovary showing no well-defined stigma. It is solid, the central region showing elongated conducting cells. Its surface is shiny green and gland-dotted.

The mature ovule is anatropous with a strong curve on the side of the raphe (Fig. 1). It is generally twice as long as broad. The vascular supply consisting of a few spiral elements traverses the funicle and enters the integument.

The ovule is invested by a single integument and a parietal tissue of several cell layers is formed above the megaspore mother cell. The micropylar canal is narrow and oblique in relation to the longitudinal

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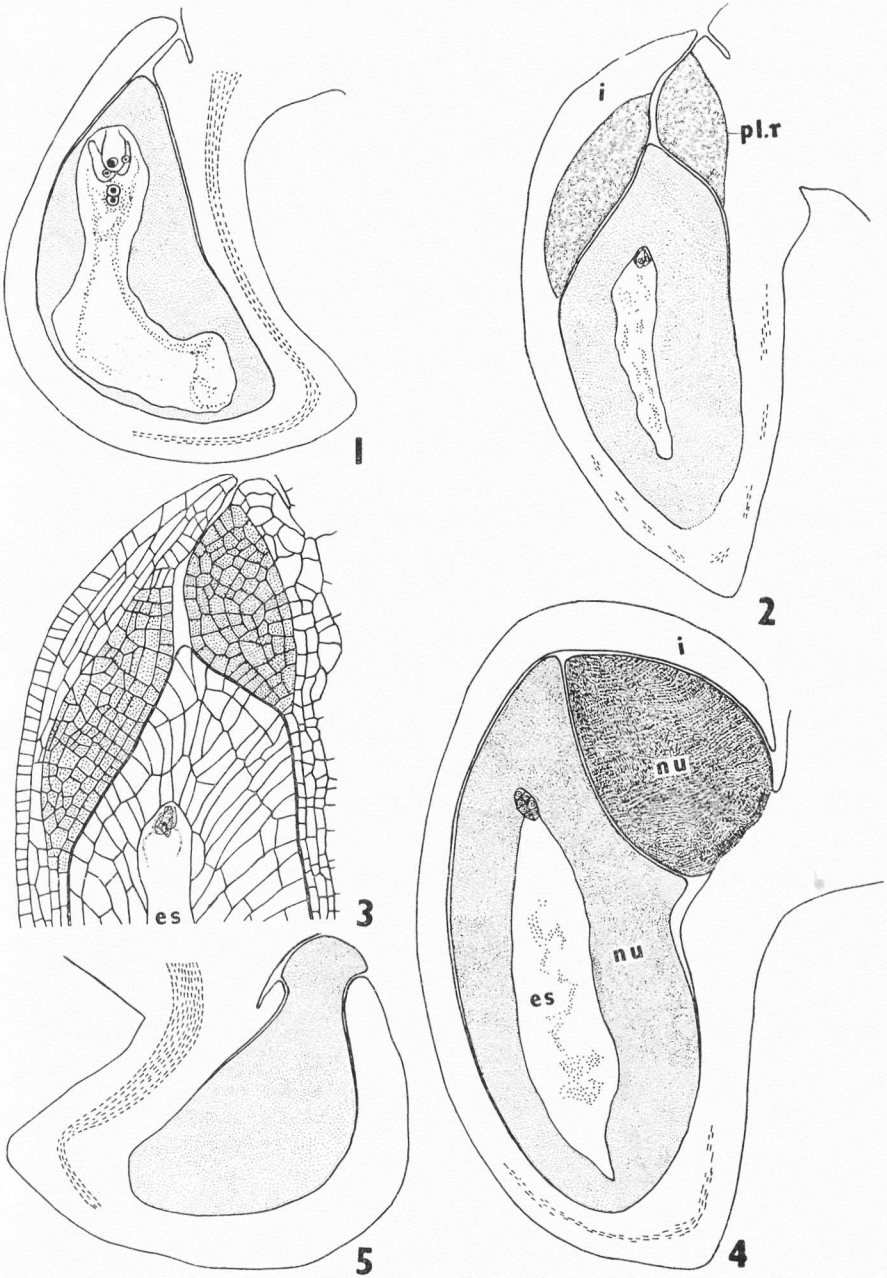
Figs. 1—5. — 1. L.s. normal ovule. ×78. — 2. L.s. ovule showing plasma-rich tissue (pl.r) of inner layers of integument. ×105. — 3. L.s. Enlarged view of upper part of ovule shown in Fig. 2. ×153. — 4. L.s. ovule showing twin nucelli of which one is sterile. ×105. — 5. L.s. ovule showing protrusion of nucellus through integument. ×153. (Abbreviations — *e*, egg; *es*, embryo sac; *i*, integument; *nu*, nucellus; *pl.r*, plasma rich cells; *gn*, generative nucleus; *syn*, synergid; *sp*, sperm.)



Figs. 1—5.

axis of the ovule. The micropyle terminates near the basal portion of the funicle.

The integument is four to five cells thick. Its outer epidermal cells are enlarged and somewhat rectangular in shape. The middle layers are narrow and elongated.

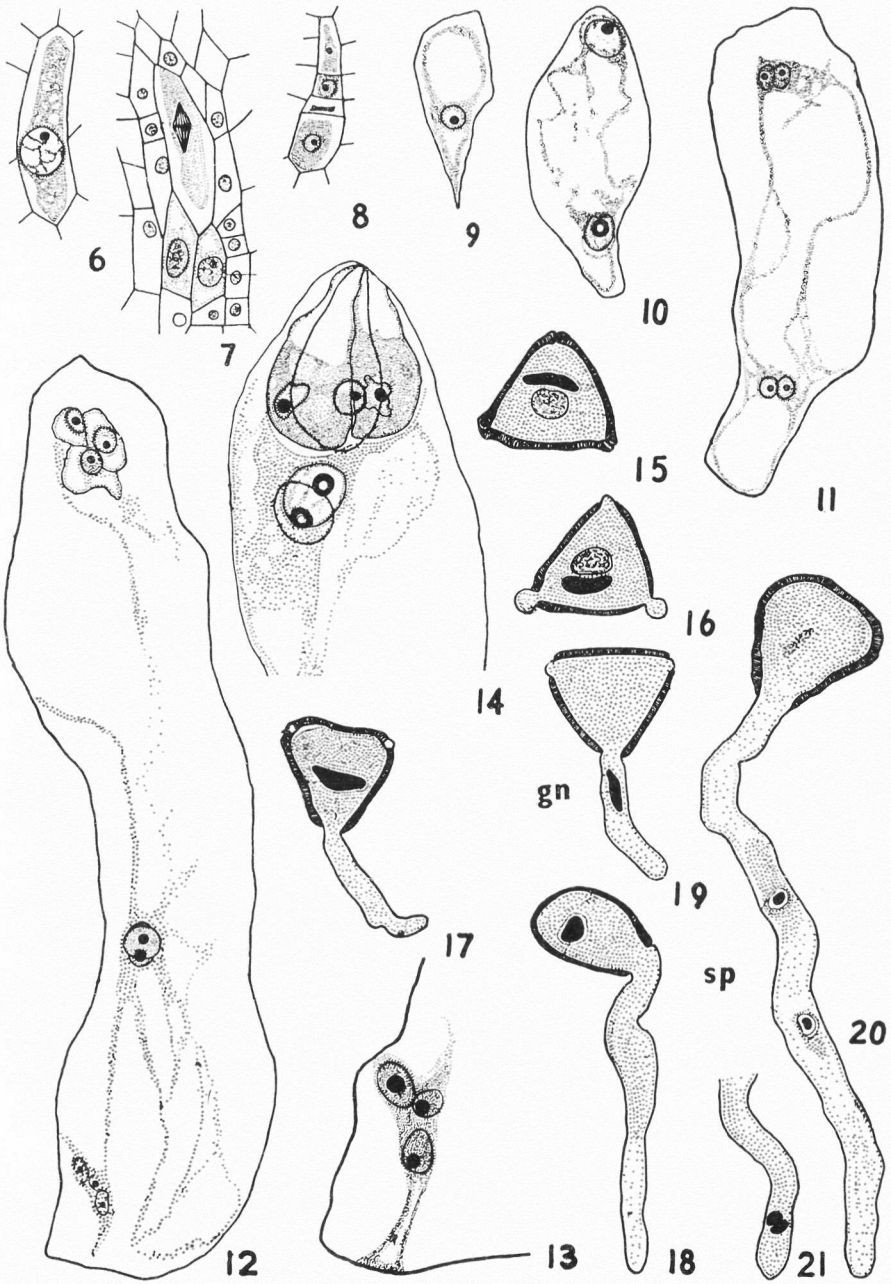
Departure from the normal structure of the ovule was also noted. Many ovules showed the formation of plasma-rich tissue (pl.r) on the inner side of the integument (Figs. 2, 3). Such tissues were, however, not embryonal. One ovule showed, apart from the normal fertile nucellus, a small mass of sterile tissue protruding from the base of the funicle, more or less conical in shape and adhering to the normal one (Fig. 4). The unusual position of this tissue resulted in the formation of a long and curved micropylar passage. In some ovules the upper end of the nucellus was exposed, the integument having been arrested in growth (Fig. 5).

Megasporogenesis and embryo sac: The megaspore mother cell (Fig. 6) is deep-seated, bounded by twelve to fourteen layers of parietal cells and arranged more or less in radial rows. Meiosis is normal and a linear tetrad of megaspores is formed (Figs. 7, 8), the three non-functional megaspores degenerating successively.

The functional megaspore enlarges considerably and by three successive divisions an eight-nucleate embryo sac is formed (Figs. 9—14). Due to the ephemeral nature of the antipodals the mature embryo sac appears always five-nucleate containing an egg apparatus and a pair of prominent polar nuclei. The egg cell bears a close resemblance to the synergids which appear pyriform.

Abnormal embryo sacs: Two cases of abnormal embryo sacs were encountered worthy of report. In one, the embryo sac was only four-nucleate with the two upper nuclei having organized into cells (Fig. 22). In the second instance, the nucellar cells lining the chalazal end of a mature embryo sac showed hypertrophy (Fig. 23). Such cells indicate the possibility of formation of aposporic embryo sacs by their further activity.

Figs. 6—21. — 6—12. Stages in development of embryo sac. ×280. — 13. Enlarged view of antipodals shown in Fig. 12. ×470. — 14. Embryo sac showing egg apparatus and polar nuclei. ×280. — 15—16. Pollen grains showing generative and vegetative nuclei. ×570. — 17—18. Germinating pollen grains. ×570. — 19. Generative nucleus in pollen tube. ×570. — 20—21. Pollen tubes containing sperm nuclei. ×570.



Figs. 6—21.

Microsporogenesis and male gametophyte: Cross sections of a young anther showed a number of pollen mother cells surrounded by four to five wall layers. Meiosis in the mother cells is normal; the tapetal cells are binucleate, and the microspore tetrads are tetrahedral in arrangement. The pollen grains vary in size and contents. Some are empty and sterile. The normal ones are more or less triangular showing three germ pores and three germinal furrows. The intine is thin and the exine thick and smooth. The pollen is shed at the two-celled stage (Figs. 15, 16).

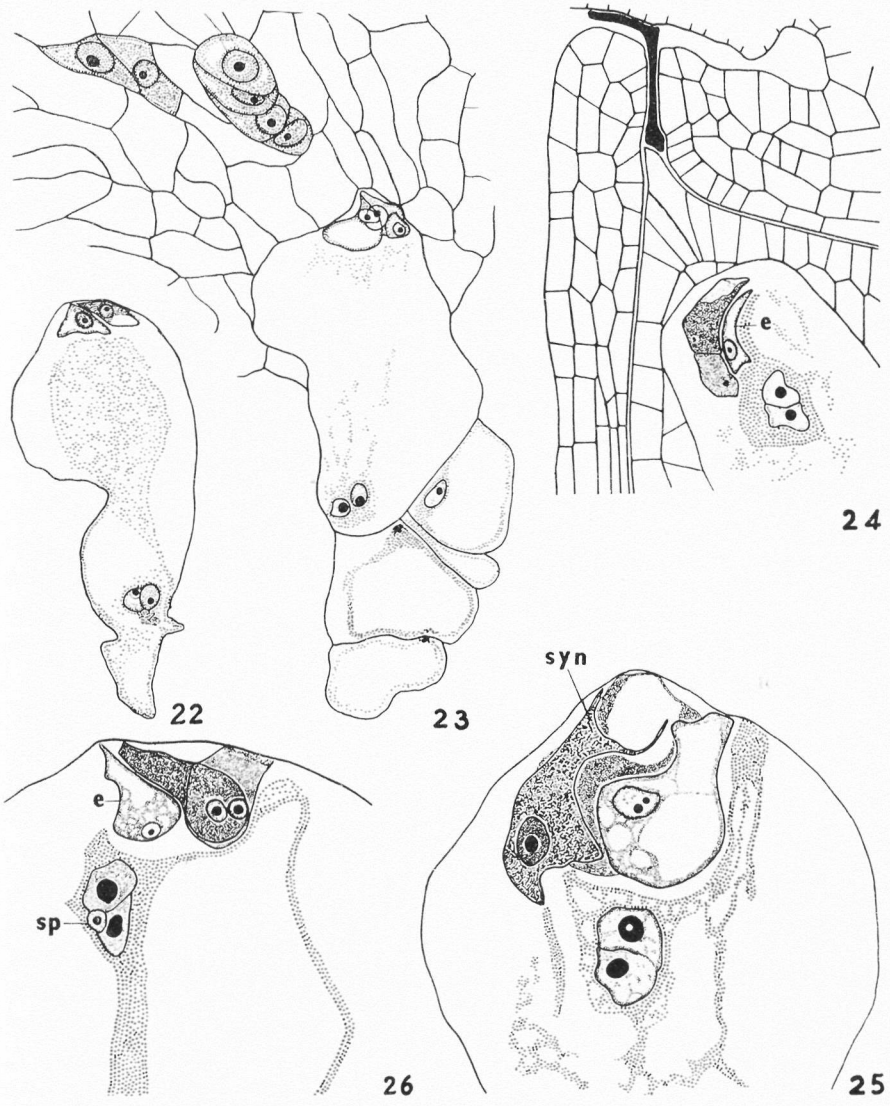
Acetocarmine squashes of the pollinated stigma showed the pollen grains to have germinated. The generative nucleus migrates and divides within the pollen tube resulting in the formation of two sperms which later on move towards the tip and lie in close association (Figs. 17—21).

Fertilization and embryo: Figure 24 shows a pollen tube traversing the micropylar passage before reaching the nucellar epidermis. Syngamy was indicated by the presence of two unequal nucleoli within the egg nucleus (Fig. 25) and triple fusion by the presence of a small sperm nucleus in association with the two polar nuclei (Fig. 26). The further growth of the zygote appears to have been arrested.

Neither a zygotic nor a parthenogenetic embryo could be found in several ovules sectioned at this stage. On the other hand the nucellar tissue around the micropylar part of the embryo sac was active (Fig. 23). Embryo initials were formed, which on enlargment begin to divide resulting in the formation of globular embryos which later project into the embryo sac (Figs. 27—29) or remain within the nucellus (Fig. 23). The egg apparatus is displaced and degenerates later. Three to five embryos were common but as many as nine embryos were also present in the immature seeds. In one instance a proembryo was found to have organized from the chalazal part of the nucellus (Fig. 30).

A large number of mature seeds were dissected out in order to observe the nature of the embryos. The embryos were frequently unequal in size in the same seed and some of them were not viable as they failed to germinate.

Seed coat and pericarp: About nine to twelve layers of cells of the integument constitute the seed coat (testa) (Fig. 31). Sections of young seeds show the innermost layer of the seed coat to be made up of parenchymatous cells rich in cytoplasm. The cells of this layer are small, rectangular and more or less elongated, and showed no proliferations as was the case in *Eugenia jambos* (Roy, 1953). Other layers of the seed



Figs. 22—26. — 22. Abnormal embryo sac in which the upper two nuclei are organized into cells. ×280. — 23. Embryo sac abutting against conspicuously enlarged nucellar cells at the base resembling embryo sacs, and by nucellar tissue containing young nucellar embryos at the top. ×280. — 24. Micropylar portion of ovule showing pollen tube and egg apparatus. ×280. — 25. Syngamy. ×465. — 26. Triple fusion. ×465.

coat are also mostly parenchymatous with lignified and spiral elements of various shapes and sizes scattered among the cells. No nucellar layer was ever found to adhere to the seed coat.

The fruit wall is thick and juicy. It is made up of a number of isodiametric parenchymatous cells. The epidermis is composed of small rectangular cells (Fig. 32). At places the radial wall of the epidermal cells may be longer than the tangential ones. The outer wall of the cells of the epidermis is covered by a shining layer of cuticle. The rest of the cells of the pericarp are bigger in size than the epidermal cells.

Discussion

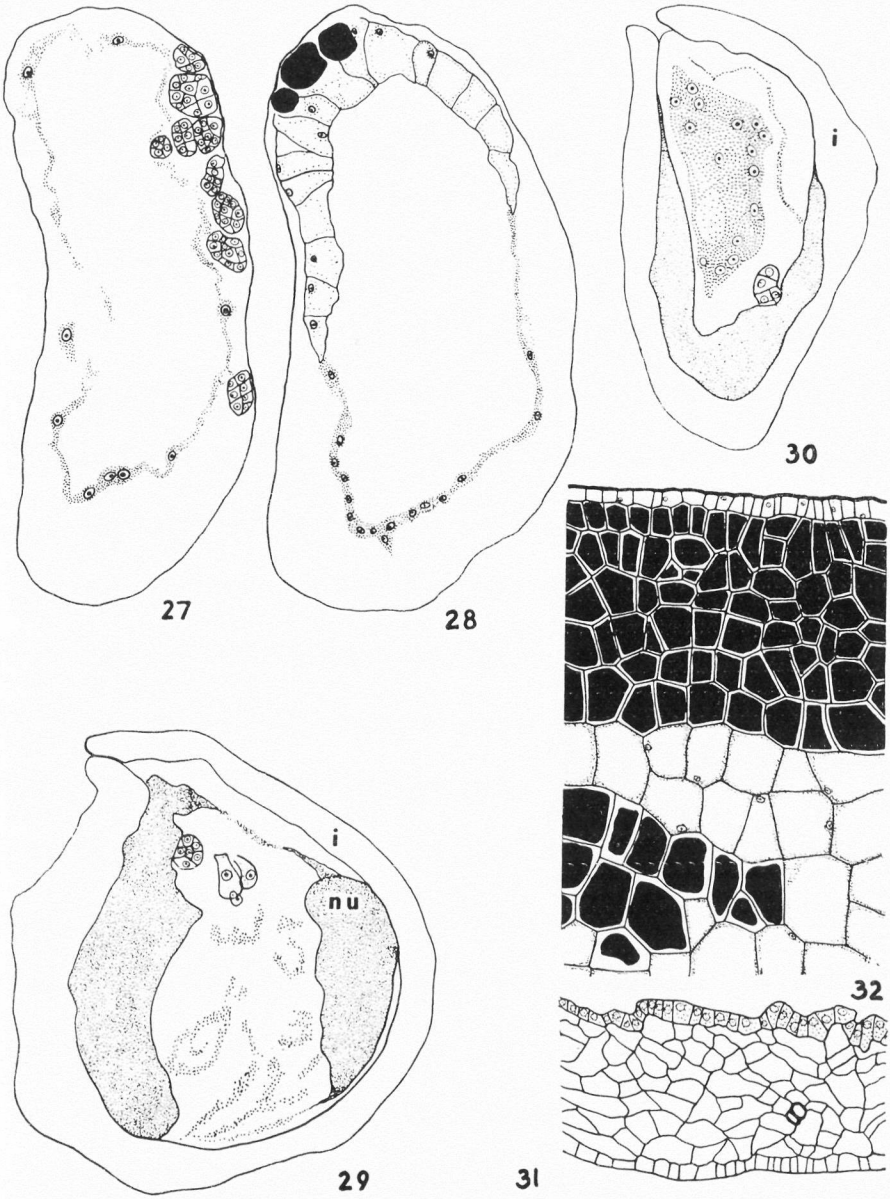
The structure and arrangement of the ovules in the several members of the family Myrtaceae are in general agreement with those of Lythraceae (Joshi & Venkateswarlu, 1935 a, b; 1936), Melastomaceae (Subramanyam, 1942), Rhizophoraceae (Cook, 1907), Onagraceae (Johansen, 1929, 1931) and Combretaceae (Fagerlind, 1941). In Combretaceae, however, the nucellar epidermis is said to divide tangentially forming a "nucellar cap", a structure not present in Myrtaceae. Another difference was the absence of a hypostase in *Syzygium cumini* reported to be present in members of the allied families.

The ovules of *Syzygium cumini* are invariably unitegminal containing a single vascular trace — a rather exceptional feature in the Myrtaceae where they are regularly bitegminal. Also the twin nucelli present in some ovules of *Syzygium cumini* are somewhat different from those of the apparently similar types originating from fusion between two adjacent ovules (Mauritzon, 1934; Joshi & Venkateswarlu, 1935, 1936; Venkateswarlu, 1937).

The archesporium is single and sub-hypodermal in origin. It functions directly as the megaspore mother cell as reported for *Punica granatum* (King, 1947). Meiosis is normal and results in a linear tetrad of megaspores.

According to Pijl (1934), the five-nucleate embryo sac of *Eugenia*

Figs. 27—32. — 27. Embryo sac showing young nucellar embryos. ×68. — 28. Embryo sacs showing nucellar embryos (dark) and endosperm. ×68. — 29. L.s. ovule showing nucellar embryo and displaced egg apparatus; note the nucellus being digested away by embryo sac at micropylar and chalazal ends. ×93. — 30. L.s. ovule showing protrusion of nucellar embryo into the embryo sac at the chalazal end. ×93. — 31. Portion of integument. ×133. — 32. Portion of fruit wall. ×133.



Figs. 27—32.

jambos has been derived as a result of an extra division of one of the micropylar nuclei at the four-nucleate stage of the embryo sac. The egg cell and one of the synergids constituted sister cells. The two chalazal nuclei presumably migrate upwards to form the polar nuclei. Pijl has cited the development of the megagametophyte in *Garcinia*[1] (Treub, 1898) in corroboration of this view. Our present investigation, however, shows that in *Syzygium* the embryo sac always follows the Polygonum type of development. Because of the ephemeral nature of the antipodals, the mature embryo sac consists only of the egg apparatus and the two polar nuclei.

The demonstration of a pollen tube in *Syzygium* is rather difficult because they are short-lived. This led Tiwary (1926) to state that possibly, fertilization never took place, and the egg cell if it ever developed an embryo, did so parthenogenetically. Pijl (1934) also failed to locate a pollen tube in sections of his material. In our investigation, however, the persistence of the remnants of pollen tubes in the micropylar region and the certainty of occurrence of syngamy and triple fusion rule out the possibility of any parthenogenetic development of the egg in *Syzygium*. The fertilized egg degenerates along with the synergids.

In the early stages of endosperm development a greater accumulation of nuclei and cytoplasm was observed at the chalazal end. Such a feature is also reported in *Jussieua* (Täckholm, 1915), *Ammania, Woodfordia* and *Nesaea* (Joshi & Venkateswarlu, 1936), *Sonneratia* and *Daubanga* (Venkateswarlu, 1937), and also *Leandra, Osbeckia* and *Memecylon* (Subramanyam, 1942) where in addition to this, the micropylar end also showed such aggregations. The endosperm later turns cellular.

To start with, quite a few proembryos differentiate in the upper part of the nucellus, but only a few pursue their development, others degenerating at one stage or other. No embryo was ever found to originate from the synergid as presumed by Tiwary (1926). Generally a mature polyembryonic seed possesses two to four embryos. In such seeds the shape of the cotyledons may differ even in the same pair due to mutual pressure by overcrowding.

Syzygium cumini agrees with *Eugenia jambos* in the mode of development of the adventive embryos. Occasionally, irregularly fused masses of embryonal primordia were observed in this species. Pijl (1934) also reports the occurrence of such embryos fused in pairs. In *E. malaccensis*

[1] Cited in Pijl (1934).

plasma-rich cells on the inner side of the integument developed into adventive embryos as observed by Pijl.

In *Syzygium cumini* the egg apparatus degenerates soon after syngamy and the nucellar embryos become prominent, a condition similar to that reported in *Eugenia jambos,* also, by Pijl. Tiwary (1926) has reported a weakening of sexuality in *E. jambolana,* which if not altogether lost, was at any rate very much impaired. The present investigation lends support to this view.

Summary

The pollen mother cells are bounded by an anther wall of four or five cell layers. The tapetum is glandular and the cells are binucleate. The microspores are 2-celled at shedding. The mature pollen grain is triangular and possesses three germ pores. The exine is thick and smooth while the intine is thin.

The ovules are unitegminal and crassinucellar. A vascular bundle traverses the integument.

The mature embryo sac extends considerably towards the chalazal and micropylar ends at the expense of the nucellar tissue and thus comes to lie against the integument. Ovules with double nucelli have been observed.

The archesporium differentiates as a single sub-hypodermal cell which functions directly as the megaspore mother cell. The latter becomes deep-seated owing to the formation of a large number of cover cells. Meiosis is normal and a linear row of megaspores is formed of which only the chalazal one functions.

The development of the embryo sac is of the Polygonum type. The antipodals are ephemeral. The synergids are prominent and may develop hooks.

A few nucellar cells adjacent to the embryo sac may enlarge and develop into aposporous embryo sacs.

Syngamy and triple fusion occur normally.

The endosperm is of the Nuclear type. A chalazal accumulation of endosperm nuclei is commonly observed. The free nuclei usually show random fusion amongst themselves.

Soon after fertilization, the egg apparatus degenerates. The upper half of the nucellus becomes proliferative and produces several embryos of which a few may survive resulting in the polyembryony of the seed. However, seeds containing only one nucellar embryo are also observed.

Our grateful thanks are due to Professor P. Maheshwari, University of Delhi, for facilities and encouragement.

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Notes on the Finer Structure of Some Pollen Grains

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A desire to indicate sundry technical possibilities etc. of illuminating some much debated palynological problems may excuse the somewhat heterogeneous nature of this paper which can be regarded as a second part to "UV micrographs and photomicrographs from the Palynological Laboratory, Stockholm-Solna" (first part printed in Grana Palynologica, Vol. 2: 1, 1959).

First the character of the colpus floor in a cucurbitaceous plant, *Ecballium elaterium,* will be discussed. The pollen grains (Pl. I, Figs. 1—3, UVMG Goldmann) are colporate. As shown in Fig. 3 — a horizontal section just above or below the oral part of one of the tremata — the colpi are comparatively broad. Their exinous floor is at least as thick as the mesocolpial exine and certainly more "compact". The inner and main part of the floor consists of "nexine 2" (grey in the figure), underlain by intine (bright) and overlain by a thin, heavily stained layer ("nexine 1", sexine, or both?). The latter layer is also shown in the longitudinal section, Fig. 1 (at the extreme right, just above the os, the section is slightly oblique and thus the colpus margin — not the colpus proper — appears below the os). The os is provided with a thin membrane, possibly consisting of nexine 3, coated with very reduced sexine. The membranes are also indicated in Fig. 2 together with the nexine 2 thickenings on both sides of the ora (in Fig. 2 they are darker than in Fig. 3). The innermost part of the "nexine 2" in Fig. 1 may or may not have the character of "nexine 3" (endonexine sensu Erdtman).

Sporoderm comparison can be made with *Volutarella* sp. (Compositae; Pl. I, Fig. 4; EMG Barbro Afzelius-Gullvåg) and *Chamaenerion angustifolium* (Pl. I, Fig. 6; UVMG Goldmann). Besides sexine the electron micrograph undoubtedly shows an outer, dark layer (nexine 1), underlain by brighter nexine 2 which, in its turn, is possibly underlain

by a thin, dark layer of nexine 3. In *Chamaenerion* a distinct nexine 1 is shown. (In contradistinction no nexine 1 can be seen in the EMG of acetolysed exine in *Oenothera biennis* published in Grana Palynologica, Vol. 1: 2, Fig. 11, p. 35.)

Pl. I, Fig. 5 (UVMG Goldmann) exhibits a part of a section through a pollen grain of *Althaea chinensis*. Trema membranes (nexine 3 overlain by sexinous material?) can be seen in the two pores cut by the section.

Pl. II, Figs. 1—4 shows a type of trema membrane recently encountered in the pollen grains of *Dracaena hookeriana* (Botanical Garden, University of Uppsala, July 1960). The pollen grains are anacolpate. In acetolysed grains the colpus is widely open, almost circular. There is no trace of a colpus membrane. However, if fresh pollen grains are transferred to a drop of water a thick, beautifully structured colpus membrane bulges out in a few seconds. The pollen grains thus become more or less spherical (Fig. 2). The colpus membrane is so delicate that it soon disappears if the grains are treated with glacial acetic acid. The membrane is provided with tiny, radial, densely-spaced baculoid elements (cf. Fig. 4) which may or may not correspond to the minute intinous radial elements shown at and inside the mouth of one of the funnel-shaped tremata in *Morina longifolia* (Pl. IV and V). Cf. also the radial elements in *Heliconia aurantiaca* (Fig. 160 B, p. 276, in G. Erdtman, Pollen Morphology and Plant Taxonomy. I. 1952 — a pollen grain treated with NaOH) and in *Hedychium coronarium* (Pl. VI in G. Erdtman, On the pollen grains in *Hedychium coronarium*, Bot. Notiser, Vol. 112, pp. 178—179, 1959).

The *Morina*-illustrations (Pl. IV, V, UVMG Goldmann) also show a granular fine structure in the inner part of the nexine (cf. particularly Pl. V). This, together with other photomicrographs to be published shortly, indicates that several features hitherto exclusively, or almost exclusively, revealed by electron micrographs can also be shown in UV micrographs (as well as in ordinary phase contrast photomicrographs of thin sections; thickness preferably less than 0.5 μ). With the optical equipment used when taking the UV micrographs reproduced in Pl. IV and V it should — theoretically — be possible to trace details with diameters down to 0.1 μ. However a careful survey of the micrographs has shown that the resolution obtained is slightly larger: some of the "radial" elements in the intine are quite distinct although their diameter in the micrograph is only 0.08 μ (800 Å).

Pl. III illustrates difficulties met with when tracing the sporoderm stratification in unsectioned acetolysed pollen grains. In *Oxera aurea*

(Figs. 1, 2; Verbenaceae; New Caledonia, Däniker 639) the spinulae-bearing sexine is probably much thicker than the nexine (cf. Fig. 2, central part). With oblique light some sexine details can be seen even if the grains are embedded in glycerine jelly (Fig. 1; the details will be more distinct in grains embedded in distilled water or in silicone oil).

Pl. III, Figs. 5—9, is an LO-analysis showing five consecutive exine patterns in acetolysed pollen grains of *Nothofagus obliqua* (Chile, Valdivia; ex herb. Stockh.). The white dots are spinules, probably of much the same kind as in *Myrica, Corylus* etc. (cf. Pl. I—III in Erdtman and Praglowski in Botan. Notiser, Vol. 112, 1959) and as those shown in the particularly beautiful electron micrographs by Yamasaki and Takeoka (cf. Sci. Rep. Saikyo Univ. Agric. 1957, 1958, 1959). The greyish dots in Figs. 8 and 9 indicate the presence of minute infrategillar bacula (cf. also the optical cross section, Fig. 10). It goes without saying that minute characters such as those exhibited in Pl. III, Figs. 5—10, can be of great value in the description and identification of fossil spores.

Pl. III, Figs. 3—4, has been inserted as a stimulus towards tracing the relationships of the Oligocene monoporate pollen grain *Aglaoreidia cyclops* Erdtm. from the Lower Headon Beds in the south of England (cf. Botan. Notiser, Vol. 113, 1960, p. 47). It shows a pollen grain of a modern plant. Unfortunately, however, all information concerning its name, the collector, and the collector's number etc. has been lost. The pollen grains are fairly similar to some small aberrant (anaporate instead of anacolpate) pollen grains of the palm *Nenga macrocarpa* Scort. (Perak; Scortechini 351; ex herb. Firenze).

Pl. VI, Figs. 1—6, shows six consecutive sporoderm patterns (LO-patterns and optical cross sections) of the type specimen of *Tricolporites protrudens* Erdtm. Descriptions of fossil spores are often accompanied by poor drawings or by photomicrographs showing the spore(s) at one focus only.

Surely it would be entirely beneficial if insufficiently described species of fossil pollen grains and spores (about 90 per cent of the total?) were to be invalidated and if, at the same time, agreement could be reached as to the minimum requirements for diagnoses of fossil spores.

Pl. VI has been compiled to show that *Tricolporites protrudens* has at least some morphological features in common with, e.g., *Pometia* (Sapindaceae; Figs. 7—9) and *Aparisthmium* (Euphorbiaceae; Figs. 10—14; cf. also *Faramea,* Svensk Bot. Tidskr., Vol. 45, Fig. 1, p. 356, 1951).

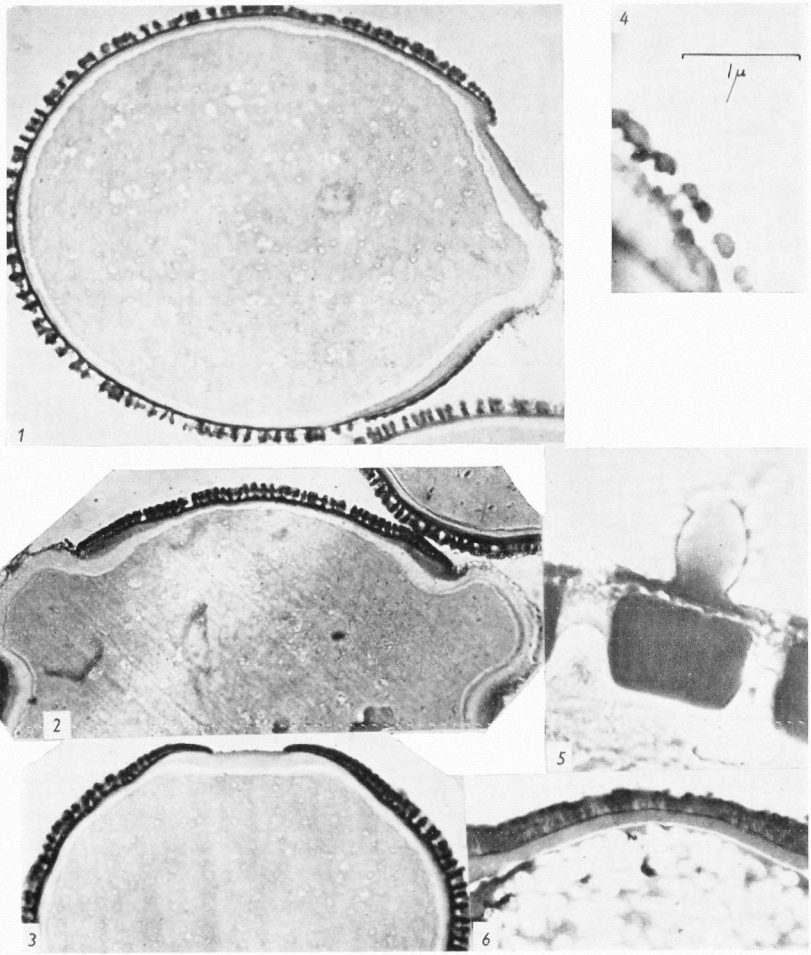
A monographic study of the pollen morphology in the Sapindaceae is desirable both for palaeobotanical and for taxonomic reasons: macro-

fossils of sapindaceous plants have, i.a., been encountered in the London Eocene Clay and Cronquist (Outline of a new system of families and orders of dicotyledons, 1957) has suggested a relationship between the Sapindaceae and the Umbelliferae. The morphology of the pollen grains of *Diplopeltis huegelii,* Pl. VII, Figs. 1—3, does perhaps support Cronquist's view. Be that as it may, the fact remains that the pollen grains of *Diplopeltis huegelii* (Australia; Drummonds 95) are so remarkably similar to the pollen grains in the Umbelliferae that, if found in a fossil state, they would undoubtedly be referred to the Umbelliferae by palynologists unaware of the *Diplopeltis* pitfall. The pollen grains in the second species, *D. stuartii* (Central Australia; ex herb. Melbourne), are less umbelliferoid. It is interesting to note that each species has been placed in a section of its own.

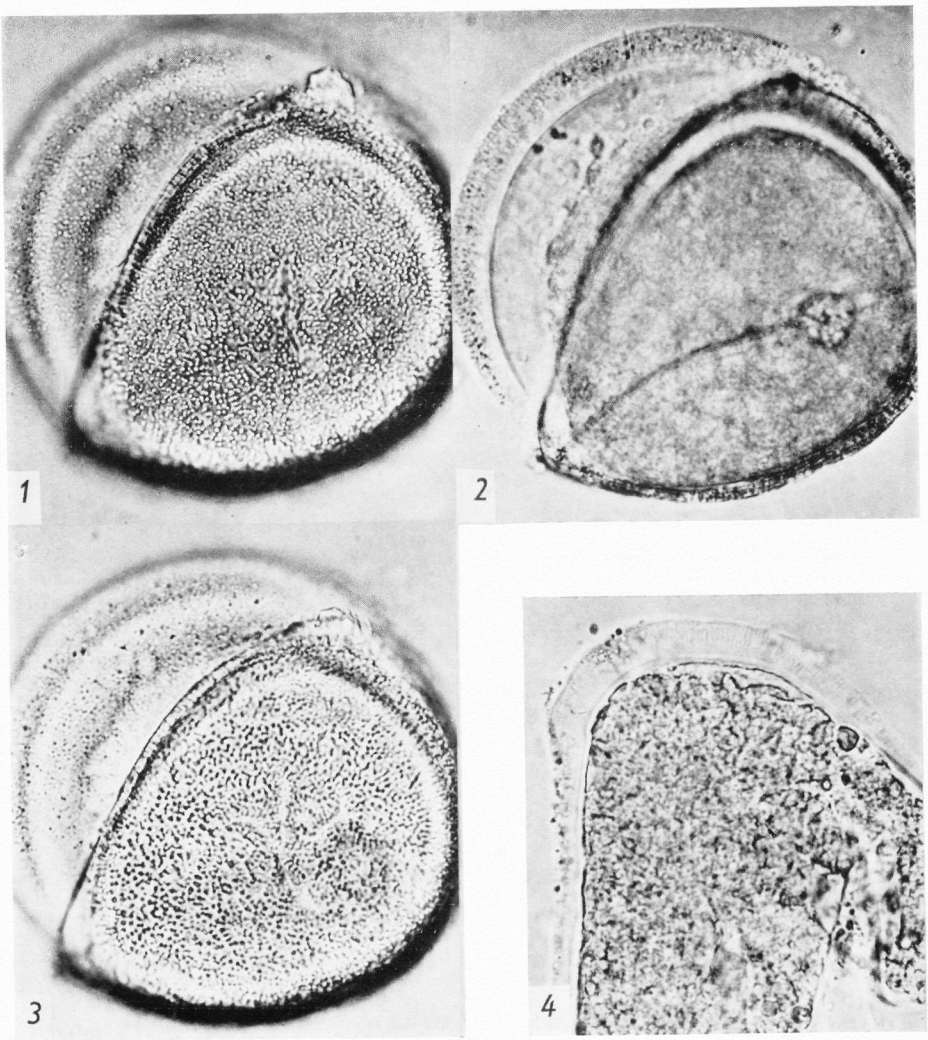
The similarity in certain details between *Tricolporites protrudens* and the pollen grains in the recent genera mentioned above probably does not indicate any relationship. The nature of *Tricolporites protrudens* and similar sporomorphs is still an enigma: were they perhaps produced by entomogamous forerunners of the Rhoipteleaceae and the Betulaceae?

The pollen grains in *Aparisthmium cordatum* (Pl. VI, Figs. 10—14, Euphorbiaceae; Brazil, Klein 749) are of some interest not only with regard to the inner, nexinous part of the exine which lies like "an inner pollen grain" within a sexinous casing, much as in *Tricolporites protrudens.* Their sexine stratification and trema status are also interesting. The grains are 3-colporate with operculate colpi and thus very different in trema status from the likewise colporate grains in *Ecballium elaterium* (Pl. I, Figs. 1—3).

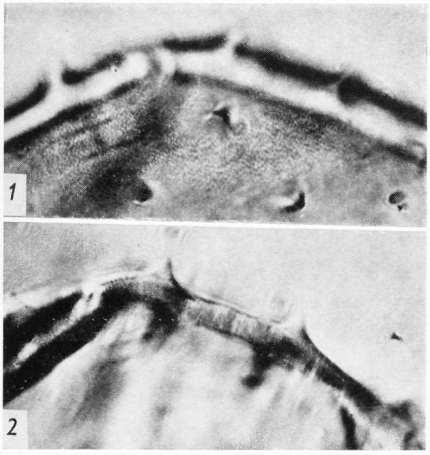
Attention may also be drawn to the occurrence in many plants, of resistant tapetal(?) material in the shape of small globules (Pl. VII, Figs. 9, 10: acetolysed 2-colporate pollen grains of *Echinophora spinosa,* Umbelliferae; Erdtman s.n., Italy 1953). Finally an example is given of photographic palynograms as a complement to India ink drawings (Pl. VII, Figs. 4—8: *Collomia mazamae,* Polemoniaceae; Crater Lake, Oregon 1959; Erdtman s.n., det. H. P. Hansen).

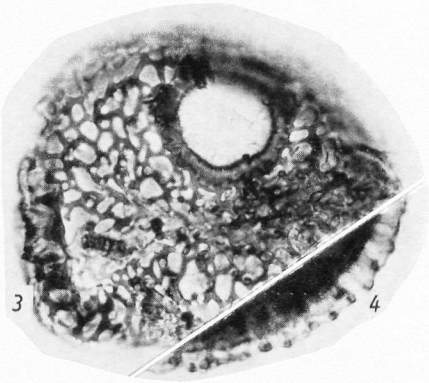


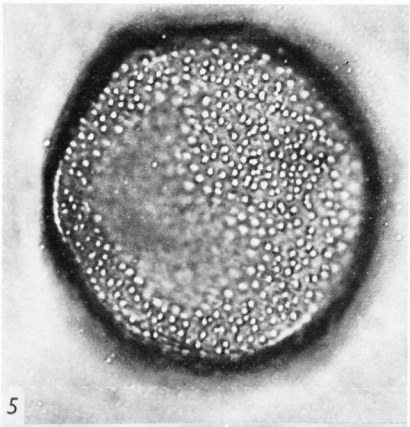
Pl. I, Figs. 1—3. *Ecballium elaterium.* ×1500. — Fig. 4. *Volutarella sp.* ×1600. — Fig. 5. *Althaea chinensis.* ×3000. — Fig. 6. *Chamaenerion angustifolium.* ×1600.

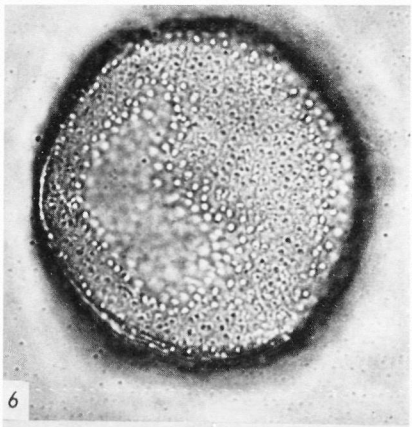


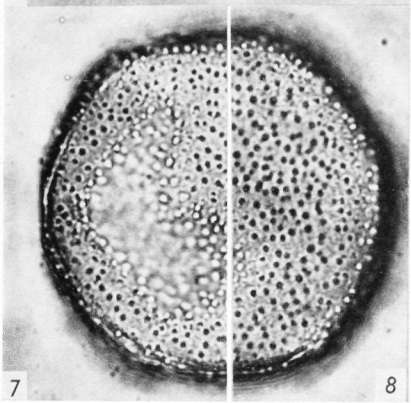
Pl. II, Figs. 1—4. *Dracaena hookeriana*. Embedding medium aqua dest; fresh, untreated, unstained pollen. ×1000.

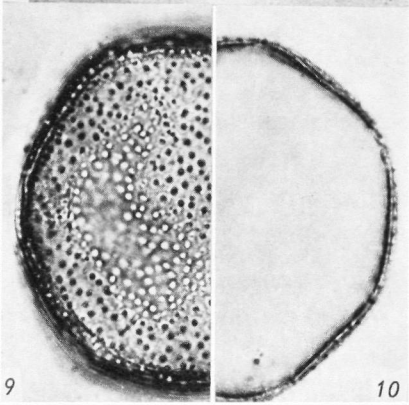




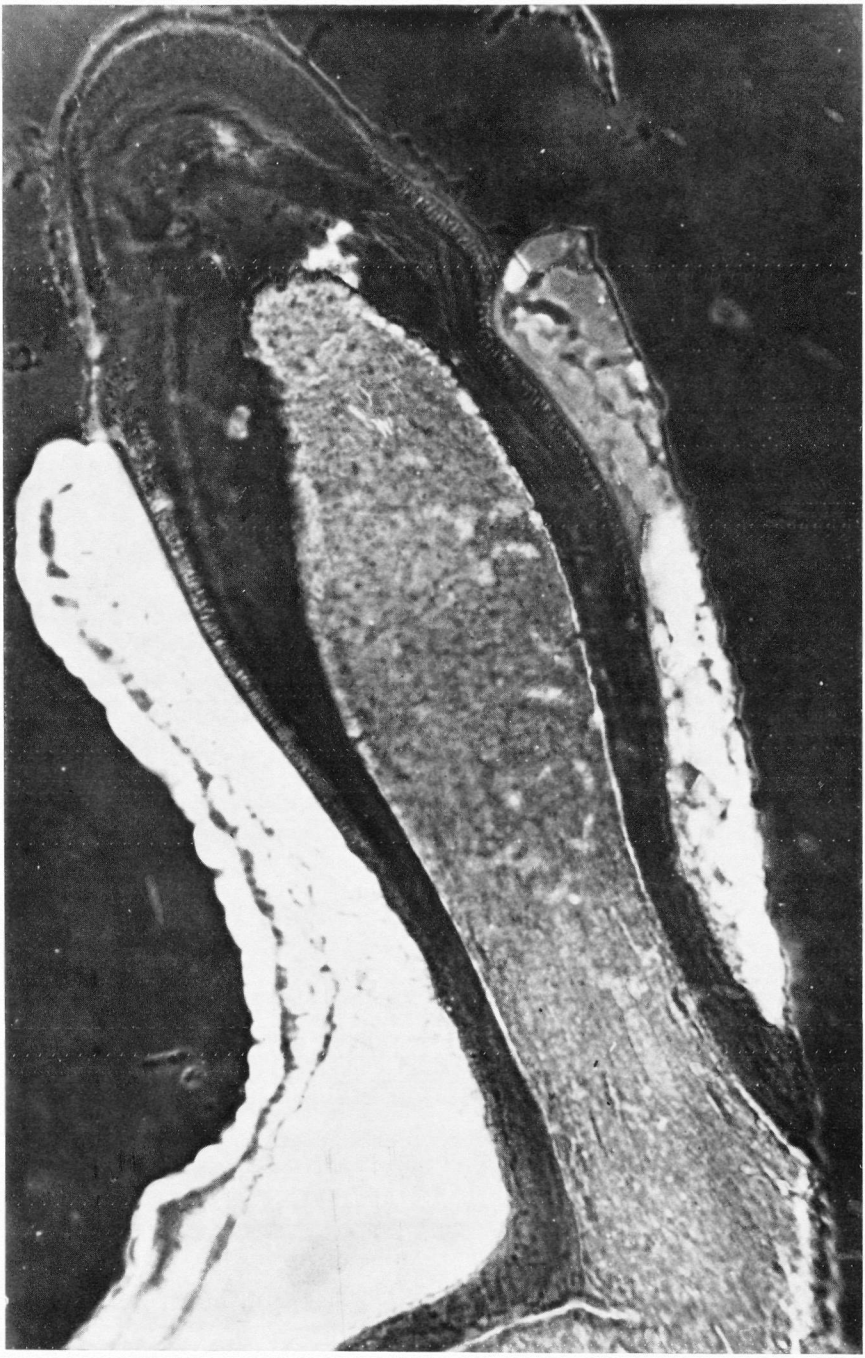




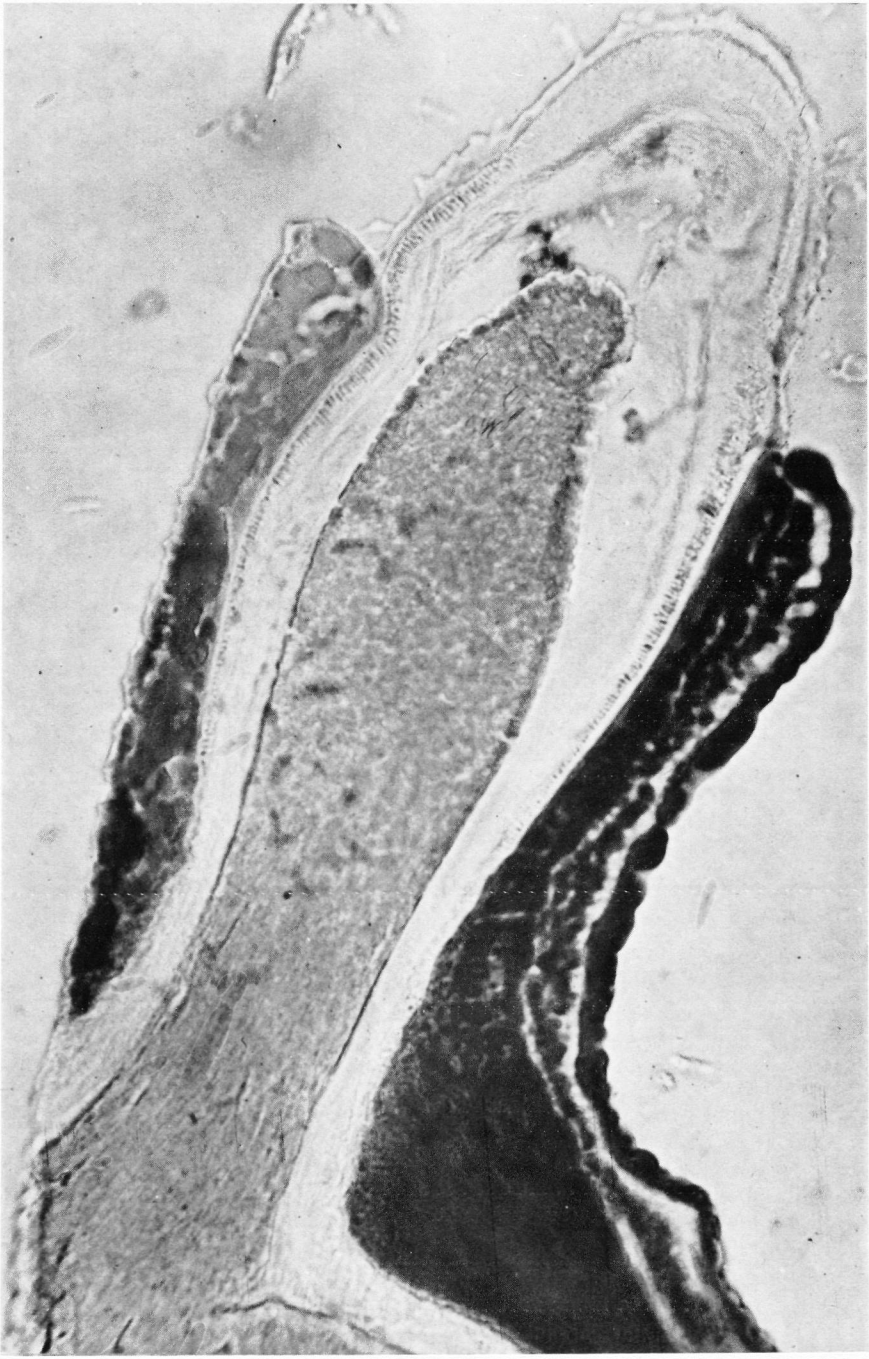




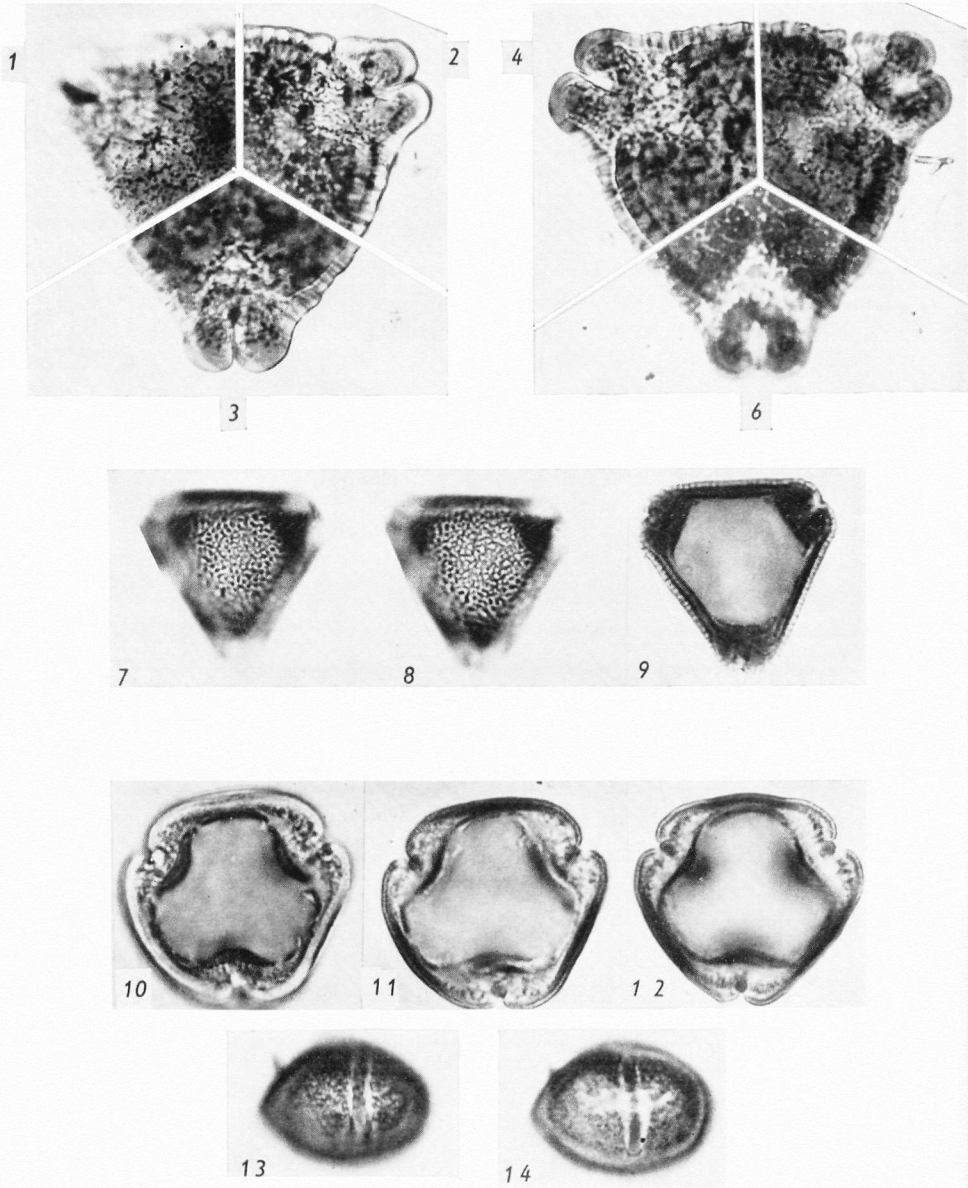
Pl. III, Figs. 1, 2. *Oxera aurea*. Oblique light. — Figs. 3, 4. Unknown recent pollen grain, somewhat similar to the Oligocene *Aglaoreidia cyclops*. — Figs. 5—10. *Nothofagus obliqua*. Embedding medium glycerine jelly. — ×1125.



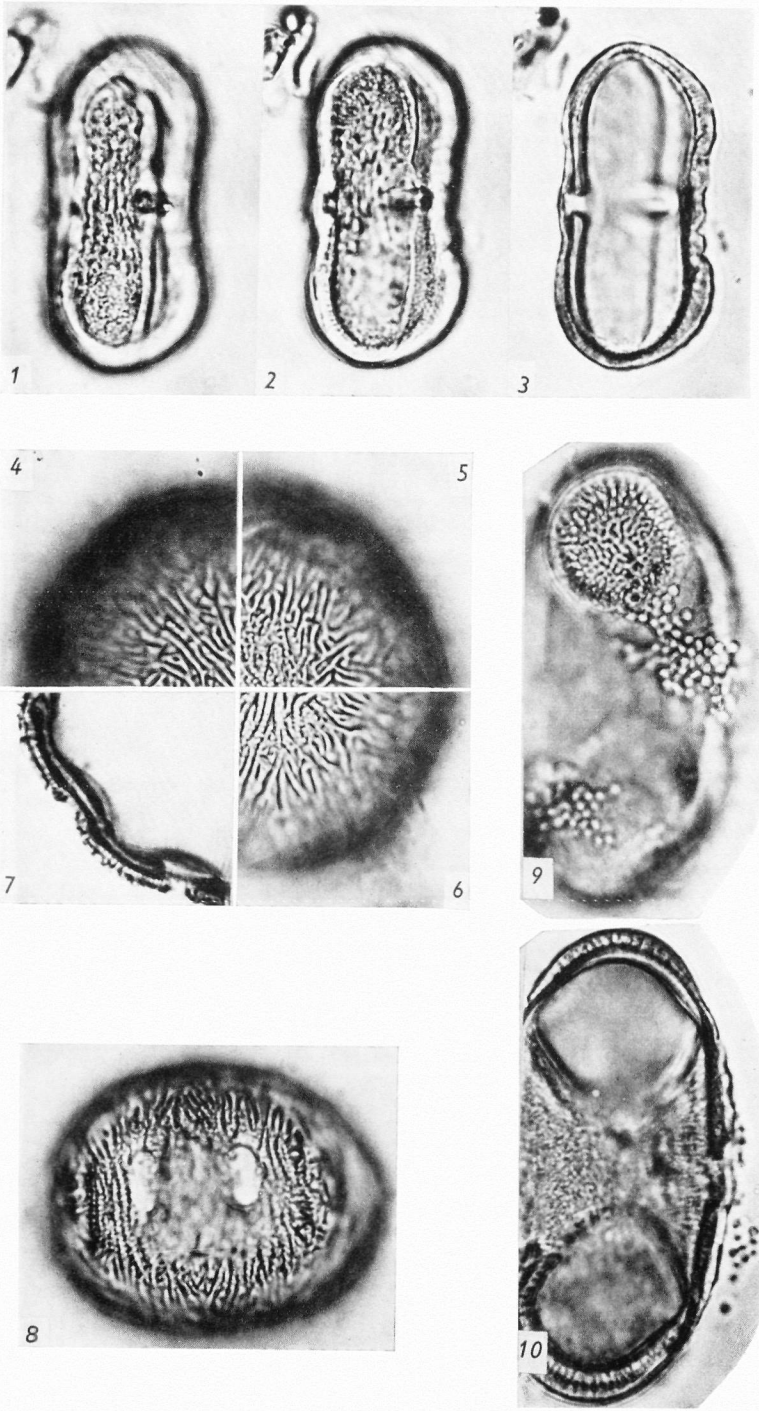
Pl. IV, *Morina longifolia*. UV-micrograph 2536 Å. Original magnification ×1050. Negative print of Pl. V. ×2700.



Pl. V, *Morina longifolia*. UV-micrograph 2536 Å. Original magnification ×1050. ×2700.



Pl. VI, Figs. 1—6. *Tricolporites protrudens.* — Figs. 7—9. *Pometia pinnata.* — Figs. 10—14. *Aparisthmium cordatum.* Embedding medium glycerine jelly. ×1125.



Pl. VII, Figs. 1—3. *Diplopeltis huegelii.* — Figs. 4—8. *Collomia mazamae.* — Figs. 9, 10. *Echinophora spinosa.* Embedding medium glycerine jelly. — ×1125.

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A Note on the Nomenclature of the Genus Cleistogenes Y. Keng (Gramineae)

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The genus *Cleistogenes* was erected by Keng (1934) and is generally considered to belong to the tribe Eragrosteae, Hubbard (1936) or, where the Eragrosteae and Chlorideae are combined, to the sub tribe Eragrostinae of the tribe Chlorideae, Ohwi (1942), Tateoka (1957). The name of this genus is of some interest as it would appear to contravene Article 68 of the International Code of Botanical Nomenclature. The second part of this article states that, "Names of genera are illegitimate and must be rejected . . . when they coincide with technical terms currently used in morphology . . . All new generic names published on or after January 1, 1912 and coinciding with such technical terms are unconditionally rejected."

The term 'cleistogene' was coined by Chase (1908) and though no precise definition of the term is given it is apparently used to describe spike-lets, occurring in certain members of the Gramineae, that are found wholly or partially enclosed in the leaf sheaths and which may produce one or more cleistogamous florets. She distinguishes two types and observes that the 'cleistogenes' differ markedly from spikelets borne on the terminal panicle. The term is used frequently in her paper, for example, "Hence this habit of producing two forms of cleistogene belongs to the whole genus (*Triplasis*) . . .", "the terminal spikelets are fruitful in *Triplasis* as well as the two forms of cleistogene . . .", "The presence of these cleistogenes at the nodes explains the habit of disjointing at the lower nodes . . .". In a later paper Chase (1918) again uses the term extensively when reviewing the occurrence of axillary cleistogamous spikelets in American grasses generally.

The term 'cleistogene' used in this sense has been adopted subsequently

by various authors. Bews (1929) refers to the presence of 'cleistogenes' in *Cottea pappophoroides* and in some species of *Danthonia*. Beddows (1931) uses it when discussing the occurrence of cleistogamous basal spikelets in *Sieglingia decumbens*, for example, ". . . the cleistogenes of *S. decumbens* are restricted to the base . . .". Hitchcock (1935) uses 'cleistogene' in the generic descriptions of both *Danthonia* and *Triplasis*; the same is true of the second edition of Hitchcock's work revised by Chase (1950). Dyksterhuis (1945) and Brown (1949) in papers on *Stipa leucotricha* both use the term while Hubbard (1954) in a description of *Sieglingia decumbens* refers to the occurrence of 'basal spikelets' following which 'cleistogenes' appears in parenthesis. Mention of the term with reference to *Enneapogon brachystachys* is made by Chippindall (1955) who also, like Vickery (1956) in the case of Australian species, uses it when noting the absence of cleistogamous basal spikelets in South African species of *Danthonia*.

On the other hand the term has not been adopted by all authors. Weatherwax (1928) uses the expression 'axillary spikelets' in his paper though fully aware of Chase's terminology. Similarly Uphof (1938) when citing the work of Chase (loc. cit.) uses the term 'cleistogam' in place of 'cleistogene'. Stebbins (1957) also citing Chase refers to 'axillary cleistogamous flowers' rather than 'cleistogenes'.

With respect to the use of the term 'cleistogene' it should be mentioned that Chippindall (loc. cit.) though using it in the original sense of Chase in the text, as for example in the description of *Enneapogon brachystachys* where she refers to a ". . . tendency to produce cleistogenes. These are spikelets enclosed within the basal leaf sheaths . . .", in her glossary of terms defines 'cleistogene' simply as a 'cleistogamous flower'. A similar definition which again is at variance with its use in the text is given by Hitchcock (loc. cit.) in his glossary and retained in the second edition. This use of the term is regarded as being irregular and so far as can be established it has been used in this sense on but a single occasion; by Chase (1942), who rather inexplicably uses it thus when describing the cleistogamous florets of the otherwise perfectly normal terminal inflorescence of *Aciachne pulvinata*.

It would appear that the term 'cleistogene' has by no means become generally accepted, but it has obtained a certain currency in the limited field where it has application. This is rather regrettable since 'cleistogene' is a somewhat obscure term and frequently requires immediate definition when used, making it superfluous. However, regardless of this opinion, it is clear that within the literal meaning of Article

68, 'cleistogene' is a term 'currently used in morphology', since no qualifying statement requiring universal acceptance of the morphological term follows.

In view of the fact that the generic name *Cleistogenes* coincides with a morphological term and must be unconditionally rejected, the following new generic name and combinations are proposed:

Kengia Packer, nom. nov., based on *Cleistogenes* Y. Keng, in Sinensia 5, 1934, p. 147, which is nom. rejic., cf. Int. Code, Art. 68.

Type species: *Kengia serotina* (L.) Packer.

The genus includes the following previously described taxa:

Kengia serotina (L.) Packer, comb. nov., based on *Festuca serotina* L. in Syst. Nat. ed. 10,2, 1759, p. 876, & Sp. Pl. ed. 2,I, 1762, p. 111.

Syn.: Agrostis serotina L., Mantissa, 1767, p. 30,

Bromus strictus Scop., Fl. Carn. ed. 2,I, 1772, p. 79,
Melica nodosa Pill. & Mitterp., Iter Poseg. Slavon. 1783, p. 143,
Schedonorus serotinus PB., Agrostol. 1812, pp. 99, 163, 177,
Molinia serotina Mert. & Koch. in Roehl. Deutschl. Fl. ed. 3,I, 1823, p. 585,
Diplachne serotina Link, Hort. Berol. I, 1827, p. 155,
Cleistogenes serotina Y. Keng, Sinensia 5, 1934, p. 149.

Kengia Nakaii (Y. Keng) Packer, comb. nov., based on *Cleistogenes serotina* var. *nakai* Y. Keng, l.c., p. 151.

Syn.: Cleistogenes Nakai Honda, in Rep. First Sci. Exp. Manchoukuo, Sect. IV,4 (Index Fl. Jehol.), 1936, p. 98,
Cleistogenes Nakaii Y. Keng, in Sinensia 11, 1940, p. 409,
Diplachne latifolia Nakai, in Bot. Mag. Tokyo 55, 1921, p. 139, non Hackel, 1920.

Kengia Hackelii (Honda) Packer, comb. nov., based on *Diplachne serotina* var. *aristata* Hackel, in Bull. Herb. Boiss. 7, 1899, p. 704, and on *Diplachne hackelii* Honda, in Journ. Fac. Sci. Univ. Tokyo, Sect. III, Botany 3, 1930, p. 112.

Syn.: Cleistogenes Hackelii Y. Keng, in Sinensia 11, 1940, p. 409,
Cleistogenes serotina var. aristata (Hack.) Y. Keng, in Sinensia 5, 1934, p. 151.

Kengia chinensis (Maxim.) Packer, comb. nov., based on *Diplachne serotina* var. *chinensis* Maxim., in Bull. Soc. Nat. Mosc. 54, 1879, p. 70.

Syn.: Cleistogenes chinensis (Maxim.) Y. Keng, in Sinensia 5, 1934, p. 192.

Kengia bulgarica (Bornm.) Packer, comb. nov., based on *Diplachne serotina* ssp. *bulgarica* Bornmüller, in Bot. Centralbl. 36, 1888, p. 156, and in Bull. Soc. Dauph. 1890, p. 28.

Syn.: Cleistogenes bulgarica (Bornm.) Y. Keng, in Sinensia 5, 1934, p. 152,
Diplachne bulgarica (Bornm.) Roshev., in Fl. SSSR II, 1934, p. 751.

Kengia caespitosa (Y. Keng) Packer, comb. nov., based on *Cleistogenes caespitosa* Y. Keng, in Sinensia 5, 1934, p. 154.

Kengia squarrosa (Trin.) Packer, comb. nov., based on *Molinia squarrosa* Trin. in Ledeb., Fl. Alt. I, 1829, p. 105.

Syn.: Diplachne squarrosa Richter, in Fl. Europ. I, 1890, p. 72,
Cleistogenes squarrosa Y. Keng, in Sinensia 5, 1934, p. 156.

var. *squarrosa.*

var. *longe-aristata* (Rendle) Packer, comb. nov., based on *Diplachne squarrosa* var. *longe-aristata* Rendle, in Journ. Linn. Soc. Bot. 36, 1904, p. 36.

Syn.: Cleistogenes squarrosa var. longe-aristata (Rendle) Y. Keng, in Sinensia 5, 1934, p. 156.

Kengia andropogonoides (Honda) Packer, comb. nov., based on *Cleistogenes andropogonoides* Honda, in Rep. First Sci. Exp. Manchoukuo, Sect. IV, 4 (Index Fl. Jehol.), 1936, p. 98.

Kengia festucacea (Honda) Packer, comb. nov., based on *Cleistogenes festucacea* Honda, in Rep. First Sci. Exp. Manchoukuo, Sect. IV, 4 (Index Fl. Jehol.), 1936, p. 98.

Kengia Kitagawai (Honda) Packer, comb. nov., based on *Cleistogenes Kitagawai* Honda, in Rep. First Sci. Exp. Manchoukuo, Sect. IV, 4 (Index Fl. Jehol.), 1936, p. 99.

Kengia striata (Honda) Packer, comb. nov., based on *Cleistogenes striata* Honda, in Rep. First Sci. Exp. Manchoukuo, Sect. IV, 4 (Index Fl. Jehol.), 1936, p. 100.

Kengia foliosa (Y. Keng) Packer, comb. nov., based on *Cleistogenes foliosa* Y. Keng, in Journ. Wash. Acad. Sci. 28, 1938, p. 298.

Kengia mutica (Y. Keng) Packer, comb. nov., based on *Cleistogenes mutica* Y. Keng, in Journ. Wash. Acad. Sci. 28, 1938, p. 299.

Kengia Hancei (Y. Keng) Packer, comb. nov., based on *Diplachne sinensis* Hance, in Journ. Bot. 8, 1870, p. 76 (non Cleistogenes chinensis Y. Keng, 1934), and *Cleistogenes Hancei* Y. Keng, in Sinensia 11, 1940, p. 408.

Syn.: Cleistogenes serotina var. sinensis Y. Keng, in Sinensia 5, 1934, p. 150.

Kengia kokonorica (Hao) Packer, comb. nov., based on *Cleistogenes kokonorica* Hao, in Bot. Jahrb. 68, 1938, p. 582.

Kengia songorica (Roshev.) Packer, comb. nov., based on *Diplachne songorica* Roshev. in Fl. SSSR II, 1934, p. 752.

Kengia maeotica (Klokov & Zoz) Packer, comb. nov., based on *Cleistogenes maeotica* Klokov & Zoz, in Fl. RSS Ucr. II, 1940, p. 200.

Kengia polyphylla (Y. Keng ex P. Keng and Liou) Packer, comb. nov., based on *Cleistogenes polyphylla* Y. Keng ex P. Keng and Liou, in Acta Bot, Sinica 9, 1960, p. 69.

Kengia longiflora (Y. Keng ex P. Keng and Liou) Packer, comb. nov., based on *Cleistogenes longiflora* Y. Keng ex P. Keng and Liou, in Acta Bot, Sinica 9, 1960, p. 69.

Kengia gracilis (Y. Keng ex P. Keng and Liou) Packer, comb. nov., based on *Cleistogenes gracilis* Y. Keng ex P. Keng and Liou, in Acta Bot, Sinica 9, 1960, p. 69.

Kengia mucronata (Y. Keng ex P. Keng and Liou) Packer, comb. nov., based on *Cleistogenes mucronata* Y. Keng ex P. Keng and Liou, in Acta Bot, Sinica 9, 1960, p. 70.

Acknowledgments

The writer is indebted to Dr. A. Löve and Dr. T. Tateoka for their comments, and to the former for his valuable assistance with the nomenclatural revisions.

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Taxonomic and Nomenclatural Notes on the Florideae, II

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The present notes are concerned with problems of nomenclature and taxonomy which have been discovered during preliminary work for the preparation of the volume on *Rhodophyta* for the proposed *Flora of British Marine Algae*. The first paper in this series was published previously in this journal (Dixon, 1959 a).

A nomenclatural study of the genus *Compsothamnion*

The genus *Compsothamnion* includes only two widely distributed species to which the names *C. thuyoides* and *C. gracillimum* are currently applied, together with the rather obscure *C. truncatum*, known only from the Adriatic. *C. gracillimum* and *C. thuyoides* both occur on the European shores of the Atlantic Ocean, extending from Scandinavia to the Iberian peninsula, and into the Mediterranean. Within Great Britain, the two species are said to be of rare occurrence, although widely distributed (Westbrook, 1930; Newton, 1931). Neither species is ever found in quantity, and the individual plants are by no means conspicuous, so that it is very probable that the two species are actually more abundant than has been realised, and that the reported rarity is a result of the inconspicuous appearance of the thallus. The occurrence of both species in the sub-littoral region is another factor contributing to their apparent rarity, whilst it is quite likely that both are frequently dismissed as young plants of *Callithamnion* spp., which they resemble closely.

Apart from the problematical *Compsothamnion truncatum*, which has been ignored completely in recent publications (c.f. Kylin, 1956),

the species attributed to the genus, the names applied to these two species, and the authorities cited for them have been accepted without question by all recent investigators. A detailed nomenclatural study of the genus and the two British species showed that the present position was far from satisfactory. Firstly, the paper in which the name *Compsothamnion* was first published is somewhat ambiguous, in that it is not clear whether generic or sub-generic status was intended (Nägeli, 1862).[1] and, secondly, the nomenclature of the two species is very confused, partly because of the uncertainty regarding the status of *Compsothamnion* Nägeli, but also because of the unresolved confusion between the two species by the early authors.

Compsothamnion was established by Nägeli (1862) in his monograph of the Ceramiaceae, the name appearing first in a key (p. 326), entitled "Uebersicht der Gattungen und Untergattungen welche dem früheren Genus *Callithamnion* (*Callithamnion* und *Phlebothamnion* Kg.) entsprechen". As pointed out by Silva (1952), in his discussion of *Pleonosporium,* it is obvious that in this key, as also in the general discussion and the index, Nägeli regarded *Compsothamnion,* together with *Eucallithamnion, Pleonosporium* and *Dasythamnion*[2] as sub-genera of *Cal-*

[1] The date of publication of this monograph has been accepted by most authorities as being 1861 (Feldmann-Mazoyer, 1940; Fritsch, 1945; Kylin, 1956), but the evidence available indicates that it could not possibly have been published before the early part of 1862. For the year 1861, the journal in which the monograph appeared was published in two independently-paged parts, *Band* I and *Band* II. The latter was published in three *Hefts,* of which the last to appear (*Heft* 3) consisted of pp. 195—436. Nägeli's paper, read in the early part of December 1861 (pp. 297—415), is followed by a short abstract of a paper which was not read until 21st December 1861. The *Heft* concludes with details of literature received and on pp. 428 and 429 are listed no less than three books or journals which did not appear before 1862. One must conclude therefore that although *Heft* 3 is dated '1861', it was not actually published until the early part of 1862.

[2] The position regarding the name *Dasythamnion* is extremely confused. Harvey (1863, p. li) established a subgenus of *Callithamnion* to which he gave the name *Dasythamnion,* apparently in ignorance of the previous proposal by Nägeli. Agardh (1894, p. 119), having shown that Harvey's concept corresponded closely with *Spongoclonium* Sonder (1855), was of the opinion that the name *Dasythamnion* was therefore 'vacant' and he applied it to a newly-established monotypic genus, although it should be noted that Agardh makes no mention of the original proposal by Nägeli. Although by modern standards the reasoning put forward by Agardh is incorrect, the generic name *Dasythamnion* Agardh is nevertheless legitimate. Recently, Dangeard (1951, p. 3) established independently another genus to which he applied the name, apparently in complete ignorance of all the previous proposals. Subsequently, having become aware of these proposals, Dangeard (1952) changed

lithamnion Lyngbye (1819). However, at the end of the discussion of each of these entities, the species attributed to it are listed; under *Pleonosporium* and *Dasythamnion* Nägeli made 'new combinations' using the initial letter of the respective name, whilst under *Eucallithamnion* the initial letter 'C' is used. For *Compsothamnion* the position is a little obscure in that the initial letter of the name is here the same as that of *Callithamnion,* but from the text it is obvious that it is the former name which is intended. With regard to the listing of 'new combinations', Nägeli is most inconsistent, because in the key mentioned above two other genera, viz. *Herpothamnion* and *Poecilothamnion,* are sub-divided in exactly the same way as *Callithamnion. Herpothamnion* is divided into *Euerpothamnion, Rhizophyes, Anisarthrum* and *Meristothamnion* and the species attributed to these subdivisions are listed on pp. 351, 353 and 354 respectively; in every case the initial 'H' is used in the 'new combinations'. *Poecilothamnion* is sub-divided into *Eupoecilothamnion, Miscosporium* and *Maschalosporium* and the attributed species are listed on pp. 363, 366 and 372. Under *Eupoecilothamnion* the initial 'P' is used, whereas 'M' is used for the 'new combinations' under *Miscosporium* and *Maschalosporium.*

Nägeli's original intention, both in the key and in the general treatment, was clearly to regard the sub-divisions of *Callithamnion, Herpothamnion* and *Poecilothamnion* as sub-genera. Although the formation of 'new combinations' in the attribution of species may indicate that his intention changed a little during the preparation of the monograph, the inconsistent behaviour in this respect is certainly not sufficient to justify the view that Nägeli intended the entities under discussion to be treated as genera. It must be concluded therefore that *Compsothamnion,* as understood by Nägeli, must be interpreted as a sub-genus of *Callithamnion* Lyngbye.

The first indisputable use of *Compsothamnion* as a generic name was that of Schmitz (1889, p. 450), who as Silva, (1952) has shown, indicated the authorship of the name correctly. Silva, in his analysis of *Pleonosporium,* has shown that, despite the correct interpretation of *Compsothamnion,* Schmitz erred in his treatment of *Pleonosporium,*

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the name of his genus to *Pycnothamnion,* although his comment "Il existait d'ailleurs antérieurement à la creation d'Agardh un *Dasythamnion* Harvey (1863) comme l'indique De Toni dans son Sylloge, p. 1357" is completely unjustified, in that it was made quite clear, both in the original description of *Dasythamnion* Harvey, and in the citation of that description by De Toni (1903, p. 1357), that this entity was of subgeneric status.

by attributing the latter name directly to Nägeli. It is to be regretted that Schmitz, when in a position to correct the previous inconsistencies of Nägeli, erred himself by being inconsistent. Consequently, the majority of later authors have tended to accept Nägeli as the authority for the two generic names *Pleonosporium* and *Compsothamnion* (De Toni, 1903; Preda, 1908; Kylin, 1944) although a few have cited "Schmitz" for the latter (Batters, 1902; Newton, 1931). The correct position regarding the Nägeli sub-division of *Callithamnion* was first indicated by Silva, who in his analysis, showed that *Pleonosporium* Nägeli "should be considered as originally constituting a sub-genus", and that *Compsothamnion,* as understood by Nägeli, should be interpreted as having the same status. Despite the careful analysis made by Silva, most subsequent authors have failed completely to acknowledge the validity of his arguments (Feldmann, 1954; Funk, 1955; Kylin, 1956) whilst Parke (1953), although accepting Silva's comments on *Pleonosporium,* attributes *Compsothamnion* to "Nägeli, 1861". Because of this, and because Silva was concerned principally with *Pleonosporium* mentioning *Compsothamnion* only incidently, it was considered that a detailed nomenclatural study of the latter, although containing some repetition of Silva's arguments, was justified in the present context. As a result of this study, it must be concluded that the correct citation of name and date of valid publication for the genus *Compsothamnion* is '(Nägeli) Schmitz 1889'.

The nomenclature of the two widely-distributed species of *Compsothamnion* is very confused, partly because of the previous errors regarding the status of *Compsothamnion* Nägeli, but also because of certain confusions between the two entities in the writings of the older authors. As has been stated previously, at the end of the treatment of the sub-genus *Compsothamnion* Nägeli (1862, p. 344) attributed three species to the subgenus, making the following, invalid 'new combinations', as follows: —

(1). *Compsothamnion thuyoides,* based on *Callithamnion thuyoides* (Sm.) C. Agardh (1828) [=*Conferva thuyoides* Smith (1810, Pl. 2205)],

(2). *Compsothamnion gracillimum,* based upon *Callithamnion gracillimum* Harvey (1833),

(3). *Compsothamnion truncatum,* based upon *Callithamnion truncatum* Meneghini (1844 b).

These 'new combinations', although invalid, have been widely accepted, and it is as *Compsothamnion thuyoides* (Sm.) Näg. and *C. gracillimum* (Harv.) Näg. that the two widely-distributed species have been known (De Toni, 1903; Parke, 1953; Feldman, 1954).

As Schmitz (1889) was the first author to apply *Compsothamnion* as a generic name, the application of specific epithets and the formation of new combinations must be considered, from the point of view of priority, in relation to this publication, rather than to the earlier monograph of Nägeli in which it has been shown that the name *Compsothamnion* was applied to a sub-genus. Schmitz states quite clearly that the genus is typified by *Compsothamnion thuyoides* (Smith) Schmitz, with "*Callithamnion thuyoides* (Smith) J. Ag." cited as a synonym; the latter citation is a misquotation of *Callithamnion thuyoides* (Sm.) C. Ag. As there appear to be no nomenclatural objections to the use of the epithet *thuyoides* for this taxon, the name can remain as in present usage, although the authority for the binomial must be corrected. The correct citation for the species is therefore *Compsothamnion thuyoides* (Sm.) Schmitz, based upon *Conferva thuyoides* Smith (1810, Pl. 2205).

The nomenclature of the other widely-distributed European species of *Compsothamnion* is a little more involved. Most authors have regarded *Callithamnion gracillimum* Harvey (1833, p. 345) as the basionym of the species, apparently without realising that Harvey had attributed the name to Agardh and had indicated the place of publication. Harvey was not describing the species as new, but referring his specimens to a previously described species, viz. *Callithamnion gracillimum* C. Agardh (1828, p. 168). A further complication results from the observations of J. G. Agardh (1851, pp. 44—5), who, having studied specimens identified by both authors, stated that Harvey and C. Agardh applied the name *Callithamnion gracillimum* to different taxa. The name, as applied originally by C. Agardh (1828), referred to a specimen of what was known subsequently as *Compsothamnion thuyoides,* so that *Callithamnion gracillimum* is a synonym of *Compsothamnion thuyoides.* Harvey was therefore misapplying *Callithamnion gracillimum* when he described, under that name, a specimen of the alga known subsequently as '*Callithamnion gracillimum*'. The general acceptance of Harvey's concept of '*Callithamnion gracillimum*' is indicated by the fact that at the present time there is no other epithet available for the taxon. Schmitz does not cite the entity under discussion as a species of *Compsothamnion,* either in his original abbreviated

treatment of the genus (Schmitz, 1889), or in the later, more detailed study (Schmitz & Hauptfleisch, 1897). In the latter it is stated that there are a few species in the genus ("Wenige Arten der europäischen Meere") although none is listed other than the type species, *C. thuyoides*. It may even be doubted whether the entity to which the name '*Callithamnion gracillimum* Harv.' was applied was regarded by Schmitz at this time as a species of *Compsothamnion,* because the figure of "*Callithamnion gracillimum* Harv.", published in an earlier paper (Schmitz, 1883, Taf. V, fig. 34), is reproduced, at a reduced size, under *Callithamnion,* on the page opposite to that on which the genus *Compsothamnion* is discussed. It would appear that De Toni (1903, p. 1356) was the first author, following the validation of *Compsothamnion* as a generic name, to treat the entity under discussion as a species of that genus.

As stated previously, no epithet other than '*gracillimum*' has been applied to the taxon. Accordingly, it had no validly published name before 1903, since the use for it of the name *Callithamnion gracillimum* was actually a misapplication. As De Toni excluded the type of *Callithamnion gracillimum* C. Ag. from his account of *Compsothamnion gracillimum,* he must be regarded as having published a new species under that name. This is perfectly legitimate under the *International Code of Botanical Nomenclature,* for the name is not a later homonym, nor is there an earlier epithet which he should have adopted. The correct name for the species is therefore *Compsothamnion gracillimum* De Toni.

It should be realised that in at least two publications (Newton, 1931; Mail & Senay, 1957), the correct citation for this species, viz. "*Compsothamnion gracillimum* De Toni", is quoted, but no explanation is offered by these authors to account for their deviation from what was general practice.

In order to complete this present study, a brief consideration of the nomenclature of the third species which has been attributed to the genus *Compsothamnion* is necessary. Described originally by Meneghini (1844 b, p. 288) as *Callithamnion truncatum,* the entity was treated somewhat sceptically by both J. G. Agardh (1851) and Nägeli (1862), whilst Hauck (1885), without giving any reasons, dismissed it as being synonymous with *C. hirtellum* Zanardini (1846). Nägeli accepted *C. truncatum* sufficiently to list it among the species attributed to the sub-genus *Compsothamnion* and to make the invalid 'new combination'. As a result it is as '*Compsothamnion truncatum* (Meneg.)

Näg.' that the species has been known generally. Following the valid publication of *Compsothamnion* as a generic name, De Toni (1903) was the first author to refer to the species, and although he attributed it to the genus *Compsothamnion,* the attribution is queried, so that De Toni cannot be regarded as the authority for the transfer of the species to that genus. Preda (1908), as the first author to accept the attribution unreservedly must be cited as the authority for the transfer, so that the correct citation for the species under discussion is therefore *Compsothamnion truncatum* (Meneg.) Preda, based upon *Callithamnion truncatum* Meneghini (1844 b).

The dates of publication of J. G. Agardh's *'In systemata algarum hodierna adversaria'* and G. Meneghini's *'Del genere Ceramium e di alcune sue specie'*

Agardh's '*In systemata algarum hodierna adversaria*' (Agardh, 1844), a critical work surveying the situation then existing in algal taxonomy, contains a number of descriptions of species of the Rhodophyta. Meneghini (1844 a) described independently a number of the same taxa in his survey of the genus *Ceramium,* published in the same year. If problems of priority are to be resolved, it is essential that the precise date of publication for these two works should be determined or, if that is not possible, then at least sufficient information must be accumulated to indicate the relative dates of publication.

Meneghini's paper on the genus *Ceramium* was published in the first part of the first volume of the '*Giornale botanico Italiano*', the original wrapper of which is labelled "Tomo 1° Parte prima Da Gennajo a Giugno 1844". This particular part contains more than twenty papers, notes and reports, of which five are dated. The dates range from September 10th, 1843, to May 20th, 1844, Meneghini's paper on *Ceramium* being dated "1° April 1844". It must be assumed from the dates on the papers, notes and reports that the first part of the first volume of the '*Giornale*' was published after May 20th, whilst the date given on the wrapper indicates that it was actually published in the following month.

Most of the copies of J. G. Agardh's publication which have been examined are dated merely as "1844". It should be realised that this publication was in fact the thesis prepared by him for disputation. J. G. Agardh's own personal copy of this work, now preserved in the Library of the Botaniska Museet, Lund, contains additional un-num-

bered pages, on which are indicated the sections allocated to the various disputants, viz. N. J. Wetterquist (pp. 1—7), O. N. Hammar (pp. 8—31), C. O. N. Dalgren (pp. 32—56). On each of these additional pages is indicated the date and place of the disputation, "in auditorio botanico die XXII Maj. MDCCCXLIV". The publisher's records for the thesis appear to have been lost so that it has not been possible to determine the precise date of publication. The latest possible date for the publication of the thesis is therefore May 22nd, but it is likely to have been published some days or weeks before this date, as copies of the thesis must have been available to the disputants before the date of the disputation.

From the evidence which has been obtained, it is obvious that Agardh's thesis, '*In systemata algarum hodierna adversaria*', must be regarded as having been published before Meneghini's paper on the genus *Ceramium*.

This conclusion is of critical importance in relation to the alga known currently as *Ceramium echionotum*. This taxon was described by J. G. Agardh (1844, p. 27) under that name in his thesis, and also by Meneghini (1844 a, pp. 185—6) under the names *C. dalmaticum*, *C. echionophorum* and *C. azoricum* in his paper on the genus *Ceramium*. The priority of J. G. Agardh's name is now clearly established.

The correct name for the European species of *Pterocladia*

Having been regarded as a species of *Gelidium* for some time, the European species of *Pterocladia* was transferred to the latter genus by Bornet and Thuret (1876), following the discovery of its unilocular 'cystocarp'. The genus *Pterocladia* had been established previously by J. G. Agardh (1851, 1852), who had argued, quite rightly, that the presence of a unilocular 'cystocarp' in *Gelidium lucidum* (Turn.) Sond. [=*Fucus lucidus* Turner], was sufficient to justify the separation of that species as a new genus, distinct from *Gelidium*, in which the 'cystocarp' is bilocular. Since 1876, the European species of *Pterocladia* has been known generally as *Pt. capillacea* (Gmel.) Born. & Thur., although a second epithet, *pinnatus*, has been used by certain authors, particularly at varietal level. Papenfuss (1950), arguing that *pinnatus*, in that it is derived from *Fucus pinnatus* Hudson (1762), antedates *capillaceus*, derived from *F. capillaceus* Gmelin (1768), claimed that *pinnatus* was therefore the correct specific epithet for the taxon. This proposal has been accepted generally and the species referred to as *Pt. pinnata* in

a number of recent publications (Parke, 1953; Feldmann, 1954). A careful study of the nomenclature of the species under discussion shows that the Papenfuss proposal is not justified and that the name of the species must be reconsidered.

The original description of *Fucus pinnatus* Hudson (1762, p. 474) is extremely brief: —

"Fucus membranaceus, frondibus triplicato-pinnatis.
Anglis, Pinnated Fucus,
Habitat in littoribus Eboracensi et Sussexiano",

although in the second edition of '*Flora Anglica*' (Hudson, 1778, p. 586), the description of *F. pinnatus* is a little more detailed:

"Fucus fronde cartilaginea filiformi compressa subtriplicato-pinnata, laciniis subulatis erectiusculis.
Anglis, pinnated Fucus.
Habitat in rupibus et saxis submarinis in Cornubia, Devonia et Suffixia passim; prope Scarborough in comitatu Eboracensi. V—X.
Desc. Frons triuncialis, filiformis, compressa, cartilaginea, rubra, duplicata vel triplacato-pinnata acuta; laciniis oppositis subulatis, brevissimis, erectiusculis."

The earlier authors regarded *F. pinnatus* Huds. with considerable suspicion. Gmelin (1768, p. 239) lists only two species, *F. pinnatus* and *F. filicinus,* as 'Fuci in Flora Anglica Hudsoni dubii', whilst Goodenough and Woodward (1797, p. 182) state that "all botanists have been puzzled in allotting limits to Mr. Hudson's *corneus, pinnatus* and *filicinus*". The confusion has been worse by the independent description by subsequent authors of other algae under the name *Fucus pinnatus.* Gunnerus (1766,[1] p. 96) applied the binomial *F. pinnatus* to the alga described by Linnaeus (1767, p. 135) under the name *Fucus esculentus* as is shown by the figure given by Gunnerus (1768,[1] t. 8, fig. 1), which is of the alga known currently as *Alaria esculenta* (L.) Grev. From the description given, it would appear that Burman (1768) described, under the name *Fucus pinnatus,* an alga which at the present time is referable to the genus *Caulerpa,* although precise identification is impossible as the type material of *F. pinnatus* Burman cannot be located in the Burman herbarium, which is now preserved at the Conservatoire Botanique, Geneva. Finally, Linnaeus (1781, p. 452) described, independently under the name *Fucus pinnatus,* an alga collected by Koenig in Ceylon,

[1] The dates cited as those accepted generally at the present time, but, as the figure given in the supposedly later publication is quoted in the earlier, some investigation of the relative dates of publication of these two works is obviously required.

which is also referable to the genus *Caulerpa.* Specimens so named by Linnaeus, now preserved in the Linnean Herbarium (*Fucus* 1274/116), are of a species of *Caulerpa,* although there is some doubt as to whether these represent the type material, whilst the figures given by Turner (1808, Pl. 53) and Esper (1808, T. 158) are also referable to this genus.

It is becoming increasingly obvious that, as far as the algae are concerned, the scarcity of copies of the first edition of Hudson's '*Flora Anglica*' has been the cause of many of the present nomenclatural problems, in that most of the early phycologists appear to have been completely unaware of the existence of an edition previous to that published in 1778. At the present time it is relatively simple to decide which edition was used by a particular author from the pagination cited. The failure to compare the two editions of '*Flora Anglica*' has meant that numerous changes of name and circumscription, introduced by Hudson into the second edition, have passed un-noticed. The present difficulties with *Fucus pinnatus* Hudson are one result of this failure.

A comparison of the two descriptions of *Fucus pinnatus,* given in the first and second editions of '*Flora Anglica*' shows that there are several very significant differences. The most important of these relates to the general appearance of the species. In the first edition the description begins "*Fucus membranaceus . . .*", whilst in the second edition '*membranaceus*' is omitted and the description changed to "*Fucus fronde cartilaginea . . .*". The latter is a perfect description of the texture of the European species of *Pterocladia,* but by no stretch of the imagination can this taxon be described as membranaceous. This suggests the possibility that the alga described in the first edition of '*Flora Anglica*', under the name *Fucus pinnatus,* is not the same as that described in the second edition under the same name.

There are also very significant changes in the localities given for *F. pinnatus* in the two editions. "Yorkshire" and "Sussex" are cited in the first edition, whereas in the second, "Cornwall" and "Devon" are added and the Yorkshire locality stated more specifically as "Scarborough". The localities cited by Hudson must be considered in relation to the known distribution of this species of *Pterocladia* in the British Isles.

In the past there has been a great deal of ambiguity regarding the distribution of the taxon under discussion in the British Isles, resulting principally from confusion between it and larger specimens of certain of the more prominent species of *Gelidium.* However, as a result of extensive fieldwork carried out during the last few years, the distribu-

tion of this species of *Pterocladia* in the British Isles is now known with a fair degree of accuracy. The species occurs only on the southern and western coasts of Britain and Ireland, extending from Anglesey and the Isle of Man to Dorset, in the former, and from Sligo to Waterford, in the latter. It must be admitted that there have been some previous reports of the occurrence of this taxon in the North Sea, but in every case investigation has shown that these reports must be discounted. The references to "Scarborough" or "Yorkshire" quoted by a number of British authors (Greville, 1830; Batters, 1902; etc), are all derived from the original Hudson reference under discussion, whilst Kuckuck (1897) has corrected the report of the occurrence of this species on Heligoland, given by Reinke (1891), and shown it to be a misidentification. Børgesen (1927, p. 23), on the other hand, has stated that the species "extends from Norway along the Atlantic coast of Europe", although there is no evidence whatsoever to support this statement of its occurrence in Norway. It is possible that this report results from the misinterpretation of the report of '*Fucus pinnatus*' given by Gunnerus, who, as has been stated previously, applied that binomial to the alga known currently as *Alaria esculenta*. The recent discovery of the long-lost Lightfoot herbarium (Dixon, 1959 b) raises a serious problem in relation to the alga described by that author as *Fucus nerideus,* which according to Lightfoot (1777, p. 956) was collected "in the Firth of Forth and other places . . .". There are in the Lightfoot herbarium, two specimens labelled "*F. nerideus* Fl: Scot.", which are of the European species of *Pterocladia*. At first sight this would appear to be definite proof of the occurrence of the species in the North Sea, but, from a detailed study of the algae of the Lightfoot herbarium in relation to the descriptions published in '*Flora Scotica*' (Dixon, unpublished), it can be stated that very few of the algae described in that publication were actually collected in Scotland. It is obvious that many of the descriptions are based on collections from various parts of Wales and southern England (Cornwall, Dorset, Isle of Wight), made by Lightfoot either before or after his scottish journey (see Riddelsdell, 1905). It would appear that Lightfoot assumed that the algae seen or collected on his tour of Scotland were identical with those of his other collections, an assumption that is not always justified. In the case of the species of *Pterocladia* under discussion, there is no direct evidence to indicate whether the specimens were actually collected by Lightfoot in Scotland or not, but from a consideration of the annotations on specimens in the Lightfoot herbarium, it would

appear very probable that these specimens were those used in the preparation of the description of *F. nerideus* in '*Flora Scotica*'. In view of the uncertainties regarding the origin of many of Lightfoot's supposed scottish specimens, this determination of *F. nerideus* Lightf. cannot be used to substantiate the occurrence in the Firth of Forth of this species of *Pterocladia*. The other scottish record, for the Clyde estuary (Bute), given by Batters (1902), would appear to be nothing more than a repetition of the previous report by Greville (1830). A search for the Greville specimen, or specimens, in the Herbarium of the Royal Botanic Garden, Edinburgh, and in other herbaria, has proved unsuccessful. It must be assumed therefore that this report of the occurrence of the European species of *Pterocladia* in the Firth of Clyde was based originally on a misidentification. As was stated previously, the present range of the taxon under discussion in the British Isles is very restricted, the species occurring only on the southern and western coasts of Ireland and Britain.

The two localities, Yorkshire and Sussex, cited by Hudson in his original treatment of *Fucus pinnatus* are both *outside* the present range of distribution of the species of *Pterocladia,* whereas the additional localities given in the later treatment are within the range of the species.

The possibility that Hudson had collected drift specimens must be considered also, because the older phycologists usually failed to discriminate between attached and drift specimens. From a consideration of the drift currents in the North Sea (Carruthers, 1925; Tait, 1937), it would appear that this suggestion is not the answer to the problem, although the possibility that the original description of *Fucus pinnatus* was based on drift specimens cannot be eliminated completely. The occurrence of drift specimens of *Pterocladia* on the coast of Sussex is very probable in view of the prevailing eastbound current in the English Channel, but the currents in the southern part of the North Sea are such that the bulk of the drift material coming from the Channel tends to move towards the coasts of Belgium, Holland and Germany (c.f. Lucas, 1950). From an examination of the drift Florideae of the Yorkshire coast (Dixon, unpublished), it can be stated that the bulk of the specimens collected were of local origin. Such specimens as were not indigenous tended to be of northern rather than southern affinity, an observation which is supported by the oceanographical data (Tait, 1937). The oceanographical data suggest that there is only a very slight chance that a specimen of *Pterocladia,* which had originated on

the west coasts of Britain or Ireland, could drift around the north of Scotland to the coast of Yorkshire. Thus, although the possibility that the original description of *Fucus pinnatus* was based upon drift specimens cannot be eliminated completely, it would appear to be highly improbable. The suggestion made previously, that the alga described in the first edition of '*Flora Anglica*' under the name *Fucus pinnatus* is not the same as that described in the second edition under the same name, is a much more likely explanation for the fact that the two localities cited in the original treatment of the species are outside its present range of distribution.

There are thus two good reasons for suggesting that the alga described under the name *Fucus pinnatus* in the first edition of '*Flora Anglica*' is not the same as the alga described under that name in the second edition. From the published descriptions it is obvious that whilst the alga described in the second edition is referable to *Pterocladia,* the alga described originally in the first edition is not. From the comments which have been made previously, regarding the usage by subsequent workers of the second edition of '*Flora Anglica*', and the tendency to ignore the first edition, this is to be expected. Unfortunately, the epithet '*pinnatus*' must be applied to the alga described originally by Hudson under that name, whilst the later interpretation is in fact a misidentification.

The description of *Fucus pinnatus* in the first edition of '*Flora Anglica*' is so poor that precise identification is difficult if not impossible; the description could be applied equally well to a number of algae, both of the Rhodophyta and of other divisions. The location of the original Hudson herbarium material would enable this problem to be answered immediately, but unfortunately, the survival of any of the specimens on which the descriptions of the first or even the second editions of '*Flora Anglica*' were based would appear to be very doubtful (Dixon, 1959 b). As was there shown, there is good evidence to suggest that such specimens as have survived to the present day were collected after 1783. Where there are discrepancies between the two editions of '*Flora Anglica*', the herbarium specimens, if any are still in existence, tend to be referable to the alga described in the second edition, rather than to that of the first edition. One would expect therefore that should any surviving Hudson specimen, identified by him as '*Fucus pinnatus*', be located, it would be referable to *Pterocladia,* but it should be realised that this does not necessarily give any indication of the original application of the name. However, despite a widespread

search, no Hudson specimen, so labelled, is known to exist at the present day. A specimen which is of interest in connection with the possible identity of the *Fucus pinnatus* of the first edition of '*Flora Anglica*' has been located in the Lightfoot herbarium. Collected by Sir Thomas Frankland at Scarborough, this specimen, which is labelled "does not ys agree with Hudson's *Fucus pinnatus*?", in Frankland's hand, and, "I think it does", in Lightfoot's hand, is a young plant of the entity known subsequently as *Fucus clavellosus* Turner [=*Lomentaria clavellosa* (Turn.) Gaill.]. This specimen is of considerable interest, firstly, because the original description of *Fucus pinnatus,* given in the first edition of '*Flora Anglica*' could apply to this species, and, secondly, because the Yorkshire algae described by Hudson were collected largely at Scarborough, by Frankland, who had previously been his pupil. The association of the alga known subsequently as *Lomentaria clavellosa* with the original *Fucus pinnatus* of Hudson is thus highly suggestive, although definite proof is wanting. However suggestive this association might appear, in view of the complete ignorance of the herbarium material on which the original description of *Fucus pinnatus* was based, there is no justification whatsoever for any changes regarding the nomenclature of the alga known currently as *Lomentaria clavellosa.*

It will be obvious from this discussion that there are two good reasons for suggesting that although the alga described as *Fucus pinnatus* in the second edition of '*Flora Anglica*' may be referable to the genus *Pterocladia,* the alga described originally under that name, in the first edition, to which the name must legally be applied, is referable elsewhere. As has been shown, typification is impossible at the present time, and there is also good evidence to suggest that the type materials have been destroyed by fire, (Dixon, 1959 b). It would seem best therefore to reject the epithet *pinnatus,* by Article 65 of the International Code of Botanical Nomenclature (Lanjouw, 1956). The oldest legitimate epithet which can be applied to the European species of *Pterocladia* is therefore *capillacea,* derived from *Fucus capillaceus* Gmelin (1768), so that the correct name for the taxon under discussion is *Pt. capillacea* (Gmel.) Born. & Thur.

The present location of Gmelin's algal herbarium is unknown. In the absence of type material, it is considered that *Fucus capillaceus* Gmelin and *Pterocladia capillacea* (Gmel.) Born. & Thur. should be typified by the figure given by Gmelin (1768, T. 15, fig. 1), which is

a good representation of the species. Gmelin (p. 146) does not indicate the type locality, stating merely that the alga occurred in the Mediterranean.

On the identity of *Conferva arbuscula* Dillwyn

The realisation that the names of two very distinct species of Rhodophyta, viz. *Callithamnion arbuscula* and *Dasya arbuscula,* are both derived from the same basionym *Conferva arbuscula* Dillwyn necessitates a detailed nomenclatural study of the three entities involved.

Part of the confusion is undoubtedly a result of the method of publication of the '*British Confervae*' of Dillwyn (1802—1809).[1] This was published as a series of fascicles, issued at irregular intervals between July 1st, 1802, and the summer of 1809, and it would appear that the 87 pages of text, which comprise the '*Introduction*' (pp. 1—35) and '*Synopsis of the British Confervae*' (pp. 36—87), were published, together with the title-page and index, late in 1809.

The first treatment by Dillwyn of *Conferva arbuscula* is in the text associated with Plate 85, issued on March 1st, 1807, in which it is stated that the specimens figured were collected by Robert Brown "on calcareous rocks near Ballycastle, North of Ireland" and named by him: "the specific name of this plant was given by Mr. Brown, and is excellently descriptive of its mode of growth". It is stated also that a second collection of the entity, made by Miss Hutchins, at Bantry Bay, had been seen. The figures given (Plate 85, figs. A—D) are of the alga known currently as *Callithamnion arbuscula.* From the annotations on the plate, the latter was drawn by W. J. Hooker, although in the '*Introduction*', (p. 35) Dillwyn acknowledges the help of Dawson Turner for information on a number of species, stating "to him I am indebted for the description of *C. arbuscula* . . .". Thus, the original account of *Conferva arbuscula* published by Dillwyn, is of an alga, collected and named by Robert Brown, described by Dawson Turner and illustrated by W. J. Hooker, so that it is not surprising that there was subsequent confusion. In the '*Synopsis*' (p. 80), issued in the autumn of 1809, Dillwyn makes the following additional comments: "since I published my descriptions of this species, it has been found

[1] A careful study of the publication dates of the fascicles and introductory text of '*British Confervae*' has confirmed the data given previously by Setchell and Gardner (1920, p. 311). It is to be regretted that the dates of publication of the last parts to be issued can still not be cited with any precision.

on the shores of Caithness and Orkney by Mr. Borrer and Mr. Hooker. Two kinds of fructification produced by this species, from a drawing by Mr. Hooker, are represented in Plate G magnified 1". The plate referred to contains two figures, which are of fragments of the tetrasporic and 'cystocarpic' plants of a member of the Dasyaceae. In order to clarify this confused situation, an attempt was made to locate the original specimens on which the various descriptions and figures of *Conferva arbuscula* were based.

A number of specimens, which may have formed part of the original collection made by Robert Brown, have been located, but of these, only two are still associated with a label written by him. These two specimens, mounted on a single herbarium sheet, are now in the Herbarium of the British Museum (Natural History), with the label

"Conferva arbuscula Nost Coast of Antrim 1797 RB
for Mr. Sowerby, sent also to Dr. Smith"

written in Brown's hand. In addition there is another specimen, in the same herbarium, acquired with the collections of Edward Forster, labelled:

"Conferva arbuscula North of Ireland Brown"

in Forster's hand. Forster's herbarium contained a number of important collections, but his habit of removing the original labels from specimens acquired by him (c.f. Dixon, 1959 b) makes the attribution of these collections somewhat difficult. In this instance, although it is very probable that the specimen in question formed part of the original Brown collection, definite proof is wanting in the absence of the original annotation. At the Herbarium of the Royal Botanic Gardens, Kew, there is a further specimen, labelled:

"Conferva arbuscula N coast of Ireland",

in Dawson Turner's hand. This specimen, possibly part of the original collection, is of particular interest in view of the remark made by Dillwyn that the original description of the taxon was made by Turner. These specimens mentioned have all been examined microscopically and they are all of the alga known currently as *Callithamnion arbuscula*. Unfortunately, there is a complete lack of evidence, either direct or indirect, to indicate that one or more of these specimens was used in the preparation of the original description. Macroscopically, none of these specimens resembles the figure of the whole plant given by Dillwyn in his original Plate 85A. Moreover, from the comments made

subsequently regarding the discovery of the reproductive structures, it would appear that the specimen or specimens used in the preparation of that plate were sterile, whereas the specimens which have been located are all very obviously fertile, with either tetraspores or 'cystocarps'.

It has not been possible to locate the specimen commented upon in the original description of *Conferva arbuscula,* collected "by Miss Hutchins, and preserved in the beautiful collection of my friend Dr. Scott, of Dublin". The collections of Scott were absorbed into those of W. H. Harvey, which have become somewhat scattered, although most of Harvey's specimens are now preserved at Trinity College, Dublin. Several appropriately-labelled specimens have been located in various herbaria, but there is nothing to indicate that any of these had ever passed through the hands of Scott, or had been examined or seen by Dawson Turner. In fact, all the Hutchins specimens of '*Conferva arbuscula*' which have been located are not referable to the genus *Callithamnion* at all, but to *Dasya.* It would appear therefore that the Hutchins specimens may possibly have been primarily responsible for the confusion between the two taxa.

The specimens used by Hooker in the preparation of the additional plate published by Dillwyn (Plate G) appear to be those now preserved in the Herbarium of the Royal Botanic Gardens, Kew. These specimens are mounted on small pieces of glass, in packets; both packets are labelled "*C. arbuscula* fruit", with rough ink drawings indicating the illustration for which they had been used. The ink drawing of the 'cystocarp' is very similar to that of the published plate, although the representation of the tetrasporic plant is slightly different from that published. The two small packets are mounted in a larger packet, marked as having belonged to Dillwyn and labelled: "this I take to be the original specimens from which Dillwyn t. G is taken and these belong to *Dasya hutchinsiae*". Attribution of the latter inscription is a little difficult, but most probably it was written by W. H. Harvey. Harvey's handwriting varied considerably during his life, the script used in his youth differing significantly from the more characteristic hand of his later years. As is stated in the inscription, the specimens are referable to the genus *Dasya.*

Thus it would appear that the specimens collected by Robert Brown, from which the original description of *Conferva arbuscula* was prepared, are attributable to the genus *Callithamnion,* as understood at the present time, even though the actual specimen used by Dawson

Turner has not been definitely located, whilst the additional specimens acquired subsequently by Dillwyn are referable to the genus *Dasya*. This situation was commented upon by Harvey (1841, p. 98) who said that "of Mr. Brown's plant, the original *Conf. arbuscula*, Dillwyn appears to have had but a single specimen, whilst of the present plant ["*Dasya arbuscula* Ag."] he had many, which he seems to have almost exclusively distributed as the *Conf. arbuscula* of his work". Harvey was obviously unaware of Dillwyn's acknowledgement to Dawson Turner as the author of the description but this does not affect the general issue. The later comment by Howe (1918, p. 525), "the type of *Conferva arbuscula* Dillw., on which *Dasya arbuscula* Ag. was based, is evidently a *Callithamnion*", would appear to have been based on the remarks made by Harvey, as no evidence is quoted in support of this comment.

The result of this situation is that the epithet *arbuscula* must be applied to the alga which at the present time is placed in the genus *Callithamnion*. Those references to algae which are now regarded as species of the genus *Dasya* must be rejected as misidentifications.

Lyngbye (1819, p. 123) subsequently established the genus *Callithamnion,* referring to his *Callithamnion arbuscula* the *Conferva arbuscula* of Dillwyn and *Hutchinsia arbuscula* of C. Agardh (1817, p. XXVI), the latter being based directly on *C. arbuscula* Dillw. Lyngbye, in quoting both Plate 85 and Plate G of Dillwyn, clearly failed to realise that these two plates were based on different taxa, and, in addition, he repeated the error, in that three of his illustrations (Pl. 38, figs. 1—3) are referable to a species of the genus *Callithamnion,* whilst the remainder (Pl. 38, figs. 4—6) are of a species of *Dasya*. The ecological notes on '*Callithamnion arbuscula*' given by Lyngbye are reasonably accurate (c.f. Børgesen, 1902), but, as no species of *Dasya* is known to occur as far north as the Faeroes, it must be assumed that Lyngbye added, to his original observations on the species of *Callithamnion,* details and figures derived from a specimen of *Dasya* which had been collected in another locality. It would appear that Lyngbye included observations and figures derived from non-Faeroese or non-Danish algae for quite a number of species, as for instance with his report of '*Ceramium ciliatum*' in the Faeroes (Børgesen, 1902; Dixon, unpublished), so that all Lyngbye records need to be scrutinised carefully before acceptance. It is obvious that Lyngbye was thinking predominantly of the specimen of *Dasya,* in that he associated his *Calli-*

thamnion arbuscula with *Callithamnion coccinea* [=*Heterosiphonia plumosa* (Ellis) Batt.] as being somewhat different from the other species of the genus, an opinion which is completely unreasonable if Lyngbye had in mind the original *Conferva arbuscula* of Dillwyn, which at the present day is referable to the genus *Callithamnion*. However, as a result of the direct and indirect citations of *Conferva arbuscula* Dillw. given by Lyngbye in his original treatment of *Callithamnion arbuscula,* the latter binomial must be applied to the alga which at the present time is known by that name, whatever other interpretation Lyngbye may have intended. The references by him to specimens which at the present day would be referred to the genus *Dasya* must be rejected as misidentifications.

C. Agardh (1828, p. 121) was clearly aware of the existing confusion, which he attempted to overcome by separating the entities under discussion into two species. Unfortunately, Agardh's separation was based upon a series of misconceptions, so that the resultant situation was even more confused than before. Agardh referred both taxa to the genus *Dasya,* which he had created previously (Agardh, 1824, p. 211), under the names '*Dasya arbuscula*' and '*Dasya spongiosa*'. The first of these was based on: —

"*Conferva arbuscula,* Dillw. t. 85. et tab. G",

whilst the second was based on: —

"*Conferva arbuscula,* Engl. Bot. t. 1916 nec Dillwyn
Callithamnion arbuscula Lyngb. p. 122. t. 38 (exclus. fig. 4.5.6.)"

From a study of the Agardh herbarium it is clear that the binomial '*Dasya arbuscula*' was applied by that author to the alga which at the present time is known widely under that name. It is however obvious that the binomial '*Dasya arbuscula*' can be interpreted nomenclaturally only in one way, as a result of Agardh's citation of Dillwyn's Plate 85 in his treatment of this entity, viz. that it is legally a synonym of *Callithamnion arbuscula* (Dillw.) Lyngb. From the comments made by Harvey (1841, p. 98), this situation would appear to have resulted from Dillwyn sending to C. Agardh a specimen of '*Conferva arbuscula*', which was not of the original gathering by Brown, but which was apparently one of the later collections referable to the genus *Dasya*. It should be realised that C. Agardh (1828, p. 121), in his treatment of this entity, does not acknowledge the receipt of a specimen from Dill-

wyn, which is surprising if one had been sent, and that at the present time there appears to be no trace of such a specimen in the Agardh herbarium. On the other hand, J. G. Agardh had obviously examined an authentic specimen at some time, as he states (Agardh, 1841, p. 34) "haec itaque vera planta Dillwynii existimata fuit et specimina, ipsius manu inscripto, condita fuit descriptio *Dasyae arbusculae* in speciebus Algarum data». The synonyms cited by Agardh under '*Dasya spongiosa*' are, from the figures quoted, of algae which are referable to *Callithamnion arbuscula* (Dillw.) Lyngb. From a consideration of the specimens so named in the Agardh herbarium, it is obvious that the binomial '*Dasya spongiosa*' was applied by C. A. Agardh to the alga which at the present time is known as *Callithamnion arbuscula*. From these observations it is obvious that both *Dasya arbuscula* (Dillw.) C. Ag. and *Dasya spongiosa* C. Ag. must be regarded as synonyms of *Callithamnion arbuscula* (Dillw.) Lyngn.

The species of *Dasya,* which was confused by Dillwyn and Lyngbye with *Callithamnion arbuscula* (Dillw.) Lyngb., and which up to the present time has been referred to as '*Dasya arbuscula*', is therefore without a specific epithet, as neither that name, nor *Conferva arbuscula* Dillw. can be applied to the taxon.

It is obvious that an elucidation of the confused situation which has been discussed in the present paper could have been achieved at any time by a study of the original material. This was, in fact, undertaken by Harvey, who, over a hundred years ago, made a correct assessment of the situation. Harvey (1833)) correctly attributed *Conferva arbuscula* Dillw. to the genus *Callithamnion* and, in addition, proposed a new epithet *hutchinsiae* for that species of *Dasya* which had been confused with *Conferva arbuscula* Dillw., and which Agardh had incorrectly described under the name '*Dasya arbuscula*'. Harvey stated that "a careful examination of original specimens enables me to refer Dillwyn's tab. G. (*C. arbuscula*) which has created so much perplexity, to the present species [viz. *Dasya hutchinsiae*] as well as so much of his description (Syn. Conf. p. 80) as relates to the fruit. His t. 85, however, with the accompanying description, belongs to *Callithamnion arbuscula*". Harvey himself did not retain the epithet *hutchinsiae* for more than a few years, and in a later publication (Harvey, 1841, p. 98) he returned to the incorrect usage of '*Dasya arbuscula*' for this taxon, stating "I rather hastily inferred in the 'British Flora', that Agardh's

Dasya arbuscula must be regarded as a synonyme [sic] of *Callithamnion arbuscula,* and accordingly gave the name of Miss Hutchins, its discoverer, to the present plant. I am indebted to Mr. Agardh jun., for having set me right on this point . . .". Thus, as a result of incorrect advice from J. G. Agardh, Harvey abandoned his correct assessment of the entities involved, and in consequence, the state of confusion has persisted to the present day.

It is to be regretted that a complete answer to the question of the correct name for the species of *Dasya,* which has been known generally as '*Dasya arbuscula*', cannot be given at the present time. From the comments given by Harvey, quoted in the last paragraph, it would appear that *Dasya hutchinsiae* Harv. is the correct name for this species. There are, however, two other specific epithets, viz. *punctata* and *boucheri,* derived from *Gaillona punctata* and *Gaillona boucheri* of Bonnemaison (1828), which must be taken into consideration in that they antedate *Dasya hutchinsiae* Harv. It is obvious that both *Gaillona punctata* and *G. boucheri,* as outlined by Bonnemaison are representatives of the genus *Dasya,* but the descriptions given are insufficient for precise identification. A careful examination of the type material is obviously necessary. It has not yet been possible to obtain the original material and there is some evidence to indicate that the type specimen of *Gaillona boucheri* Bonnem., which was described from a single specimen in Lamouroux's herbarium, has been lost. In addition, in view of the taxonomic difficulties in the genus *Dasya,* which are becoming increasingly apparent, it would be better to withhold the identification until knowledge of the limits and range of form of the European species of that genus is more adequate than at the present time. A further complication, which can only be resolved by adequate typification, is the relationship between *Gaillona punctata* Bonnem. and *Ceramium granulatum* Ducluzeau (1805). *Ceramium granulatum* Ducluz. is cited by Bonnemaison as a synonym of *Gaillona punctata,* although it is usually referred to the genus *Callithamnion,* as *Callithamnion granulatum* (Ducluz.) C. Ag. Once again the original description is so poor that precise identification is difficult. It is possible, therefore, that this taxon should actually be referred to the genus *Dasya.*

There is thus no specific epithet, which at the present time can be applied, indisputably, to the species of *Dasya* under discussion. Work on this problem is proceeding, and it is hoped that the answer will be available in the near future.

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Lytic Activity on Autoclaved and on Intact Eubacterial Cells by a Preparation U2D, Obtained from a Metabolic Solution of Myxococcus virescens

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Myxobacteria grown in a suitable nutrient solution containing the amino acids of casein and some salts produce an agent which is lytically active on autoclaved eubacteria (Oxford 1947; Norén 1953, 1955 b). The dissolution of such autoclaved eubacteria may however only indicate a proteolytic capacity since the heat treatment ruptures or damages the walls of many Gram negative eubacteria (Salton and Horne 1951). Also, autoclaved Gram positive bacteria, which are known to be more resistant to heat treatment than Gram negative species (Kantorowicz 1909; Salton 1953), are lysed by the cell-free metabolic solution of *Myxococcus virescens* (Norén 1955 b). Furthermore, it has been shown repeatedly that living eubacteria, Gram positive as well as Gram negative, are lysed by various myxobacteria (Pinoy 1913, 1921; Solntzeva 1939; Snieszko *et al.* 1943; Singh 1947; Oetker 1953; Kühlwein 1955, Singh *et al.* 1958; Mathew and Duduni 1955, a.o.). However, Loebeck and Klein (1956) found that the cytoplasmic contents of intact, living cells of *Escherichia coli* were not available to a mutant strain of *Myxococcus virescens*. They also reported that cell walls of *E. coli* were not oxidized by this myxobacterium, a finding which was in keeping with the observation by Salton (1955).

In order to study the lytic activity of *Myxococcus virescens* on intact eubacteria the author performed experimens to test the lytic effect of a cell free metabolic solution of *M. virescens* on washed, intact cells

of *Aerobacter* sp. The experiments, which were carried out according to a method previously described (Norén 1953), seemed to reveal a strong lytic activity on intact eubacteria. Simultaneously, however, it was found that the uninoculated nutrient solution used for the growth of *M. virescens* caused in some way a decrease of the turbidity of a suspension containing non-heated eubacteria. A lytically active agent was therefore prepared from the metabolic solution of *M. virescens, i.e.* from the culture solution in which the myxobacterium had grown. The lytic activity on ruptured and intact eubacterial cells of the preparation thus obtained was investigated and the results are recorded in this paper.

Materials and Methods

In the present investigation attention was concentrated on one myxobacterium: *Myxococcus virescens,* strain 271/2 (Norén 1952). It was cultured in Nutrient Solution III B (Norén 1955 a), containing casein hydrolysate 2.5 g, asparagine 2.5 g, K_2HPO_4 2.0 g, NaCl 1.0 g, $MgSO_4 \cdot 7\ H_2O$ 0.1 g, $CaCl_2$ 10 mg, $MnSO_4 \cdot 4\ H_2O$ 1 mg, ferric citrate 3 mg, distilled water 1000 ml.

The myxobacteria were grown in large flasks, each containing 150 ml nutrient solution. The bottoms of the flasks were covered with fiber glass (Pyrex Brand Wool) which reached the surface of the liquid. The myxobacteria, inoculated as previously reported (Norén 1955 a), developed rapidly on the glass fibers as well as on the bottom of the containers. After an incubation of 10 days at 30°C, the pooled culture solution was filtered and the clear metabolic solution was concentrated about 10-fold by evaporating off the water under reduced pressure at 35—40°C. The concentrate was kept at 4°C overnight and then clarified by centrifugation (3000 rpm) for 10 minutes. The concentrated metabolic solution thus obtained is referred to as "Sl" in the following account.

The Sl preparation was dialysed in sacs of seamless regenerated cellulose tubing (The Visking Corporation, Chicago, Illinois, U.S.A.) with an average pore radius of 24 A, against running tap water for 48 hours and then against distilled water under steady agitation for 2 hours, the distilled water being replaced after one hour. The dialysed solution is referred to as "SlD".

A lytically active substance was obtained from the concentrated metabolic solution Sl by slowly adding an equal amount of a saturated solution of $(NH_4)_2SO_4$. The precipitate was recovered by centrifugation, redissolved in distilled water — up to the same volume as the original Sl — and finally dialysed as described above. The dialysed preparation of the redissolved $(NH_4)_2SO_4$ precipitate is henceforth referred to as "U2D" and the dialysed supernatant obtained at the precipitation with $(NH_4)_2SO_4$ is referred to as "S2D". When stored at 4°C the active preparations could be kept for a month or two without reduced activity. Absolute alcohol also gave a precipitate, which however was found to be inactive on autoclaved cells of *Aerobacter*.

The active components are apparently not heat stable. In some experiments with U2D, small amounts of the preparation were heated to 50°, 60°, 70°, 80° and 100°C, respectively, and then kept at these temperatures for 1 minute. A test on autoclaved *Aerobacter* showed that the 50°C treatment had hardly any effect, while the treatment at 60°C drastically reduced the lytic activity of U2D. Thus in 2 hours the effect was 23 % and in 5 hours 44 %, respectively, of that of the non-heated U2D. The 70°C treated U2D had no visible lytic effect during the first two hours but in 5 and 24 hours it had produced a turbidity loss of 6 % and 27 % respectively. However, the preparation was not completely inactivated by a heating to 80°C, or even 100°C. U2D heated to 80°C produced in 24 hours a turbidity decrease of 6 %, and a preparation heated to 100°C a decrease of 3 %. In view of the observation by Solntzeva (1939) that a lytically active substance of *Chondromyces aurantiaca* could withstand 100°C for 15 minutes, and of observations made during this investigation a further study of the problems connected with the thermostability of the bacteriolytic agent(s) of myxobacteria would seem to be of great interest.

The eubacteria employed were *Aerobacter* sp. (strain 1912, Singh 1941) and *Bacillus subtilus* (strain 209 P, State Bacteriological Laboratory, Stockholm). The eubacteria were grown in large flasks each containing 75 ml of nutrient solution. After an incubation at 30°C for 24 hours the cells were harvested and washed in distilled water three times by centrifugation. The concentrated thick suspension of washed eubacterial cells thus obtained was dispersed in distilled water so that each 7 ml contained 2 mg eubacterial cells, dry weight. Such a stock suspension of eubacteria was made up for each experiment and portions of it were treated in one of the following three ways: (1) The suspension was autoclaved at 120°C (autoclaved bacteria); (2) The suspension was frozen at —20°C and then thawed at +20°C, this being repeated three times, Methiolate to 0.01 % was then added (freeze-thawed eubacteria); (3) The suspension was supplied with 0.01 % merthiolate (merthiolate treated eubacteria). After adjusting the pH to 7.6 the suspensions were aseptically distributed in tubes, 7 ml in each, and 1 ml per tube of the preparation to be tested was added. In this way each tube of an experiment contained an identical amount of eubacterial material. The initial turbidity, E_0, on the other hand varied somewhat for the various series.

Merthiolate is known to have a bactericidal (Bucca 1943) or bacteriostatic (Morton, *et al.* 1948) effect. In the case of *Aerobacter* and *Bacillus subtilis* it seemed to act as a bactericidal agent. Whereas 0.01 % merthiolate completely prevented the growth of the eubacteria in a broth nutrient solution, it was further found that if 0.01 % merthiolate was added to a 24-hour culture and within an hour 1 ml was transferred to 25 ml of a new medium without merthiolate, no growth was produced in the new medium. Merthiolate has been used with good success in a study on cellulolytic enzymes (Aschan and Norkrans 1953), and it seemed suitable for the present investigation since it does not affect the lysis of autoclaved eubacterial cells by Sl, SlD or U2D.

Cell walls of *Aerobacter* sp. have been obtained according to the method of Albertsson (1958). (For the cell wall preparations the author wants to express his sincere gratitude to Dr. Albertsson.)

The bacteriolytic effect of Sl or the preparations thereof was followed according to the method previously described (Norén 1953). A decrease in turbidity has been taken as a measure of the bacteriolytic effect, and according to Rodhe (1948) it has been expressed by the formula $Z = (e_\gamma - e_0) \cdot 10^3$. In the diagrams the turbidity decrease, Z, has been expressed in per cent of E_0. The figures represent the average of at least three replicates. The turbidity of non-inoculated controls, set up for each series of each experiment, did not change during the incubation if not so indicated under the experiment.

Experiments and Results

It was first a matter of interest to elucidate in what extent the bacteriolytic agent present in Sl was recovered in the preparation U2D. This was made in Experiment 1.

Expt. 1. *The lytic effect on autoclaved Aerobacter of the concentrated metabolic solution of M. virescens, Sl, and of various preparations thereof.* (Fig. 1.)

The experiment, performed on autoclaved *Aerobacter,* comprised 4 series, Series 1 being supplemented with Sl, Series 2 with SlD, Series 3 with U2D, and Series 4 with S2D, 1 ml per tube.

The results obtained, which are summarized in Fig. 1, showed that the main part of lytic activity exhibited by Sl on autoclaved *Aerobacter* cells was recovered in the preparation U2D. A slow decrease in turbidity occurred however in the S2D series, resulting in a complete lysis in 3 days, and it is thus evident that a small fraction of an active agent still remained in the metabolic solution after the precipitation with $(NH_4)_2SO_4$. It was not clear if there existed a difference in quality between U2D and S2D. However, a mixture of U2D and S2D had no greater effect on autoclaved *Aerobacter* cells than that of an U2D solution adequately diluted with distilled water.

It was a striking result of the experiment that the dialysis of Sl so drastically reduced its lytic effect, as shown for the curve of SlD.

Experiment 1 demonstrated a good lytic activity of the preparation U2D on autoclaved *Aerobacter* cells. As mentioned, the results, however, may only reflect the lysis of the freely exposed eubacterial cytoplasms, *i.e.* the proteolytic capacity of U2D.

The activity of the preparation on intact cells of *Aerobacter* was tested in the following experiment. In addition, a test of the effect on ruptured but not heat treated (freeze-thawed) cells was carried out.

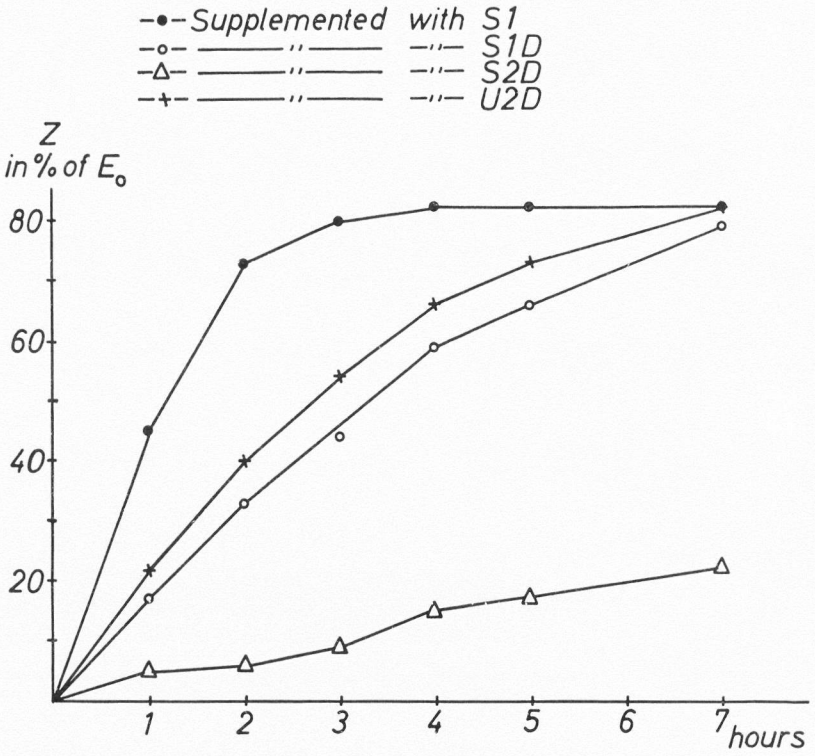

Fig. 1. The lytic effect of Sl and preparations thereof on autoclaved cells of *Aerobacter* sp. (Expt. 1).

Expt. 2. *The lytic effect of the preparation U2D as compared with Sl on intact, freeze-thawed, and on heat treated cells of Aerobacter sp.* (Fig. 2).

The experiment comprised 6 series as follows: (1) Autoclaved *Aerobacter* cells plus Sl; (2) Autoclaved *Aerobacter* cells plus U2D; (3) Freeze-thawed *Aerobacter* cells plus Sl; (4) Freeze-thawed *Aerobacter* cells plus U2D; (5) Merthiolate treated *Aerobacter* cells plus Sl; (6) Merthiolate treated *Aerobacter* cells plus U2D. The amount of test preparation was 1 ml. E_0 of series 1 and 2 was 900, of series 3 and 4 775 and of series 5 and 6 750.

The two series with autoclaved *Aerobacter* were included for purposes comparison and both the test preparations used caused a very rapid decrease in turbidity. As in the previous experiment the effect of Sl was more rapid.

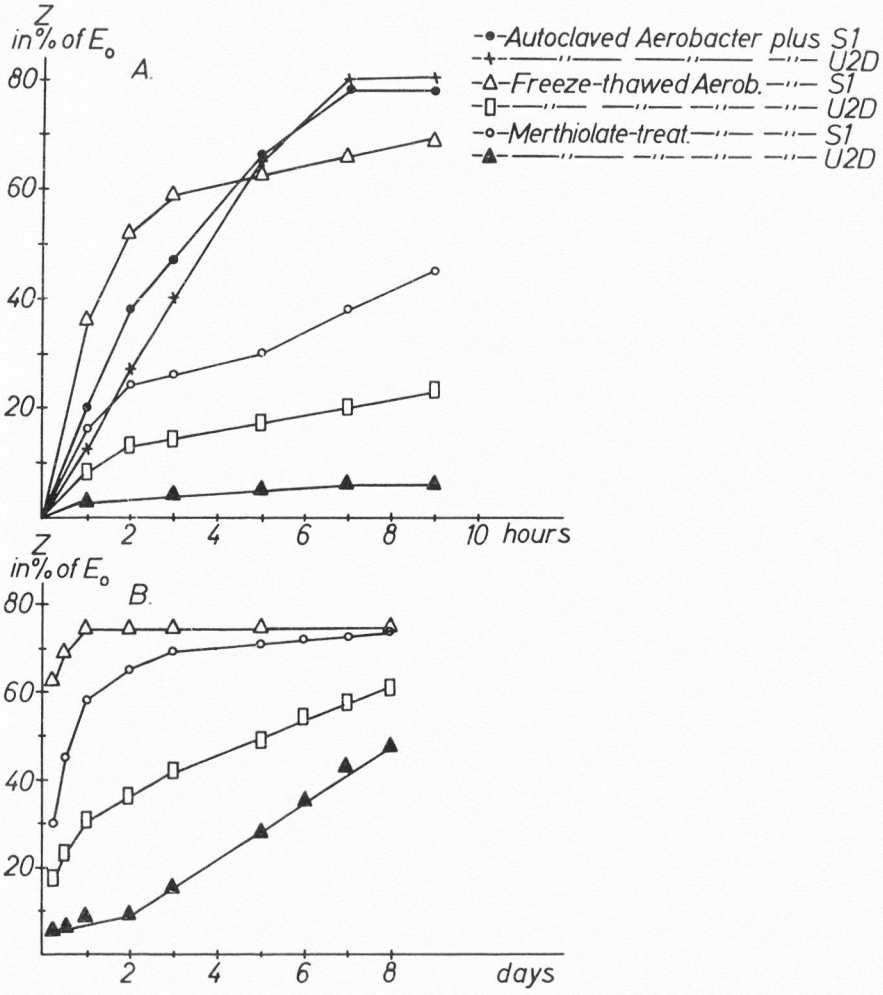

Fig. 2. The lytic effect of Sl and U2D on variously treated cells of *Aerobacter* sp. A. The effect during the first 9 hours. B. The effect during 8 days.

A rather strong effect on the freeze-thawed eubacteria was obtained with Sl. As a mater of fact, the effect obtained was even superior to that on the autoclaved cells. Since the turbidity loss mainly resulted from the dissolution of the eubacterial cytoplasms, part of which here being readily accessible due to the rupture of the cell walls, it may be concluded that the heat treatment makes the cytoplasms of *Aerobacter* somewhat resistant to the proteolytic agent(s) secreted by *M. virescens*.

This can be a factor contributing to the repeatedly made observations that myxobacteria grow more vigorously on living eubacterial cells than on autoclaved eubacterial cells. (Singh 1947; Oetker 1953; Norén 1960).

Although the preparation U2D acted much more slowly on the freeze-thawed cells than did Sl, it caused a continuous lytic effect, resulting in a turbidity loss of 13 %, 20 %, 31 %, and 61 % in 2, 7, and 24 hours and in 6 days, respectively. At an incubation of 6 days the control tubes became somewhat more turbid due to evaporation. The results seemed to indicate that U2D acted not only upon the ruptured cells but to a certain degree on the intact cells as well.

As could be expected, the intact merthiolate-treated *Aerobacter* were more resistant to the lytic activity of both Sl and U2D. Undoubtedly this was due to the protection which was provided the eubacterial cytoplasm by the cell walls. However, the protection was by no means complete. Sl caused in 2 hours a turbidity decrease of 25 %, in 9 hours 45 %, and it cleared the suspensions completely within 4 days. Although this result seems to indicate that the concentrated, cell-free metabolic solution of *M. virescens* had a fairly good lytic activity on the intact eubacteria it is questionable if the effect obtained was entirely due to the bacteriolytic products secreted by the myxobacteria. It is possible that the inorganic matter present in Sl might have influenced the results, how much and in what way being still obscure. It was found simultaneously that the non-inoculated nutrient solution had a certain clearing effect when added to a suspension of merthiolate treated, non-heated cells of *Aerobacter,* causing a turbidity loss of 16, 18, 23, and 28 % in 2, 5, 24, and 48 hours, respectively. The factor primarily responsible for this effect was found to be the phosphate present in the solution since the exclusion of this salt made the nutrient solution almost inert. On the other hand, an addition of 1 ml of 0.2 M phosphate buffer (pH 7.0) to 7 ml of a suspension of merthiolate killed cells of *Aerobacter* in distilled water caused a rather rapid decrease in the turbidity. However, the phosphate never cleared the eubacterial suspensions completely as did Sl, only up to about 30 %. A close study of the nature of the activity of the phosphate buffer or of the nutrient solution represents a problem that was beyond the purpose of this investigation. (For the effect of various buffer solutions on eubacterial suspensions cf. Mager *et al.* 1956 and Gossling 1958). However, in an adequate buffer solution an autolysis of eubacterial cells can occur, a fact which frequently has been used for the preparation

of cell free bacterial endo-enzymes (Avery and Cullen 1920; McIlvain 1948). The possibility was thus to be considered that although merthiolate killed cells of *Aerobacter* do not autolyse when dispersed into distilled water they do so in the presence of the inorganic matter introduced in the suspension with the Sl preparation. The lytic effect obtained with Sl on the merthiolate treated eubacteria might then simply be a result of the activity of the proteolytic enzymes secreted by the myxobacteria — and to a certain extent derived from the eubacterial cells themselves — on the eubacterial cytoplasms which were made accessible to the enzymes by autolysis. Such a view seemed also to be supported by the fact that about 80 % of the activity of Sl on intact *Aerobacter* appeared to be lost upon dialysis. However, although SlD had a rather weak lytic effect on the merthiolate treated eubacteria it produced a limited turbidity decrease, 5 % in 5 hours, 8 % in 24 hours, and 13 % in 6 days, indicating a certain activity upon the intact eubacteria.

The preparation U2D produced a slow but continuous decrease of the turbidity of the suspension with intact cells of Aerobacter. In 5 days about 30 % and in 8 days about 50 % of the turbidity was lost. The effect was thus not a very strong one. It is an interesting fact that the curves for the lysis of the freeze-thawed and the merthiolate treated eubacteria are about parallel after the 24th hour. Apparently, the lysis in both these series after that time was concerned with the same material: the intact eubacterial cells.

The results obtained in Experiment 2 raised certain questions. Had the preparation U2D only a proteolytic activity? Was the weak lysis produced on the merthiolate treated cells of *Aerobacter* a result of the activity of a proteolytic agent on autolysing eubacterial cells? Or was it due to another more specific activity of U2D on the intact cells? To answer these questions a series of experiments were carried out, following three lines:

(1) The lytic effect of U2D was compared with that of a proteolytic enzyme. Trypsin, which appears to have the pH-requirements about identical with U2D, was chosen for these experiments. Since trypsin does not act on eubacterial cell walls (Salton 1953, 1956) its effect would reflect the lysis of such material in the eubacterial suspension as was susceptible and directly exposured to the activity of a merely proteolytic enzyme. The lytic effect on autoclaved eubacterial cells would consequently give information concerning the proteolytic capacity of U2D as compared with that of trypsin. The results obtained on

intact, wall-covered cells would then indicate if U2D contained any activity additional to its proteolytic capability.

(2) The lytic effect of U2D was tested on an autoclaved Gram positive eubacteria, *Bacillus subtilis*. Gram positive eubacteria resist heat treatment better than Gram megative forms (Kantorowicz 1909, Salton 1953), a phenomena which has been ascribed to the chemical constitution of their cell walls which apparently withstand the heat better (Salton 1953). Consequently, if U2D should contain any agent active on the heat treated cell walls of the Gram positive eubacteria, thus making the eubacterial cell interior accessible to its proteolytic enzyme(s), then it could be expected that U2D would have a lytic effect superior to that of trypsin on the autoclaved as well as on the merthiolate treated intact cells.

(3) The effect of U2D was tested on a pure cell wall preparation of *Aerobacter*.

Expt. 3. *The lytic effect of the preparation U2D and of trypsin on autoclaved and merthiolate treated cells of Aerobacter sp.* (Fig. 3).

The experiment comprised 4 series as follows: 1. Autoclaved *Aerobacter* plus U2D; 2. Autoclaved *Aerobacter* plus trypsin; 3. Merthiolate treated *Aerobacter* plus U2D; 4. Merthiolate treated *Aerobacter* plus trypsin. The amount of test preparation was 1 ml. in all cases. Trypsin, Difco 1 : 250, was used in the concentration 0.5 mg/ml. E_0 of the series 1 and 3 was 900 and of the series 2 and 4 720.

From Fig. 3 it is seen that the autoclaved *Aerobacter* suspension to which trypsin was added lost its turbidity more rapidly than did the suspension with U2D. Thus under the experimental conditions used, the trypsin showed a higher degree of proteolytic activity than U2D. The merthiolate treated eubacteria, on the contrary, were more susceptible to the preparation U2D. It is true that the lytic activity of trypsin was rather unexpected in this case but since a non-purified enzyme preparation was used it is possible that other factors as discussed by Baumann and Tomscik (1959) may have been involved. Under all circumstances, however, the results definitely revealed that under the conditions present and in spite of its higher content of proteolytic activity, trypsin had a distinctly inferior lytic effect on the intact cells of *Aerobacter* as compared with U2D. It might thus be concluded that the lysis of the intact cells produced by U2D was not merely due to its proteolytic capacity but also, and apparently primarily, to another activity, by which the eubacterial cell interiors were made slowly accessible. This conclusion was further emphasized by results obtained in

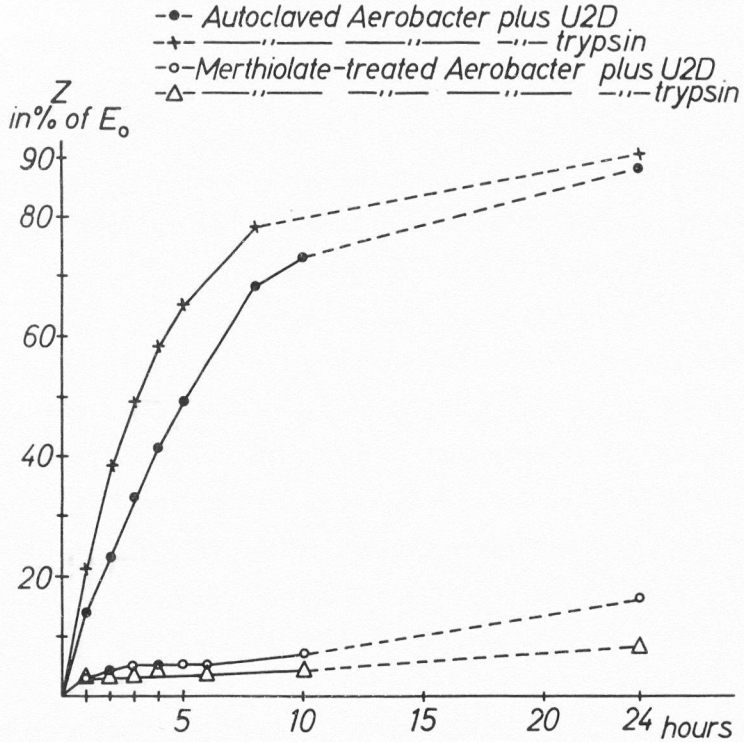

Fig. 3. The lytic effect of U2D and trypsin on autoclaved and merthiolate-treated cells of *Aerobacter* sp. (Expt. 3).

an experiment with freeze-thawed *Aerobacter*. Trypsin caused here the most rapid turbidity loss during the first two hours while in the later phase of the experiment U2D became the better lytic agent. It seems probable that the superior proteolytic activity of the trypsin produced a more rapid lysis of the ruptured eubacterial cells while U2D had the greater lytic effect on the remaining unruptured cells. Such a view is supported by the fact that during the late phase, the development in the suspension containing freeze-thawed eubacteria was parallel with that in the suspension containing merthiolate treated cells.

Expt. 4. *The lytic effect of the preparation U2D and of trypsin on autoclaved and merthiolate treated cells of B. subtilis.* (Fig. 4)

The experiment was performed exactly as Expt. 3. Four series were set up: 1. Autoclaved eubacteria plus U2D; 2. Autoclaved eubacteria plus trypsin; 3. Merthiolate treated eubacteria plus U2D; 4. Merthiolate treated eubacteria

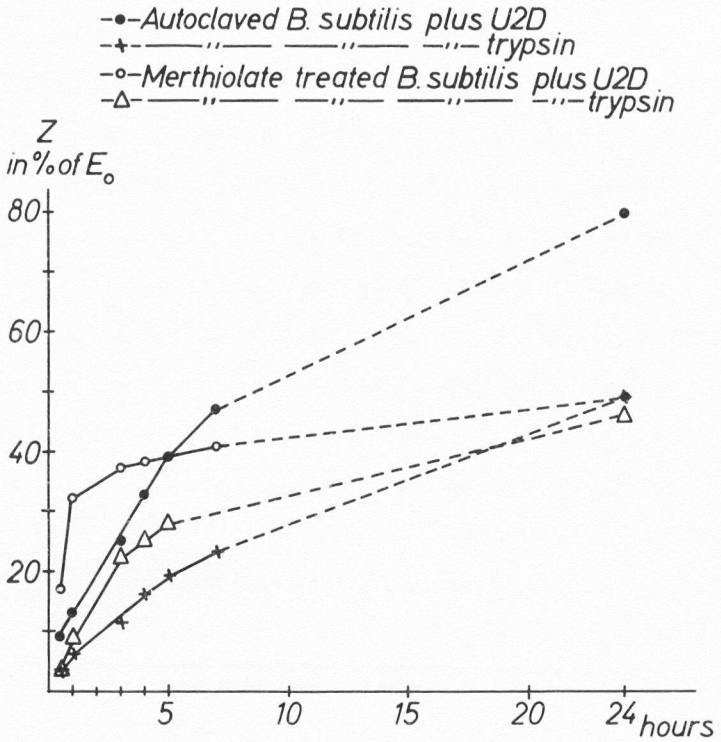

Fig. 4. The lytic effect of U2D and trypsin on autoclaved and merthiolate-treated cells of *Bacillus subtilis*. (Expt. 4).

plus trypsin. The test preparations were as in Expt. 3 and used in the identical amounts, 1 ml per tube. E_0 of the series 1 and 3 was 650 and of the series 2 and 4 was 600.

Trypsin had only a poor effect on the autoclaved cells of *B. subtilis*, the turbidity loss being only 25—30 % of that on autoclaved *Aerobacter*. The fact that *B. subtilis* is more resistant to a heat treatment than *Aerobacter* was thus clearly demonstrated. In contrast to trypsin, U2D had a rather good lytic effect on the autoclaved cells of *B. subtilis* causing a turbidity loss of 39 % and 48 % in 5 and in 7 hours, respectively. The effect obtained was about 80 % of that on autoclaved cells of *Aerobacter*.

During the first hours U2D produced a rather rapid lysis of the merthiolate treated *B. subtilis* — as a matter of fact more rapid than of the autoclaved eubacteria. The later phases occurred at a consider-

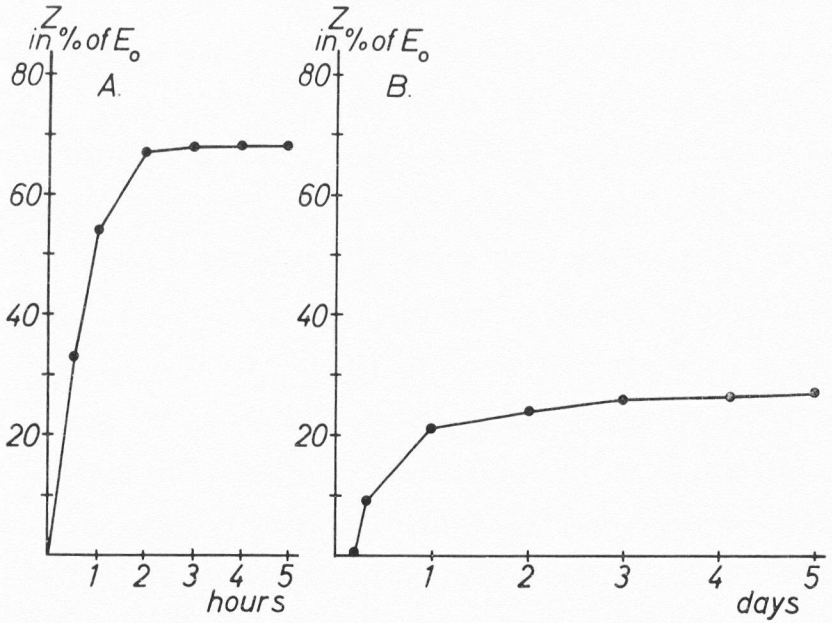

Fig. 5. The lytic effect of U2D on the cytoplasmic contents (A) and cell wall preparation (B) of *Aerobacter* sp. (Expt. 5).

ably slower rate. Trypsin also produced its maximum lysis during the first hours. However, its lytic effect on the intact eubacteria was considerably weaker than that of U2D.

The results obtained in Expt. 4 indicate that the cell walls of *B. subtilis*, heat treated or non-heated, were able to give the eubacteria a protection against the activity of a proteolytic enzyme such as trypsin. But the cell walls did not give any effective protection against the activity of U2D. On the contrary, the eubacterial cytoplasms were here rapidly made accessible to the proteolytic enzyme(s) present in U2D. It might thus be concluded that U2D in addition to its proteolytic activity has a capacity to act on the cell walls of *B. subtilis* so that its proteolytic agents can attack the cytoplasmic contents of the eubacteria. U2D had not the identical lytic effect on the autoclaved and merthiolate treated cells of *B. subtilis*, a fact which indicates that some changes occurring in the cell wall and in the cytoplasm during the heating in some way influenced their resistance to U2D.

The lytic effect of trypsin on the merthiolate treated cells of *B. subtilis* during the first hours was somewhat unexpected. Repeated experi-

ments have, however, confirmed this result. The reason for the activity is not clear. As mentioned above, the trypsin preparation used in these experiments was not a purified enzyme and it is possible that traces of some other enzymes, contaminating the preparation exerted a certain activity on the eubacterial cell walls thus making the cell interior available for proteolysis (Baumann and Tomcsik 1959). The experiment with *Aerobacter* seemed also to indicate such a possibility although the effect was very much weaker in that case.

Expt. 5: *The lytic effect of the preparation U2D on a cell wall preparation of Aerobacter sp.* (Fig. 5).

A cell wall preparation of *Aerobacter* was obtained according to Albertsson (1958). The experiment included a test of the lytic effect of U2D on the interface material obtained during preparation and mainly consisting of the cytoplasmic material from the ruptured eubacteria. The cell walls and the interface material were dispersed in distilled water with the addition of 0.01 % merthiolate and then distributed into tubes. The E_0-value of the "cell wall tubes" was 260 and that of the "interface material tubes" 430.

During the first five hours U2D did not affect the cell wall preparation at all. Later, however, a slight but distinct decrease in the turbidity occurred. The decrease continued but at a much slower rate for about 6 days with the result that 28 % of the turbidity of the cell wall suspension was lost. A prolonged incubation did not increase this effect and the suspension never became completely cleared.

Fig. 5 illustrates an experiment carried out with a cell wall preparation completely freed from any cytoplasmic material. In other experiments, in which such material had been present, U2D caused a heavy loss of turbidity during the first four hours. The subsequent development, however, was always parallel to that of the pure cell wall preparation.

The lysis produced by U2D on the interface material showed a different pattern. Here a very rapid lysis took place and in two hours the process was finished and the suspensions completely cleared. The development resembled closely that produced on autoclaved *Aerobacter* cells.

Discussion

It is a well established fact that *Myxococcus virescens* is able to lyse living intact eubacteria as well as autoclaved cells. However, we do not know very much about the processes involved in the lysis of the intact eubacterial cells. The present investigation has shown that

the concentrated metabolic solution of *M. virescens,* Sl, produces a rapid decrease in turbidity of a suspension in distilled water of intact cells of *Aerobacter* sp. Preparation Sl, however, contained phosphate and other ions, which played a certain undefined role in producing this effect. Consequently, on the basis of the results obtained with Sl no definite conclusions could be drawn concerning the lytic attack on the intact cells of any products secreted by the myxobacteria.

This investigation also revealed that a preparation, U2D, whih was obtained from the metabolic solution of *M. virescens,* by $(NH_4)_2SO_4$ precipitation, is lytically active on eubacterial cells. U2D is apparently primarily a proteolytic agent which rapidly digests ruptured eubacterial cells, *i.e.* their heated or non-heated cytoplasmic material but it appears to contain also another capacity. Whereas the lytic effect of U2D on autoclaved, ruptured *Aerobacter* cells was only 75 % of that of trypsin, its effect on merthiolate treated, intact cells was 175 %, and on the more heat resistant *B. subtilis* the lytic effect of U2D as compared with trypsin was 152 % and 153 %, respectively, on autoclaved and merthiolate treated cells. Thus the merely — or almost merely — proteolytic trypsin had the greater lytic effect on eubacterial material which consisted of cells with ruptured walls and freely exposed cytoplasms, but the preparation U2D was the superior lytic agent in those cases where the eubacteria were covered with cell walls. Such a result indicates that U2D contains an activity on the intact, wall-covered eubacterial cells which is definitely distinct from its proteolytic activity. The results seem to make it quite clear that the preparation U2D has a capability of acting on the cell walls of the intact eubacteria so that the protection given by the walls is lost more or less rapidly and more or less completely. As a consequence, the proteolytic enzyme(s) present in U2D is allowed access to the eubacterial cytoplasms. The conclusion that U2D acts on the cell walls might appear to be in conflict with the observations made by Salton (1955) and Loebeck & Klein (1956). However, the results of Salton may have been influenced by the use of a rather poor medium, certainly lacking in many essential nutrients (cf. Norén 1960). Loebeck and Klein, on the other hand, worked with a mutant strain of *M. virescens,* the behaviour of which in many respects deviated from the normal. The results obtained in these two investigations may thus be rather specific.

The lytic effect of U2D was much stronger on the intact cells of *B. subtilis* than on the intact cells of *Aerobacter* sp. On the other hand, the autoclaved cells of *B. subtilis* were much more resistant to

the lytic effect of U2D than the autoclaved cells of *Aerobacter* sp. From these facts it might be concluded: (a) that the eubacterial cell walls are structures which are important for the protection of the eubacterial cytoplasms against the bacteriolytic activity present in U2D and (b) that the protective capacity of the cell wall depends upon its chemical quality and consequently varies with the eubacterial species concerned. The lysis of the eubacterial cytoplasm produced by the metabolic solution of myxobacteria also varies with the eubacterial species and even the strain employed (Norén 1955 b). It is not clear from the experiments hitherto carried out if the lytic effect observed on the intact eubacteria is due to a partial lysis of all the cells present in the suspension or if there are certain cells with walls which are particularly susceptible to the lytic agent of *M. virescens*. The rather slow but continuous effect on *Aerobacter* sp. would possibly indicate the former view, while the two phases which occur in the lysis of the intact *B. subtilis* seem to favour the latter view. The latter view would postulate the existence of variations in the quality of the eubacterial cell walls in a culture.

In this investigation U2D lysed the intact cells of *B. subtilis* more rapidly than those of *Aerobacter* sp. However, on a non-nutrient agar *M. virescens* lyses living cells of *Aerobacter* sp. more rapidly than living cells of *B. subtilis*. These two facts seem to indicate that the metabolic solution of *M. virescens* probably contained some factor involved in the lysis of the intact cells of *Aerobacter* sp., which however was not recovered by the precipitation with $(NH_4)_2$ SO_4.

Summary

A bacteriolytic agent of *Myxococcus virescens* was prepared from its metabolic solution by precipitation with $(NH_4)_2SO_4$. The product obtained was found to be primarily a proteolytic agent which rapidly digested autoclaved or otherwise ruptured cells of *Aerobacter* sp. and *Bacillus subtilis*. Intact eubacteria were also attacked. It was found that intact cells of *B. subtilis* were more rapidly lysed than intact cells of *Aerobacter* sp. The investigation revealed that the preparation lysed intact and cell wall covered eubacteria more rapidly than did a trypsin solution although the latter showed a higher degree of proteolytic activity. On the basis of the results obtained it is concluded that the bacteriolytic agent prepared in addition to its proteolytic activity has a certain capacity to act on the eubacterial cell walls. Due to this action the eubacterial cytoplasms are exposed to and consequently lysed by the proteolytic enzyme(s) secreted by the myxobacteria. The protective capacity of the cell walls varies with the eubacterial species concerned.

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Sulphate Accumulation by Isolated Leaf Pieces of Crassula as Influenced by Indole-Acetic Acid

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It was recently shown (Kylin 1960 a) that the respiratory pathway for energy delivery to sulphate accumulation in green tissues is inhibited by light and replaced by a mechanism dependent upon processes related to photosynthesis. During the last years several papers have also appeared containing reports to the effect that indole-acetic acid (IAA) exerts a marked influence on sodium exchangeability in *Vallisneria* and *Ruppia* leaves (Kawahara and Masuda 1957, Kawahara and Takada 1958) as well as in *Avena* coleoptiles (Masuda 1958). A few experiments on the influence of IAA on sulphate accumulation by isolated leaf pieces of *Crassula argentea* Thunb. in light and darkness were therefore undertaken, in order to see whether effects similar to those obtained by the Japanese authors for passive uptake are also found in active salt absorption. Since it is known that SH-groups influence the action of IAA (*cf.* Thimann and Bonner 1949) the action of glutathion (GSH) on the above system was also investigated. — A report on the action of 2,4-dichlorophenoxyacetic acid on solute uptake was published by Wedding *et. al* (1959).

The treatment of the *Crassula* leaves and other methods have been described earlier (Kylin 1960 a). Complete nutrient solutions containing 0.5 m*M* sulphate were used, and the accumulation measurements performed with the aid of radio-sulphate added during the experiment proper. God aeration and large volumes of solution ensured that the external concentration was kept practically constant. Free-space sulphate is not included in the measurements, since the pieces were washed with inactive solutions at the end of each experiment. The temperature amounted to $25^\circ \pm 1^\circ$C, and "light" denotes an illumination of about

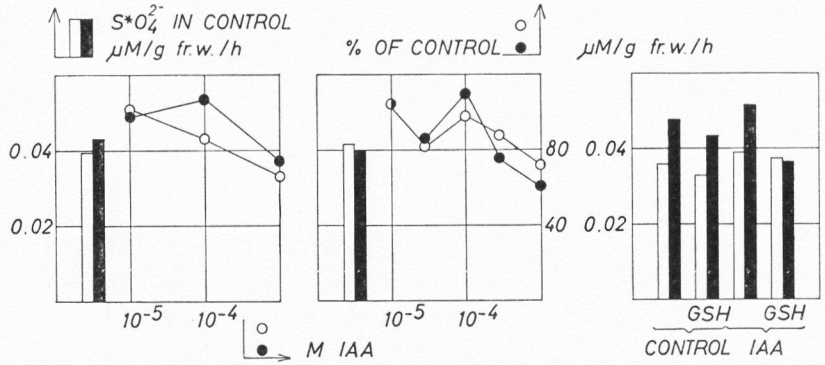

Figure 1 (left) and 2 (middle). *The effect of IAA on sulphate accumulation by leaf pieces of Crassula.* Empty symbols: light. Filled symbols: darkness. — Left ordinate/columns: sulphate uptake of control in µmol/g fresh weight and hour. — Right ordinate/circles: per cent of accumulation of control. — Abscissa/circles: *M* IAA in external solution. — Figure 3 (right). *Interaction of IAA and GSH in sulphate accumulation by leaf pieces of Crassula.* Empty symbols: light. Filled symbols: darkness. Ordinate: sulphate accumulation in µmol/g fresh weight and hour. 10^{-4} *M* IAA and 10^{-3} *M* GSH added as marked on abscissa.

9,000 lux from incandescent lamps with a heat-absorbing layer of streaming water.

From figures 1 and 2 it can be seen that at high concentrations of IAA ($>10^{-4}$ *M*) there is a certain inhibition of sulphate accumulation, whereas no significant effects are detected at lower concentrations. There is further no reproducible difference between the action of IAA in light and darkness. The same IAA effects have been obtained in the presence of 0.3 *M* mannitol (where the uptake of the controls is increased in light and decreased in darkness — Kylin 1960 b), although Kawahara and Masuda (1957) noted a reversing effect of high external osmotic values upon the interaction between IAA and sodium exchangeability in *Vallisneria* leaves. — In light there is no significant effect of 10^{-3} *M* GSH when given in addition to 10^{-4} *M* IAA but in darkness a definite inhibition is noted (figure 3). — The effect of light in the controls of the different experiments varies due to long-time adaptations of the mother plants as shown in an earlier communication (Kylin 1960 a, figure 4).

On the whole the effects of IAA on sulphate accumulation give the impression of being rather erratic and thus probably indirect, although it is of course not possible to exclude a direct action in a process com-

mon to the light and dark mechanisms of active ion uptake. The different interactions of GSH with IAA in light and darkness may be interpreted in terms of IAA-oxidase activity. It was shown by Galston and Baker (1951) that light increases the activity of IAA-oxidase and by Pilet (1958) that the IAA-destroying enzyme is inhibited by GSH. It is thus possible that in darkness the destruction of IAA is inhibited by GSH to such an extent that the *effective* concentration of auxin is high enough to cause inhibition of sulphate accumulation, whereas on illumination light activation of the oxidizing enzyme may counteract this effect of GSH.

In conclusion, the effects of IAA on sulphate accumulation in *Crassula* leaves does not parallel those reported for sodium exchangeability in other species.

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Smärre uppsatser och meddelanden

Ilex aquifolium L. åter funnen i Bohuslän

Ilex aquifolium sågs i ett exemplar på Tjörn 1959. Växten utgjordes av en buske, 0,6 m hög.

Fyndet meddelades mig genom en skolelev av lantbrukaren Kurt Arvidsson. Denne uppger, att, då han under andra världskriget upptäckte busken, den var lika hög som nu. Den skulle alltså ha uthärdat de stränga vintrarna i början av 1940-talet.

Växtstället är Mölnebo: Lyckorna: 1,4 km norr och 1,95 km öster om kyrkan i Rönnäng. Biotopen är en furuplantering, omkring 8×40 m vid, i en i övrigt öppen och bergig omgivning. *Ilex*-busken växte 3 dm från en furustam. Under furorna växte bland annat slån, röda vinbär, nypon, björnbär och rönn samt, i brynet, en.

Intet tyder på, att *Ilex* här planterats. En dunge lik denna är en naturlig övernattningsplats för fåglar som trastar och kråkfåglar. Då nämnda buskar, röda vinbär, björnbär och rönn, sprids endozoiskt med fåglar, och då *Ilex* sprids på samma sätt (Heintze; Nordhagen), kan det förmodas, att *Ilex* kommit till växtplatsen på detta sätt. *Ilex* förekommer vild närmast på Læsö, ±8 mil därifrån, och vid Jyllands nordspets, ±9 mil därifrån, (Hultén). Men den odlas ej sällan i trädgårdar och parker på närmare håll.

Vild *Ilex aquifolium* har påträffats i Sverige en gång tidigare, nämligen i Askum i Bohuslän på 1820-talet. För denna förekomst har Holmboe redogjort. Den liknar den nuvarande däri, att den utgjordes av en liten buske. Areschoug skriver om den: »Nyfikenheten utrotade detsamma, ty hvar och en, som anlände till Wägga, skulle alltid hemföra några quistar som en sällsynthet». Det nuvarande exemplaret har toppskottet och flera kvistar avskurna, varför man kan frukta att likheten skall bli än större.

Åtminstone ännu en gång har *Ilex* påträffats i svensk natur, nämligen i Skåne 1937. Fyndet gjordes under Lunds Botaniska Förenings exkursion till Kullaberg, och exemplaret omtalas som troligen spontant (Botaniska Notiser för 1938, p. 335). Jag saknar närmare kännedom om detta fynd.

Knut Egeröd

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Hypericum pulchrum L. återfunnen i Halland

Hypericum pulchrum L. upptäcktes i början av 1800-talet av Elias Fries i Hallands norra del i närheten av Kungsbacka. Fries anger senare, att han samlat den på lokalen 1830, men att den var utgången 1840. Andra lokaler har angetts från Kungsbackatrakten, men i senare tid är arten ej sedd i Halland.

Artens huvudutbredningsområde i Sverige ligger i södra Bohuslän och angränsande del av Västergötland, där den är funnen på ett tiotal lokaler. Vidare föreligger ett 1800-tals fynd från Skåne på Linderödsåsen. I senare tid har man förgäves sökt den. Bland anmärkningsvärda fynd av arten på senare år är ett från västra Blekinge.

1959 hade jag turen att under inventeringsarbete finna *Hypericum pulchrum* i Ölmevalla sn. i norra Halland. Fyndet gjordes i socknens högre belägna östra del. Lokalen är splittrad i två grupper belägna på c:a 200 meters avstånd från varandra. *Hypericum pulchrum* växer här i en hed-tallskog på en tämligen brant sluttning mot SV. Bland de arter, som ingår i fältskiktet och karaktäriserar lokalen, kan nämnas, *Deschampsia flexuosa* (L.) Trin. (dominant), *Calluna vulgaris* (L.) Hull, *Vaccinium mytillus* L., *V. vitis-idaea* L., *Erica tetralix* L., *Molinia coerulea* (L.) Moench, *Carex pilulifera* L., *Hypericum perforatum* L., *Veronica officinalis* L., *Solidago virgaurea* L. och *Rubus idaeus* L., mera anmärkningsvärda är *Rubus plicatus* W. & N., *Lonicera periclymenum* L. och *Campanula persicifolia* L. Troligt är att *Hypericum pulchrum* här överlevt skogsplanteringen för c:a 30 år sedan. Enligt utsago var lokalen tidigare öppen hedmark av den typ, som förhärskar i socknens inre delar, med inslag av några rikare element (*Campanula persicifolia* och *Lonicera periclymenum*), som följd av läget i sydbranten.

Antalet exemplar av arten är svårt att exakt ange, då de på grund av för stark beskuggning är starkt grenade, men uppskattningsvis så inrymmer den ena gruppen 25 exemplar och den andra c:a 15. 1959 blommade de flesta exemplaren rikligt, medan blomningen var betydligt sparsammare sommaren 1960.

Ett önskemål för artens fortbestånd på denna nya halländska lokal är en snar utgallring av tallskogen och en fridlysning av lokalen.

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Litteratur

Plant Pathology. An Advanced Treatise. Ed. by J. G. Horsfall & A. E. Dimond. — Volume I: The Diseased Plant. Academic Press, New York 1959. 674 s. — $22.00.

Verket är avsett att utges i tre delar med titlarna »The Diseased Plant», »The Pathogen» and »The Diseased Population». Meningen är att få till stånd en fullständig sammanfattning av de olika delarna av växtpatologin. Detta har de båda utgivarna sökt åstadkomma genom att överlåta behandlingen av de olika avsnitten åt specialister. Det internationella samarbetet belyses av att av de 19 medarbetarna i första delen är 9 verksamma i USA, medan Indien och Japan bidrager med vardera tre, Italien med två och Nederländerna och Tyskland med vardera en. Verket är inte någon handbok för den i fältet arbetande växtskyddaren. Endast i undantagsfall behandlas någon specifik sjukdom. Det är snarare begreppet sjukdom, som tas upp till diskussion.

Första volymen inleds med ett kapitel av utgivarna, där de bl.a. redogör för skälen till uppdelning i tre delar. Att man börjar med »The Diseased Plant» försvaras bl.a. med att huvudvikten är lagd på sjukdomarna — ej på sjukdomsalstrarna, och med att De Bary och Berkeley, då de började den vetenskapliga växtpatologin vid mitten av 1800-talet, just sysslade med den sjuka plantan. I fortsättningen definieras orden växtpatologi och växtsjukdom, och i samband därmed kommer förff. in på problemet vetenskap contra praktisk verksamhet. Personalen tycks inte räcka till för båda verksamhetsgrenarna i USA — lika litet som i Sverige — och vetenskapen kommer härigenom, enl. förff., att lida mest. I nästa kapitel behandlar J. G. ten Houten växtpatologins förhållande till andra vetenskaper. Den måste få hjälp från andra botaniska vetenskapsgrenar men lämnar också bidrag igen. Växtsjukdomarnas inverkan på folkhälsan berörs också något liksom möjligheterna att bekämpa patogenerna. I samband härmed påpekas emellertid även riskerna ur folkhälsosynpunkt med användandet av stora mängder kemikalier på växterna. G. W. Keitt redogör för växtpatologins historia och K. Starr Chester tar upp problemet växtsjukdomar och skördeförlust. Olika metoder för att bedöma sjukdomens intensitet liksom för insamling av material behandlas. Förf. presenterar också en del formler för korrelationen mellan sjukdomsintensitet och skördeförlust.

Efter dessa inledande redogörelser följer sex kapitel, som vardera behandlar en huvudprocess hos den sjuka plantan, eftersom växtsjukdom tidigare definierats som en process. I det första av dessa redogör Akhtar Husain och Arthur Kelman för vävnadsupplösning. Först beskrivs den enskilda cellens nedbrytning

och därefter skador på olika vävnadstyper med talrika exempel på skadegörare, främst bakterier och svampar. Armin C. Braun analyserar inverkan av virus, bakterier, svampar, kvalster, bladlöss och andra insekter på tillväxten. Framställningen är beledsagad av talrika exempel och även några teckningar och fotografier. Störningar i reproduktionen behandlas av Antonio Ciccarone. Det mesta utrymmet ges här åt rent fysiologiska förhållanden men även infektionssjukdomarna representeras. C. Sempio har skrivit ett kapitel betitlat »The Host is Starved». De direkta bristsjukdomarna på grund av brist på näringsämnen i marken behandlas inte, utan endast de hungersymtom, som uppkommer genom att en parasit angriper och utnyttjar den befintliga näringen eller stoppar tillförseln av denna till vissa delar av värdväxten. Framställningen belyses av talrika exempel och tabeller över förhållanden, som uppstår, då värdväxten angripes av t.ex. rostsvampar. D. Subramanian och L. Saraswathi-Devi redogör för de rubbningar som inträder, då plantan ej får tillräckligt med vatten, och framhåller, att den primära effekten av ett sjukdomsangrepp tycks röra vattentillståndet i cellen. Detta i sin tur påverkar sedan metabolismen på olika sätt. Förff. påpekar dock, att det ofta är svårt att påvisa, att en viss process orsakar en annan. Snarare är det fråga om en samverkan. Den sjätte och sista huvudprocessen hos den sjuka plantan, nämligen respirationen, behandlas av Ikuzo Uritani och Takashi Akazawa. Förändringarna av respirationen hos infekterade plantor åskådliggöres med en rad tabeller och diagram.

Växternas möjligheter att försvara sig mot sjukdomsangrepp skärskådas ur histologisk och fysiologisk-biokemisk synpunkt i två kapitel av S. Akai resp. Paul J. Allen. Det förstnämnda av dessa är mycket rikt på instruktiva teckningar av histologiska preparat. K. O. Müller svarar för ett omfångsrikt och högintressant kapitel om hypersensitivitet. Återigen får rostsvamparna tjäna som exempel, mycket beroende på att hypersensitivitetsreaktioner första gången beskrevs 1902 just vid en rostinfektion. Åtskilliga andra svampar behandlas emellertid, liksom bakterier och virus. Även insekter och nematoder omnämnes i korthet, då de kan ge upphov till liknande reaktioner. Miljöns inverkan på hypersensitivitetsreaktionen beröres också. Enbart i detta kapitel finns mer än 200 litteraturhänvisningar. Första volymen avslutas med ett kapitel om predisposition av C. E. Yarwood och ett om terapi av F. L. Howard och J. G. Horsfall.

Volume II: The Pathogen. New York 1960. 715 s. — $22.00.

Liksom i första volymen är medarbetarna i denna del hämtade från flera länder. Av de 18 författarna har 8 sin verksamhet förlagd till USA, 5 till England, vardera två till Canada och Indien och en till Nya Zeeland.

Den andra volymen inleds liksom den första med ett kapitel av utgivarna, där orsaksbegreppet utreds och en del definitioner ges, och George L. McNew behandlar den äkta parasitismen, d.v.s. det förhållandet att parasiten gör så liten åverkan som möjligt på värdväxten, för att så länge som möjligt själv erhålla näring.

Med nästa kapitel, »The Multiplication of Viruses» ov F. C. Bawden, inleds den del av volymen, som handlar om patogenism (syn. patogenicitet), d.v.s. förmågan hos en patogen att alstra sjukdom hos värdväxten. Först behandlas reproduktionen. Kapitlet om virus bygger till största delen på studier av tobaks-

mosaikvirus. Reproduktionen hos bakterier, aktinomyceter och svampar belyses av Lilian E. Hawker bl.a. med flera teckningar av olika typer av förökningssätt, och om sporgroning skriver Vincent W. Cochrane. Här behandlas också sporernas mognadsprocess och förmåga att bevara vitaliteten under lång tid. I samband därmed kommer också förf. in på de moderna metoderna för laboratoriemässig lagring av sporer. Ämnets stora omfattning belyses av mängden litteraturcitat. Över 200 arbeten finns upptagna i referensavdelningen.

Avdelningen om patogenismens natur börjar med två kapitel om den mekaniska resp. kemiska förmågan hos patogenen att bryta igenom olika barriärer hos värdväxten. De har skrivits av Sidney Dickinson resp. R. K. S. Wood. Därefter följer ett kapitel om den växelverkan som uppstår i marken mellan patogen, andra jordmikroorganismer, jorden själv och värdväxten. Förff. är T. S. Sadasivan och C. V. Subramanian. De redovisar en mängd intressanta saker, bl.a. tas den teorin upp, att mikroorganismer i jorden skulle kunna tjäna som mellanvärd för virus, som är sjukdomsalstrande på högre växter. R. A. Ludwig behandlar toxiner, som bildas av patogenen eller vid samverkan patogen-värdväxt. Kapitlet »Heterokaryosis, Saltation, and Adaptation» av E. W. Buxton visar att variationen hos patogenerna, och därav följande variation i patogenicitet, är mycket stor. Förf. påpekar emellertid att många frågor ännu är olösta på detta område. I förbigående kan här nämnas att bildnumren på sid. 371 blivit felaktiga. Avdelningen om patogenismens natur avslutas med genetik av T. Johnson.

Som en sista avdelning kommer fyra kapitel om bekämpning av de patogena organismerna. Först behandlas virus-inaktivering in vitro och in vivo av R. E. F. Matthews varefter följer två avsnitt om fungicider. I det första av Hugh D. Sisler och Carroll E. Cox behandlas fungitoxiciteten ur fysiologisk synpunkt med många exempel och en stor litteraturförteckning. I det senare redogörs för fungicidernas kemi av Saul Rich, som förutspår en lysande framtid för fungiciderna efter att ha dragit paralleller med insecticidernas utveckling. Volymens sista kapitel handlar om nematocider och är skrivet av M. W. Allen. Framställningen faller något ur ramen jämfört med övriga bidrag till de båda första volymerna. Här refereras nämligen en rad praktiska försök med beräkningar över lönsamheten vid användande av dessa bekämpningsmedel. Förklaringen till detta är emellertid, som förf. avslutningsvis framhåller, att man ännu praktiskt taget inte vet något om det sätt på vilket nematociderna verkar.

Det är mycket få anmärkningar som kan riktas mot detta verk. För en svensk läsare är det emellertid ofta mycket förvirrande och intetsägande med de engelska beteckningarna på vissa sjukdomar. Endast ett exempel: Slår man upp »wheat rust» i registret i volym I, finner man hänvisning till fyra ställen. På sid. 8—9 står endast talat om »wheat rust». På sid. 290 gäller hänvisningen *Puccinia triticina* och på sid. 291 *P. graminis tritici*. På sid. 593 finns återigen endast benämningen »wheat rust». Då måste man ju fråga sig om »wheat rust» i första och sista fallet skall betyda brunrost på vete eller svartrost på vete. Utgivarna hävdar i både volym I och II att man ej bör använda de latinska namnen vid sjukdomarna, eftersom man då i de flesta fall namngiver patogenen och inte sjukdomen. Skall emellertid varje språk ha sina egna beteckningar på sjukdomarna utan någon internationell gemensam nämnare, torde förvirringen

bli ännu större än om man medvetet begår det felet att benämna patogenen, där så ske kan. En lösning är också att använda det skrivsätt som t.ex. T. Johnson gjort på sid. 408 i volym II: ». . . yellow rust (caused by *Puccinia glumarum*), . . .». För att eliminera dessa förväxlingsrisker finns ju också möjligheten att använda bilder av typiska sjukdomssymtom. Man skulle kunnat önska mera av detta uttrycksmedel i vissa avsnitt av verket, trots att det inte är avsett att vara någon elementär lärobok.

Insekterna borde nog fått en något utförligare behandling, även om detta, såsom utgivarna påpekar, ej är vanligt i växtpatologiska verk i USA men väl i Europa. Oftast förorsakar väl insekterna mera direkt skada än sjukdom, men gränsdragningen mellan dessa definitioner kan vara nog så besvärlig. Om t.ex. en hallonplanta vissnar kan detta bero på angrepp av kransmögel (*Verticillium alboatrum*) eller på att en larv av hallonglasvinge (*Bembesia hylaeiformis*) finns inuti stammen. Vitaxighet hos vete kan bero på angrepp av rotdödarsvamp (*Ophiobolus graminis*) eller halmstekelns (*Cephus pygmaeus*) larv. I samtliga fall är det fråga om en fysiologisk störning i värdväxten, således en process, d.v.s. en sjukdom enl. tidigare definition.

De gjorda anmärkningarna förringar inte verkets värde. Till de stora förtjänsterna måste räknas den oerhörda mängden hänvisningar till källmaterialet. Volym I innehåller sammanlagt 89 sidor referenser och volym II 78. Dessa kompletteras sedan med ett samlat författarregister i slutet av varje volym med hänvisning dels till texten, dels till referensavdelningarna efter varje kapitel. Dessutom finns ett utförligt sakregister, som omfattar 50 resp. 58 sidor i de båda volymerna.

Verket har en tilltalande typografisk utformning med en väl genomförd rubriksättning, som gör det lättläst i de allra flesta fall. En viss ojämnhet därvidlag är dock ofrånkomlig då så många författare bidragit. Helhetsintrycket är emellertid mycket gott.

I. Björkman

Maps of distribution of Norwegian vascular plants. Edited by Knut Fægri, Olav Gjærevoll, Johnnes Lid, Rolf Nordhagen. Vol. I. Coast plants. By Knut Fægri. Introduction by Rolf Nordhagen. Oslo University press, Oslo 1960. 134 s., 54 planscher (kartblad).

Den norska floran erbjuder ur svensk synpunkt mycket av intresse, genom de många markanta avvikelserna som följer med det geografiska läget och de topografiska förhållandena. Det är därför också för oss mycket tacknämligt, att ett stort kartverk över Norges växter börjat utkomma, vars första del, författad av Knut Fægri, behandlar kustväxterna. Bland de arter som är medtagna i del I är inte de egentliga strandväxterna, vilka är avsedda att behandlas i en annan del av verket, men f.ö. alla landväxter som i Norge är inskränkta till kustområdena; några kritiska arter är t.v. utelämnade. Av stort intresse är de många utpräglat oceaniska arter som behandlas, t.ex. *Asplenium marinum, Hymenophyllum peltatum, Carex binervis, Luzula congesta, Scilla verna, Corydalis claviculata, Vicia orobus, Conopodium majus* och *Erica cinerea*. Efter några inledande allmänna kapitel utgöres huvuddelen av arbetet av en speciell redogörelse för samtliga medtagna arter, med utbredningskartor och beledsagande text.

För att börja med kartorna, som utan tvivel utgör bokens viktigaste del, så ger de en utmärkt bild av de olika arternas utbredning. De är samtliga prickkartor, i relativt stor skala (1 : 7 milj.), och det framgår tydligt, att ett noggrant källkritiskt arbete ligger bakom man kan nog säga varje prick; bl.a. har det använts ej mindre än 10 olika symboler för att ange förekomsternas natur och vilka källor uppgifterna bygger på (och dessutom anges i vissa fall med en elfte symbol bevisligen felaktiga uppgifter). Härigenom får man exakta och objektiva utbredningsbilder, som med hänsyn till det omfattande förarbetet också kan antagas vara representativa för arternas förekomst.

I anslutning till kartorna behandlas varje art även i en kort men innehållsrik text. Det redogöres här för de äldsta fynden, den aktuella utbredningen summeras och kritiska lokaluppgifter behandlas; ibland ingår förf. även på taxonomiska frågor. Framför allt diskuteras emellertid artens växtgeografiska ställning och utbredningsvillkor. Klimatförhållandena: temperatur och nederbörd, anses som de viktigaste utbredningsbetingelserna; stundom tillmätes även människans medverkan en stor betydelse för spridningen. Månadsisotermer har — framhåller förf. i inledningen — ej någon direkt betydelse för växtgränserna, men det finns en viss korrelation mellan dem och de avgörande temperaturfaktorerna. Han gör därför inget försök att nå fram till en finare metodik utan anser det ej oriktigt att karakterisera t.ex. utbredningsgränsen för *Asplenium adiantum-nigrum* med en viss januari-isoterm, om man endast är medveten om att förhållandena i själva verket är mera komplicerade. — I samband med den växtgeografiska diskussionen hade man nog önskat en kort översikt över vederbörande arts totalutbredning; uppgifter av detta slag saknas dock.

Det typografiska utförandet, såväl beträffande text som bilder, är förstklassigt, och om kommande delar ger en lika god bild av de grupper de kommer att behandla, så får vi ett förnämligt standardverk över Norges flora.

H. Hjelmqvist

Jiří Komárek—Hanuš Ettl: Algologische Studien. — Verlag der Tschechoslowakischen Akademie der Wissenschaften. Prag 1958. 358 sid. Pris Kčs 41.50.

Boken innehåller arbeten av två olika författare. Det första och största behandlar cyanophycéer, de två övriga grönalger.

Bland blågrönalgerna avvaktar man alla systematiska arbeten med intresse. Inom denna alggrupp återstår ännu mycket att göra för att få reda i de taxonomiska problemen. Vad som först krävs är självständiga förutsättningslösa studier omfattande ett så stort observationsmaterial som möjligt. Komárek har enbart arbetat med planktonformer men därvid försökt tränga in i samtliga arters samhörighet och differenser, även fast flera av dem inte förekommer i ČSR. Det är en god sak att begränsa sig, frågan är bara, om i detta fall inte monografiska studier skulle ge mer.

K. har en god beläsenhet och försöker ta kritisk ställning till samtliga taxonomiska arbeten som utkommit, således även det amerikanska av Drouet—Daily, som annars européerna gärna förbigår. Hans arbete är av stort värde, inte minst därför att K. behärskar den ryska litteraturen, som för övrigt i alldeles för liten utsträckning beaktas av oss västeuropéer. Beklagligtvis ställer språksvårigheterna rätt stora hinder i vägen. Önskemål om översättning till ett

västerländskt språk föreligger bland forskare på området, men en sådan stöter givetvis på ekonomiska svårigheter.

K:s avhandling gör nog på många ett allmänt sympatiskt intryck, eftersom den reducerar antalet arter inom släkten som hittills varit ganska svåra att komma tillrätta med. Så t.ex. slår han ihop *Microcystis*-arterna *pulverea, incerta, holsatica* och *stagnalis* till en art, *D. incerta.* Även inom *Chroococcus* och *Anabaena* gör han förenklingar genom att slå samman arter. Inom släktet *Microcystis* företar han en hel del andra förändringar. Detta allmänt brukade namn har för övrigt fått vika för det legala *Diplocystis,* som dock knappast kommit för att stanna, eftersom Committee for algae har röstat för konservering av namnet *Microcystis* Lemm. 1907. K. betvivlar *M. botrys, M. chroococcoidea* och *M. ichtyoblabe,* och *M. elabens* för han till *Aphanothece.* Han behåller fem arter bara: *D. incerta, aeruginosa* [=*M. flos aquae* (Wittr.) Kirchn. em. W.-L., Teiling], *nováčekii* [=*M. marginata* (Menegh.) Kütz.], *viridis* och *wesenbergii* [=*M. aeruginosa* (Kg.) em. W.-L., Teiling]. De nya artnamnen torde inte bidraga att minska förvirringen inom *Microcystis*-nomenklaturen. Att lägga märke till är, att han helt accepterar Teilings arter, han endast korrigerar namnen. Bland andra omflyttningar noterar man, att den allmänt bekanta *Coelosphaerium naegelianum* överförts till *Gomphosphaeria* liksom några andra arter inom samma släkte, detta av morfologiska skäl och sannolikt med stor rätt.

En ytterligare förtjänst har arbetet. K. meddelar där noggranna uppgifter om de olika arternas vegetationscykel. Sådana har tidigare i stor utsträckning saknats eller varit mer eller mindre bristfälliga. Alla teckningar och fotografier är av god klass.

Som jag redan antytt beträffande blågrönalgerna torde knappast något annat än en monografisk bearbetning lösa de taxonomiska problemen inom en alggrupp. Ettl utlovar i sin uppsats om *Volvophyceae* en framtida monografi och betraktar här föreliggande uppsats som ett led i en sådan monografi, inte minst genom den diskussion han hoppas den skall framkalla. Han bygger sitt eget nya, från de tidigare existerande något avvikande system på de pulserande vakuolernas antal och läge, karaktärer, som han anser synnerligen konstanta. Han menar sig på så sätt lätt kunna särskilja t.ex. *Chlamydomonas* och *Chlorogonium,* vilket annars är förenat med vissa svårigheter. *Carteria* har uppdelats i två släkten på grund av de pulserande vakuolernas olika läge och antal. Endast specialister kan naturligtvis bedöma giltigheten av detta system, som emellertid vid en första granskning verkar ganska så bestickande. I den följande speciella delen behandlas nya och föga bekanta arter. Många arter har överförts i andra släkten än de nuvarande, huvudsakligen beroende på beskaffenheten av de pulserande vakuolerna. Även icke-specialister torde ha nytta av Ettls arbete. Han upptar t.ex. till diskussion alla nu kända arter av *Chlorogonium* och *Chlamydomonas,* och eftersom den tillgängliga bestämningslitteraturen är gammal, hälsas givetvis alla moderna sammanställningar med glädje.

Ettl behandlar också systematiken inom ordningen *Chlorangiales,* som hör till de minst undersökta inom chlorophycéerna. Han använder även här de pulserande vakuolerna för att särskilja de olika familjerna. Däremot betvivlar han det systematiska värdet av gallertstjälkarnas förgrening och närvaron resp. frånvaron av pyrenoider och slår därför samman *Chlorangium* och *Chloran-*

giopsis. Till det förstnämnda släktet för han även några av Skuja som *Characiochloris* beskrivna arter. Ettl torde väl ha anledning att motse kritik från andra specialister, vars nybeskrivna arter han flyttat om och givit andra släktnamn. Redan i boken har kritiska anmärkningar tillfogats av den vetenskaplige redaktören.

Såväl Komáreks som Ettls arbeten är av stor värde. De måste stimulera den taxonomiska forskningen inom resp. alggrupper, inte minst därför att deras resultat vilar på mångåriga observationer av levande material.

ASTA ALMESTRAND

A. TAKHTAJAN: Die Evolution der Angiospermen. Gustav Fischer Verlag, Jena, 1959. 344 s.

Den ryske forskaren A. Takhtajan har sedan länge varit verksam inom den botaniska evolutionsforskningen och har med ovannämnda arbete samlat sig till en större allsidig överblick. Arbetet innehåller såväl en allmän del, vilken behandlar de olika organens evolution, som en speciell, där angiospermernas system avhandlas. Inledningsvis diskuteras några allmänna principfrågor och frågan om angiospermernas uppkomst: förf. anser att de härstammar från gymnospermerna och utvecklat sig monofyletiskt, varvid *Magnoliales* mycket bestämt hålles för den mest primitiva ordningen; ej utan skäl prydes bokens omslag av en *Magnolia*-blomma. I den allmänna delen avhandlas vidare evolutionen av de vegetativa organen och deras ledningssystem, samt därefter blommans och blomställningens utveckling. Blomman anses ha uppkommit ur en strobilus av gymnosperm-typ, varvid den tvåkönade, insektpollinerade blomman anses mest ursprunglig. Såväl ståndare som fruktblad anses vara verkliga bladbildningar, i överensstämmelse med den klassiska uppfattningen men i motsättning till den s.k. nya morfologien, från vilken förf. bestämt tager avstånd. I fråga om blomställningens utveckling beskrives hur den racemösa kan utvecklas ur den cymösa, men det framhålles att utvecklingen också kan gå i motsatt riktning. Fröämnet anses i sin ursprungliga form vara bitegmiskt och det yttre integumentet antages motsvara en cupula, det inre — i anslutning till en teori av Benson — vara bildat av sterila makrosporangier i ett synangium, där endast ett sporangium fungerar och blir till nucellus.

Givetvis är det i många fall svårt att säga, vad som är primitivt och vad som är härlett. I allmänhet kan man nog emellertid hålla med författaren. I några fall känner man sig dock något tveksam inför författarens metodik; han anför beträffande en del karaktärer som skäl för att de är primitiva, att de förekommer hos grupper som är primitiva (enligt hans mening); slutledningen bör väl gå i motsatt riktning, så att av karaktärerna drages slutsatser om resp. grupps ställning. Särskilt beträffande en del embryologiska karaktärer ställer man sig något skeptisk inför författarens åsikter.

I den speciella delen av boken gör förf. en indelning av dikotyledonerna i 13 större grupper, »Überordnungen». Först placeras *Polycarpicae*; förf:s uppfattning om denna grupps ursprunglighet torde vinna allmänt instämmande. Följande grupp är *Amentiferae,* som anses kunna härledas från *Polycarpicae* via *Trochodendrales* och *Hamamelidales*; båda dessa ordningar föres till *Amentiferae*. Förf. ansluter därmed till åsikter som uttalats bl.a. av Hallier, dock

på ganska svaga grunder. Även om förf:s egna resonemang är starkare, så är dock härledningen i hög grad osäker, och det är väl i varje fall ej troligt att förhållandet mellan *Polycarpicae* och *Amentiferae* är så enkelt som förf. framställer det. Beträffande sympetalerna gör förf. en viss uppdelning, vilket ju är fullt motiverat, när det gäller ett naturligt system. Ordningen *Plumbaginales* föres sålunda till *Centrospermae,* varmed den utan tvivel också är besläktad, och gruppen *Heteromerae,* dit bl.a. *Ericales* hör, placeras intill *Cistiflorae* med anslutning till den häri ingående ordn. *Theales.* Huvuddelen av sympetalerna föres dock till två grupper, *Tubiflorae* och *Campanulatae,* som placeras sist bland diktotyledonerna.

Monokotyledonerna indelas på motsvarande sätt i 5 större grupper: *Helobiae, Liliiflorae, Juncif lorae, Farinosae* (*Enantioblastae*) och *Spadiciflorae.* Gräsen föres till *Farinosae,* där de ansluter sig till *Restionales,* med vilka utan tvivel en hel del likheter kan konstateras.

Det skulle föra för långt att i detalj ingå på Takhtajans systematik. Många av hans åsikter förefaller välgrundade, andra uppkallar till opposition, som det ofta är fallet i sådana frågor. Framställningen är emellertid intressant och läsvärd; förf. motiverar sina åsikter på ett klart och lättfattligt sätt och visar sig behärska en omfattande litteratur på området.

H. Hjelmqvist

Gunnar Seidenfaden and Tem Smitinand: The orchids of Thailand. A preliminary list. The Siam Society, Bangkok 1959, utländsk distribution: Munksgaard, Köbenhavn. Part I—II, 1. 184 s., 5 pl.

Thailands orkidéflora är ovanligt rik och intressant, men är trots detta mycket ofullständigt bearbetad. Det är alltså på goda grunder som de båda författarna av det ovannämnda verket beslutit att redovisa sina samlingar och observationer, trots att ingen av dem egentligen är orkidé-specialist utan deras orkidéintresse närmast är att betrakta som en hobby vid sidan om andra botaniska huvudintressen. De har gjort vidsträckta resor och omfattande insamlingar, men på grund av svårigheten att få tillgång till all erforderlig litteratur och de i Europa befintliga samlingarna har de endast utgivit vad de anspråkslöst kallar en »preliminary list». De har här förtecknat samtliga orkidéer som av dem själva eller andra konstaterats för Thailand. Det är dock mycket mer än en förteckning, då den innehåller talrika systematiska diskussioner samt bestämningsnycklar. Av ett särskilt värde är att de gjort detaljerade teckningar av alla arter av vilka de haft användbart material; dessa ritningar visar systematiskt viktiga karaktärer i blommans byggnad o.s.v. och kommer att bli en värdefull tillgång för kommande arbeten på området. Ett antal färgfotografier finns också, visserligen inte så många, 5 planscher med sammanlagt 20 bilder, men av hög kvalitet.

Med berömvärd återhållsamhet har förff. avstått från att uppställa nya arter i de fall, då deras fynd ej kunnat inpassas i tidigare artbeskrivningar; med hänsyn till de nämnda svårigheterna att jämföra med de europeiska museernas herbariematerial upptages sådana arter endast som »sp.» men med beskrivningar och avbildningar. Åtskilliga av dem kommer väl att visa sig vara nya för vetenskapen.

Med hänsyn till det rikliga och utförligt behandlade materialet blir detta verk en värdefull källa att ösa ur för kommande forskningar på området, och det bör vara av värde även för orkidé-samlare, som i sina odlingar givetvis ofta har i Thailand inhemska arter.

H. HJELMQVIST

C. POSTMA: Växternas mosaik. Med förord av Nils Fries. Natur och Kultur 1960, 173 s., därav 77 s. planscher.

Den holländske läkaren C. Postmas bok »Växternas mosaik», som samtidigt utkommit på fem olika språk, vänder sig väl främst till den intresserade amatören. Genom sina goda fotografiska avbildningar av olika morfologiska och anatomiska motiv är den dock även av intresse för fackmannen och kan också vara till nytta för undervisningsändamål. De motiv som behandlas blir i allmänhet illustrerade med en serie bilder i allt större förstoring, som belyser vissa organ och deras finare struktur, så att man steg för steg föres allt djupare in i detaljerna. Som exempel kan nämnas de bilder som visar cellens allmänna byggnad: här visas först en *Tradescantia*-blomma i svag förstoring, därefter en ståndare med sina hår i något större skala, sedan några av håren vid starkare förstoring (×175) med pärlbanden av celler synliga, och till slut en enstaka cell vid 1100 gångers förstoring. Andra bildsviter visar stamanatomien hos en del växter, särskilt utförligt hos barrträden, där de starkaste förstoringarna bl.a. visar vackra bilder av gårdporerna. De anatomiska motiven är återgivna i kopior efter diapositiv, så att objektet är ljust och bakgrunden mörk, vilket utan tvivel är fördelaktigt för tydligheten. Bland goda detaljillustrationer kan utom bilderna av gårdporer även nämnas en bild av sklerenkymceller hos *Lilium* (×3300) och av *Iris*-rotens endodermisceller (×2000). En särskild bilaga redogör för den fotografiska metodik som använts.

Beträffande en av bilderna kan man möjligen ifrågasätta, om tolkningen av motivet är den rätta; det gäller nr 32, som skall visa en ung, tvåkärnig embryosäck; med hänsyn till den allmänna formen, kärnornas läge och det väl utvecklade mantelskiktet torde det vara mera troligt att det är en färdig embryosäck, där endast äggcellens kärna och centralkärnan är synliga.

Den text som åtföljer bilderna har ju närmast karaktären av förklaringar till dessa, men den söker samtidigt sätta in företeelserna i större sammanhang, på ett lättfattligt sätt; det omnämnes också en del aktuella forskningsuppgifter, som väntar på bearbetning. En del smärre fel eller olämpliga termer, som insmugit sig, beror väl delvis på översättningen, som att »kalk» användes i betydelsen foder, att det om maskrosens blomfäste förutom den riktiga beteckningen även användes termen »blomaxel» och att bild 47 uppges visa 3 »kärl» i stället för kärlsträngar i marhalmens blad. När det vidare säges att det hos vete (bild 7) finnes en svällkropp och att det hos *Larix* finns en fröknopp (ett fröämne) på varje kottefjäll, så bör antalet i båda fallen ökas till 2. Dessa små inadvertenser har ju dock ej någon större betydelse och minskar ej bokens användbarhet för enskilda studier eller undervisningsändamål.

H. HJELMQVIST

K. GRAM og K. JESSEN: Træer og buske i vintertilstand. 2. forøg. udg. ved K. GRAM. København 1960. Gyldendal. 115 s. Kr. 10.75.

Även om det är lättare att skilja på olika träd och buskar, när de bär blad och eventuellt också blommor, så saknas det inte igenkänningstecken för de kala lignoserna, och vissa drag är rent av mer framträdande om vintern. Gram-Jessens lilla handbok är avsedd att hjälpa intresserade att »blive dus med træerne og buskene», även när blad, blommor och frukter är avfallna, och den ger onekligen mycket rikliga anvisningar om hur det skall gå till. Inledningsvis ges en översikt över de vedartade växternas allmänna byggnad med speciell hänsyn till de karaktärsdrag, som kan iakttagas om vintern och utnyttjas för bestämningar. Därefter följer utförliga bestämningsnycklar i tre olika avdelningar; den första och mest utförliga behandlar lövfällande träd och buskar, den andra de vintergröna lövträden och -buskarna, den tredje och sista barrträden. Dessa bestämningstabeller illustreras med en del teckningar eller — för barrträdens del — med fotografier av skott eller skottdelar i svag förstoring, alla tydliga och instruktiva (inom parentes kan nämnas, att beteckningarna på fig. 15 b och c blivit omkastade). De arter som är medtagna i boken är i Danmark inhemska träd och buskar samt de viktigaste och vanligaste bland de endast i odling förekommande; särskilt kanske när det gäller olika barrträdssläkten, är listan omfattande och bör kunna vara till god hjälp vid alla bestämningsarbeten, både vinter och sommar.

H. HJELMQVIST

Notiser

Docentförordnanden. Till docenter ha förordnats: Vid Lunds universitet fil. dr Pär Fransson, i fysiologisk botanik, vid Uppsala universitet fil. dr Aage Heiken, i genetik, och fil. dr John Eriksson, i botanik, samt vid Stockholms högskola fil. dr Måns Ryberg, i botanik.

Forskningsanslag. Jordbrukets forskningsråd har vid sammanträden den 4 april och den 1 juni utdelat anslag om sammanlagt 1.148.123 kr., huvudsakligen för fortsättning av tidigare påbörjade forskningsarbeten. Till nya undersökningar har utdelats: Till agr. J. E. Falemo, Espinära, 1.600 kr. för undersökning över frostens inverkan på kornets grobarhet i nordligaste Sverige, till agr. lic. I. Fernqvist, Alnarp, 5.400 kr. för studier av adventivrotbildningen hos *Phaseolus vulgaris* och *aureus*, till fil. dr O. Gelin, Landskrona, 2.891 kr. för undersökning av bakterieknölbildningen hos ärter, dess genetiska sammanhang och inflytande på odlingssäkerheten, till prof. Å. Gustafsson, Stockholm, 24.000 kr. för arbeten vid det nya caesium-137-aggregatet vid Bogesund, till doc. A. Hagberg och fil. lic. S. Ellerström, Svalöv, 15.000 kr. för försök att med speciellt utarbetad teknik framställa allopolyploider inom några olika växtgrupper, till agr. S. Håkansson och prof. E. Åberg, Uppsala, 20.000 kr. för biologiska studier rörande kvickroten som ogräs, till prof. H. Lamprecht, Landskrona, 17.000 kr. för genanalytiska studier av vild- och primitivformer av ärter och bönor samt deras kromosomstruktur, till prof. A. Müntzing, Lund, 14.760 kr. för undersökningar av strålningsinducerade klorofyllmutationer hos korn samt mutanter hos *Potentilla*-apomikter, till agr. G. Rösiö, Uppsala, 15.000 kr. för studier rörande beståndsutveckling och mikroklimat i bestånd av varierande täthet hos vårstråsäd, samt till doc. D. v. Wettstein, Stockholm, 30.650 kr. för elektronmikroskopiska undersökningar över genernas verkningssätt.