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Aerial and Terrestrial Algae in San-in Region of Honshû, Japan

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秋山　優：山陰地方における好気性藻類ならびに土表性藻類

Introductory

As one of the algal habitats, the soil surface has fairly complicated components of algal vegetation in spite of their restricted ecological fctors relating to the moisture condition. On the other hand, the characterized algal vegetation can be observed as a result of an adaptation to an aerial condition. It has been stated by G. S. West and F. E. Fritsch that an inconceivable number of algae are able to thrive on terrestrial and subterraneous conditions. In 1931, J.B.Petersen presented an account of the ecological study of algal vegetation of Hammer Bakker, and had recorded a number of *Cyanophyceae*, *Diatoms*, *Xanthophyceae* and *Chlorophyceae*, in addition, four species and one forma of *Chlorophyceae* were newly described.

In 1935, an excellent historical summary of the study of soil algae was given by J. B. Petersen. In this summary, through such studies as Graebner on the heaths of Germany, Warming on the biology of marshes, Fritsch on the terrestrial algae of the tropics, and the comments of Treub on Cyanophytan immigrants to Krakatoa he represents some of the earlier attempts at analyzing the algal vegetation of various habitats.

In 1932, an extremely aerobic alga *Fritschiella tuberosa* Iyengar was discovered by M. O. P. Iyengar from India. Later, the life history and the autoecology of this alga were studied by R.N. Singh (1941), and still later, J. Brook (1953, 1956) reported that the alga grew in Sudan of Egypt and had many peculiarities as a terrestrial alga.

Recently on the micro-flora of subterraneous algae, F. R. Trainor and H. Bold (1953) reported three new unicellular *Chlorophyceae* viz. *Hormotilopsis, Chlorococcum* and *Characium* from soil. Later, W. Herndon (1958) isolated certain new species of Chlorosphaeracean and Chlorococcacean algae from the soil of Jamaica, and G. Arce and H. Bold (1958) isolated certain new species of *Chlorophyceae* from Guban soils.

On ecological study of soil algal flora, L. M. Shields, C. Mitchell and F. Drouet (1957) investigated from the view that alga-and lichen-stabilized surface crusts would be soil nitrogen sources.

In 1926, H. Molisch made the first botanical report on epiphyllous algae in Japan. Now, S. Suematu has been studying on parasitic and epiphytic aerial algae such members as *Trentepohlia*, *Cephaleulos* and *Phycopeltis* in Japan, and several reports on those algae have been published. Recently, H. Hirose and the present author have newly collected a terrestrial alga *Fritschiella* *tuberosa* Iyengar from Japan. Later, an account of new records of several terrestrial and aerial algae from Japan has been given by the present author.

In this paper, the author wishes to report the preliminary survey dealing with an ecology of aerial and terrestrial algae in San'in region of Honshû, Japan.

The general aspects of the algal vegetation

1. Occurrence and the type of habitats

The distribution and the occurrence of the aerobic algae in San'in region, especially the type of habitats can be divided as follows viz.
i) soil surface (terrestrial type), ii) subterraneous (soil penetrating type), iii) stones and cliff surfaces (lithophytic type), iv) surface of land plants (epiphytic type viz. epiphyllous and epiphloeophytic type), v) inner tissue of land plants (endophytic and symbiotic type).

The terrestrial algae found in this region are such algae as *Fritschiella, Protosiphon, Oedocladium, Zygogonium, Cylindrocystis, Cosmarium, Botrydium, Vaucheria, Stigonema* and *Porphyridium*. The strictly terrestrial algae *Fritschiella, Botrydium* and *Protosiphon* are more abundant in moist areas than in dry areas. And usually, they are mostly associated with one another and can be found on the foot paths of rice-fields. On the contrary, *Zygogonium* and *Stigonema* are abundant in dry areas such as sandy slope, and usually they are associated with moss protonema.

The occurrence of the lithophytic algae found in this region is about the same in component as the terrestrial members. Algae growing on damp rocks are mostly filamentous *Cyanophyceae* especially *Stigonema* and *Scytonema*, but sometimes there are widely expanded colonies of certain species of *Trentepohlia* and large gelatinous masses of desmids, especially *Cylindrocystis* and certain species of *Cosmarium*. The filamentous *Cyanophyceae* and *Trentepohlia* are usually associated with such plants as moss protonema and lichen thallus.

Strictly aerial algae are found on the bark and leaves of higher plants. The epiphyllous algae found in this region are mostly *Phycopeltis* and *Protococcus*. In some cases, a small type of *Trentepohlia* and certain species of *Aphanocapsa* are found in epiphyllous condition but these are very rare. As epiphloeophytic algae, *Trentepohlia* and *Hormidium* are mostly abundant. But in some cases, no inconsiderable number of algae are able to thrive in epiphloeophytic condition viz. such algae as *Nostoc, Aphanocapsa, Protococcus, Trochiscia* and et. al. The most abundant species of such an endophytic or parasitic alga is *Cephaleulos virescens* Kunze. This alga grews as a subcuticular or as an intercellular parasite of the leaves of *Camellia* and *Thea*, and is widely distributed in this region. In some cases, *Trentepohlia willei* (Tiff.) Printz grows into the lenticel of barks as a subendophytic condition.

On the symbiotic algae such as gonidia of lichenes and the soil pennetrating algae which are usually unicellular organism and an important components of a micro-flora of subterraneous areas have not examined in the course of this study.

2. Ecological and physiological habits of algae

The type of colonization is an important characteristic relating to the results of an adaptation to an aerial condition. For both the terrestrial and lithophytic algae, each of their characterized colonization is an important rule of accumulation of water.

The type of colonization of the terrestrial and the lithophytic algae found in this region can be regarded as follows viz. i) forming a large mass with a common gelatinous envelop, ii) forming an expanded felt-like mass, iv) forming an association with another plants. *Cylindrocystis* sp. found in lithophytic condition has an amount of common gelatinous envelop, and the conjugation and the formation of zygospores occurs in that condition (pl. III. Fig. K.). In aquatic condition, the majority of the species of *Cosmarium* have not such a gelatinous envelop, but the materials found in terrestrial condition secrete an amount of gelatinous substance (Pl. III. Eig. N.). Such algae as *Aphanocapsa*, *Nostoc* and the palmelloid phase of certain algae are found as large mass of gelatinous colony. It is considerable that the gelatinous palmelloidal phase of certain algae is an adaptative phase of that algae in an aerial condition.

An interesting terrestrial alga *Fritschiella tuberosa* Iyengar forms usually densely aggregated colony. The colony of this alga is greenish nappy spots and 1-5 mm in diameter The portion of projecting system is densely compacted, thus, the water is well accumulated in their inter-thalloidal capillaric spaces. Such a densely aggregated colonization is also regarded in *Oedocladium* and the case of *Microthamnion* found on the surface of the foot paths of the rice-fields in the vicinity of Mt. Sanbei, Shimane Prefecture.

In such algae as *Hormidium*, *Trentepohlia*, *Scytonema*, *Stigonema* and in certain caces of *Vaucheria*, these algae form an expanded felt-like mass of those plants.

In such unicellular algae as *Ourococcus* and *Trochiscia*, the plants are intermingled with another higher plants such as moss protonema and certain species of *Hepaticae*. Frequently, the gelatinous substance of such algae as *Cylindrocystis* and *Coccomyxa* envelopes another species of unicellular algae.

On the relation between the growth pattern of *Fritschiella* and the environmental factor especially on its moisture condition, it is regarded that the trend to form clusters of prostrate portions occurs in dry condition while, the trend to form projecting system occurs in rather moist condition. These phenomena have been pointed out by H. Hirose and the present author in 1960. In *Oedocladium*, the rhizoidal development from the projecting system occurs in well moistened condition. And soon after, gemma are formed on the rhizoidal portion. By the presented rule of asexual propagation, the territory of this alga is widely expanded.

On the substrata of the terrestrial algae, *Zygogonium* grows usually on the surface of sandy slope and *Stigonema* grows on yellowish clayey mud. In *Oedocladium*, the type of substrata found in this region is variable. In the case of Mt. Sanbei, the substratum is dried blackish soil, and in the case of Hokki of Matsue city, the substratum is yellowish clayey mud. Although the *Fritschiella* found in India grows under highly alkaline conditions (pH = 9.5 to 11.1) of the soil, the materials found in this region grow under more acidy conditions. The pH value of this region where that alga thrives ranges from 4.8 to 7.1. It seems that the alga is strictly adaptable to the pH factors of their surrounding medium. The culture experiments have shown that the alga can grow under the variable conditions of pH values ranging from 3.0 to 11.0.

3. Reproduction and life history of algae

It is needless to mention that the asexual propagation in *Cyanophyceae* and red alga *Porphyridium* is commonly observed, but even in the majority of *Chlorophyceae* found in aerial condition the dominant phase during the year is that of vegetative condition, and the propagation is mostly asexual.

A fragmentation is an important rule of propagation in aerial condition. In such algae as *Hormidium*, *Microthamnion*, *Zygogonium* and all members of *Cyanophyceae*, the propagation is usually by means of vegetative fragmentation. A fragment usually regenerates soon after, and forms directly a new plant. Even in *Fritschiella* and *Oedocladium* which have motile iso-gametes or oogamous reproductive organs, the vegetative fragmentation occurs usually in the prostrate portion of *Fritschiella* and the projecting thread of *Oedocladium*.

Akinates are also frequently formed in such algae as *Zygogonium*, *Oedocladium* and *Botrydium*. These akinates directly germinate but in the case of *Botrydium* the zooids are formed later. It seems that the formation of akinates is a substitutional phenomenon relating to an extremely aerial condition of conjugation in *Zygogonium* and of oogamy in *Oedocladium*. Although a usual conjugation and oogamy occur in the presented algae, these phenomena are restricted in rainy season of this region. In *Zygogonium*, the formation of akinates occurs in any season of year but the conjugation occurs in the rainy period. As like as the above mentioned, the conjugation of *Zygnema* and *Cylindrocystis* and the oogamous reproduction of *Vaucheria* occur in the same period.

The autospore formation of several Chlorococcacean algae thriving in aerobic condition occurs in about the same condition as in aquatic condition.

Accordingly, it seems that the most important and the adaptative rule of propagation in aerial condition is by means of vegetative fragmentation, and it is considerable that the formation of akinates is one of the substitutional phenomena of a precarious zooidal phase.

On the life history of the aerial and terrestrial algae in San'in region, the trends of this phenomenon is strictly restricted to the seasonal change of climatic pattern. In *Oedocladium*, the oogamous reproductive phase occurs only in rainy season (June, July), later, in and after August, akinates are formed, and the plant found in this season may be a vegetative phase, a sporophyte. The culture experiments have shown that the germination of these akinates occurs early in the next spring.

In *Fritschiella* found in India the isogamous reproduction and the existence of an isomorphic alternation of generations were revealed by R. N. Singh but in the case of the materials found in this region, the zooidal phase has not been observed, and the dominant phase during the year is an asexual vegetative phase. The culture experiments have shown that the hibernation of this alga has been done morphologically in the form of regenerated type of the projecting system. It is possible that the fragmentative propagation of prostrate portion may occur after the subterraneous hibernation. The seasonal distribution of this alga as terrestrial macroscopic colonial phase can be observed from June to October.

With the exception of such a microscopic phase of akinate in *Oedocladium*, *Botrydium*, *Zygogonium* and a subterraneous hibernate stage in *Fritschiella*, the majority of the aerial and terrestrial algae found in this region can be observed in any season during the year. And the variation of the seasonal distribution or the succession of the algal vegetation in this region is scarce.

A list of aerial and terrestrial algae in San'in region

The following list includes thirty species of *Chlorophyceae*, three species of *Xanthophyceae*, eleven species of *Cyanophyceae* and one species of *Rhodophyceae*. All totals forty-five species.

The arrangement of the genera, families and orders is based upon G. M. Smith (1950).

CHLOROPHYCEAE

Order Tetrasporales

Family Palmellaceae

1. **Palmella miniata** Naeg. (Pl. I. Fig. A.)

   Note. Mostly the alga is associated with such alga as *Coccomyxa* and *Cylindrocystis*.

2. **Ourococcus bicaudatus** Grobéty (Pl. I. Fig. B; Pl. III. Fig. A.)

   Note. This alga is found on the damp soil surface and mostly the plant is associated with another terrestrial members. New to Japan.

3. **Coccomyxa subglobosa** Pascher? (Pl. I. Fig. C; Pl. III. Fig. B.)

Order Ulotrichales

Family Ulotrichaceae

4. **Hormidium flaccidum** (Kütz.) A. Brown (Pl. I. Fig. D.)

Family Chaetophoraceae

5. **Stigeoclonium** sp. (Pl. III. Fig. F.)
6. **Fritschiella tuberosa** Iyengar (Pl. I. Fig. E; Pl. III. Fig. E)

   Note. This alga was recorded as new to Japan by Dr. H. Hirose and the author in 1960.

7. **Microthamnion kuetzingianum** Naeg.

   Note. This alga was found on the foot-paths of rice-field located in the mountainous region of Sanbe, Shimane: rare.

Family Protococcaceae

8. **Protococcus viridis** Ag. (Pl. III. Fig. C.)

   Note. Frequently the sarcinous stage of this alga was found: common.

Family Trentepohliaceae

9. **Trentepohlia aurea** (L.) Hariot (Pl. I. Fig. F.)
10. **Trentepohlia willei** (Tiffany) Printz (Pl. I. Fig.H; Pl. III. Fig. G.)

    Note. This alga was reported as a newly found species from Japan by the author in 1960: common.

11. **Trentepohlia jolithus** (L.) Wallroth?
12. **Phycopeltis epiphyton** Millardet
13. **Phycopeltis arundinacea** (Mont.) De Toni?
14. **Phycopeltis irregularis** (Schmidle) Wille (Pl. I. Fig. I; Pl. III. Fig. H.)

    Note. This alga was reported as a newly found species from Japan by the author in 1960: rare.

15. **Cephaleulos virescens** Kunze (Pl. I Fig. G.)

Order Oedogoniales

Family Oedogoniaceae

16. **Oedogonium** sp.

    Note. Sterile filaments of this alga was found on the foot-paths of rice-field, but the occurrence of this alga is probably an artificial case.

17. **Oedocladium** sp. (Pl. III. Fig. M.)

    Note. The occurrence of sterile filaments of this alga was reported by the author, recently several mature filaments are collected but these are not examined in the course of this study.

Order Cladophorales

Family Cladophoraceae

18. **Rhizoclonium hieroglyphicum** (Ag.) Kütz. ?
Note. This alga was found on the damp rock near the stream.

Order Chlorococcales

Family Chlorococcaceae

19. **Chlorococcum humicola** (Naeg.) Rab.

Family Protosiphonaceae

20. **Protosiphon botryoides** (Kütz.) Klebs (Pl. I. Fig. K.)

Family Oöcystaceae

21. **Chlorella vulgaris** Beijerinck
22. **Trochiscia aspera** (Reinsch) Hansg. (Pl. I. Fig. J ; Pl. III. Fig. D.)
Note. This alga was found on the bark of trees : rare.

Order Zygnematales

Family Zegnemataceae

23. **Zygnema** sp.
24. **Zygogonium ericetorum** Kütz. (Pl. II. Fig. C ; Pl. III. Fig. J.)
Note. The conjugation of this alga was found : common.

Family Mesotaeniaceae

25. **Mesotaenium** sp. (Pl. II. Fig. A ; Pl. III. Fig. I.)
26. **Cylindrocystis brebissonii** Menegh. (Pl. II. Figs. B_1, B_2 ; Pl. III. Fig. L.)
27. **Cylindrocystis** sp. (Pl. III. Fig. K.)
Note. The colour of the cell sup of this alga is purpure; several inmatured conjugants was found.

Family Desmidiaceae

28. **Cosmarium furcatospermum** W. & G. S. West var. **koreana** Skv. ? (Pl. III. Fig. N.)
29. **Cosmarium decedens** (Reinsch) Racib. var. **sinuosum** (Lund.) Racib.
30. **Cosmarium** sp.

XANTHOPHYCEAE

Order Heterosiphonales

Family Botrydiaceae

31. **Botrydium granulatum** (L.) Grev.

Family Vaucheriaceae

32. **Vaucheria sessilis** (Vauch.) DC. ? (Pl. II. Fig. J)
33. **Vaucheria geminata** (Vauch.) DC. ? (Pl. II. Figs. K_1, K_2.)

BACILLARIOPHYCEAE

Several species belonged to the pennate diatom were collected but these are not examined in the course of this study.

CYANOPHYCEAE

Order Chroococcales

Family Chroococcaceae

34. **Aphanocapsa grevillei** (Hass.) Rabenh. (Pl. II. Fig. E ; Pl. III. Fig. R.)
Note. In some materials, the individual sheaths are observed.

Order Oscillatoriales

Family Oscillatoriaceae

35. **Schizothrix penicillata** (Kuetz.) Gom. (Pl. II. Fig. G; Pl. III. Fig. U.)

Family Nostocaceae

36. **Nostoc commune** Vauch.
37. **Nostoc** sp. (Pl. III. Fig. V.)

Family Scytonemataceae

38. **Scytonema mirabile** (Dillw.) Born. (Pl. II. Fig. F; Pl. III. Fig. P.)
39. **Scytonema hoffmanni** Ag. ? (Pl. II. Fig. H.)
40. **Microchaete uberrima** N. Carter?
41. **Stigonema hormoides** (Kuetz.) Born. et Flah. (Pl. II. Fig. H; Pl. III. Fig. T.)
42. **Stigonema minutum** (Ag.) Hass. (Pl. II. Fig. I.; Pl. III. Fig. S)
43. **Stigonema ocellatum** Thuret (Pl. II. Figs. D_1, D_2; Pl. III. Fig. O.)

Family Rivulariaceae

44. **Calothrix fusca** Born. et Flah. ? (Pl. III. Fig. Q.)

RHODOPHYCEAE

Order Bangiales

Uncertain position

45. **Porphyridium cruentum** (Smith et Sorerly) Naeg.

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Literature

Akiyama, M. **1960** : Noteworthy Fresh-wat. Alg. From Jap. *Coll. Ess. Comm. Shimane Univ. (1960) Natural Science* 98-104.

——— & H. Hirose **1960** : A Newly Found Terrestr. Alg From Jap., *Fritsehiella tuberosa* lyeng. *Bot. Mag. Tokyo* **73** : 361-368.

Arce, G. & H. D. Bold **1958** : Some *Chlor.* from Cuban soils *Amer. Jour. Bot.* **45** 492-503.

Emoto, Y. u. H. Hirose **1940** : Studien über die Thermalfl. von Jap. III (2). *Jour. Jap. Bot.* **16**: 405-420.

Forest, H. S. **1954** : Handbook of Algae.

Fritsch, F. E. **1956** : The Struct. and tbe Reprod. of Alg. 3rd Imp. Vol. 1 & 2.

Hazen, T. E. **1901** : The *Ulothr.* and *Chaetop.* of the U. S. *Mem. Torrey Bot. Club* **11** : 155-250.

Herndon, W. **1958** : Studies on chlorosphaeracean algae from soil. *Amer. Jour. Bot.* **45**: 298-308.

——— **1958** : Some new sp. of chlorococacean Alg. *Amer. Jour. Bot.* **45** : 308-323.

Hirano, M. **1943** : The Desm.-Flor. of the Oze-dist. III. *Acta Phytotax. et Geobot.* **XII** : 71-98.

——— **1952** : The Desm.-Flor. of Mt. Azuma and Gassan *ibid.* **XIV** : 168-173.

Hirose, H. **1937** : Some Cyanophycean Alg. from Hokk. I, III & IV *Jour. Jap. Bot.* **13**: 492-499; *ibid.* **13**: 794-804 ; *ibid.* **14** : 89-100.

Iyengar, R. N. 1941 : Fritschiella, A New Terrest. Menb. Of The *Chaet. New Phytol.* **XXXI** : 329-336.

———— **1951** : Chlorophyta (in *Manual of Phyeology* edit. by G. M. Smith)

Kamiya, T. **1957** : *Vaueheria* in Aichi prefecture *Hokur. Jour. Bot.* **VI**: 107-110.

Lutkemuller, J. **1913** : Die Gat. *Cylindrocystis* Menegh. *Verh. Zool,-Bot. Ges. Wien* **63**: 212-230.

Okada, Y. **1936** : Notes on Jap. Desm., with Special Refer. to the Newly Found Species III. *Bot. Mag. Tokyo* **50** : 313-317.

———— **1939** : Nippon Inkwa Syokubutu Dukan (edit. by Y. Asahina)

Pascher, A. **1914** : Die Susswasserfl. Deutschl., Oester. und der Schw. Heft 4, 6 u. 9.

Petersen, J. B. **1931** : The Alg. Veget. of Hammer Bakker *Bot. Tidsskr.* **42** : 1-48.

Prescott, G. W. **1951** : Alg. of the Western Great Lakes Area.

Printz, H. **1939** : Vorabeit. zu einer Monogr. der *Trentepohl. Nytt Magasin for Naturv.* **90**: 137-200.

Shields, L. M., Mitchell, C. & Drouet, F. **1957** : Alga-and lichen-stabil. surf. crusts as soil nitrog. sourc. *Amer. Jour. Bot.* **44** : 489-498.

Singh, R. N. **1941** : On Some Phases In The Lifehist. Of The Terrest Alg. *Fritschiella tuberosa* Iyeng., And Its Autecolong. *New Phytol* **XL** : 170-182.

Suematu, S. **1951** : Notes on *Cephal.* and *Phyeop.*, Parasit. and Epiphyt. Aerial-alg. II. *Gakugei Kenkyu* **II**. Fac. of Liber. Arts, Wakayama Univ. 59-63.

———— **1957** : Observ. on Sporangia of *Trentep. ibid.* **VII** : 21-29.

———— **1957** : Notes on *Cephal.* and *Phyeop.*, Parasit. and Epiphyt. Aerial-alg. III. *Bot. Mag. Tokyo* **70** : 276-279.

Tiffany, L. H. **1937** : Oedogoniales *North Amer. Flor.* **11** : part 1.

———— **1951** : Ecology of fresh-wat. alg. (in *Manual of Phyeolog.* edit. by G. M. Smith)

———— **1955** : Geogr. dist. of the North Amer. species of Oedog. *Amer. Jour. Bot.* **42** : 293-296.

———— **1952** : The alg. of Illinois.

Trainor, F. & H. C. Bold **1953** : Three new unicellular Chlor. from soil. *Amer. Jour. Bot.* **40** : 758-767.

Transeau, E. N. **1951** : Zygnemataceae.

West, G. S. & Fritsch, F. E. **1927** : A Treat. On The Brit. Fresh-wat. Alg.

Wolle, F. **1884** : Desemids of the U. S. and list of Amer. Pediast.

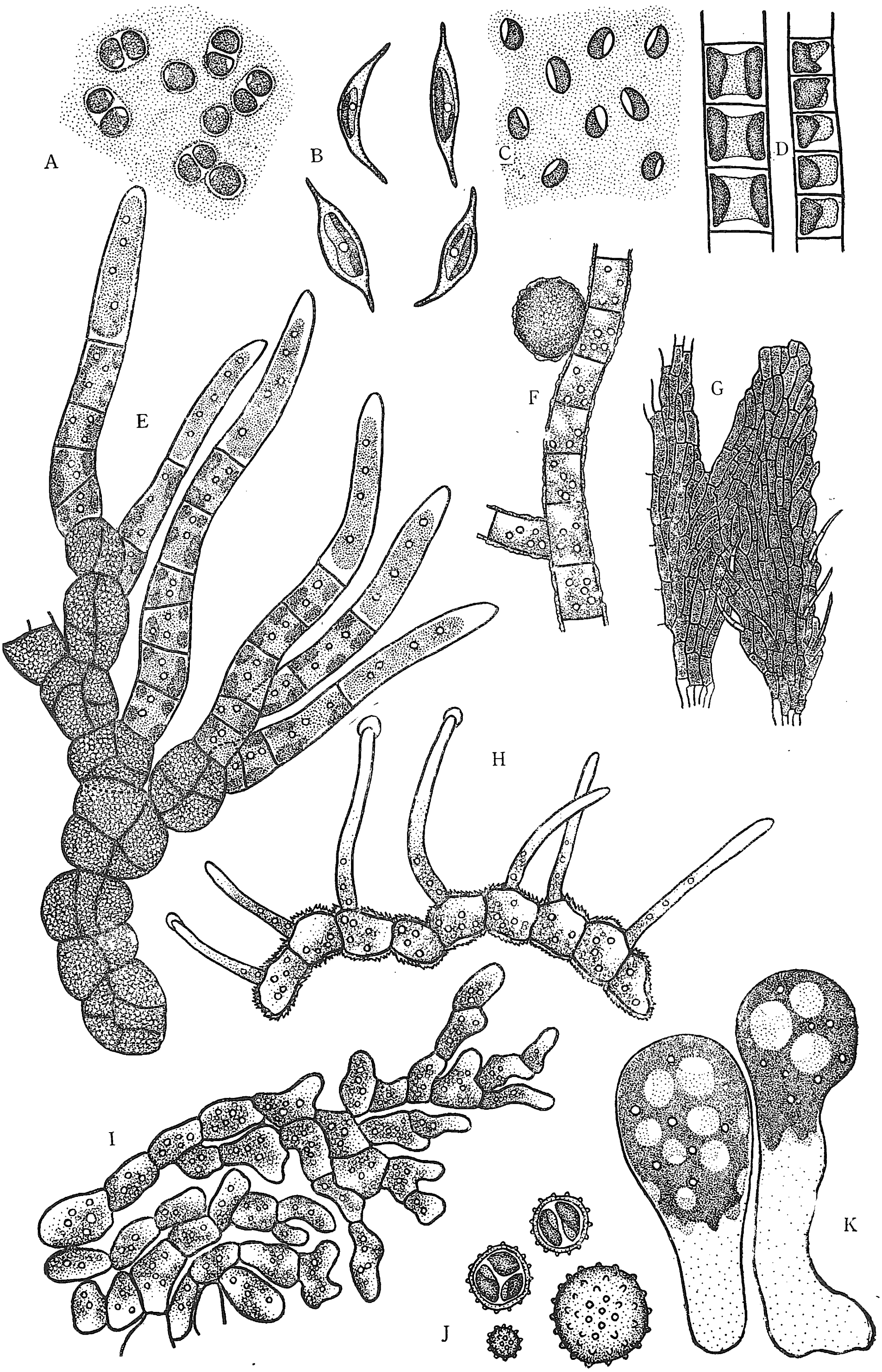
Yamagishi, T. **1959** : Genus *Vaueheria* in Jap. *Jour. Jap. Bot.* **34** : 72-85.

PLATE

Explanation of plate I.

Fig. A. *Palmella miniata* Naeg.
Fig. B *Ourococcus bicaudatus* Grobéty
Fig. C. *Coccomyxa subglobosa* Pascher?
Fig. D. *Hormidium flaccidum* (Kütz.) A. Brown
Fig. E. *Fritschiella tuberosa* Iyengar
Eig. F. *Trentepohlia aurea* (L.) Hariot
Fig. G. *Cephaleulos virescens* Kunze
Fig. H. *Trentepohlia willei* (Tiff.) Printz
Fig. I. *Phycopeltis irregularis* (Schmidle) Wille
Fig. J. *Trochiscia aspera* (Reinsch) Hansg.
Fig K. *Protosiphon botryoides* (Kütz.) Klebs

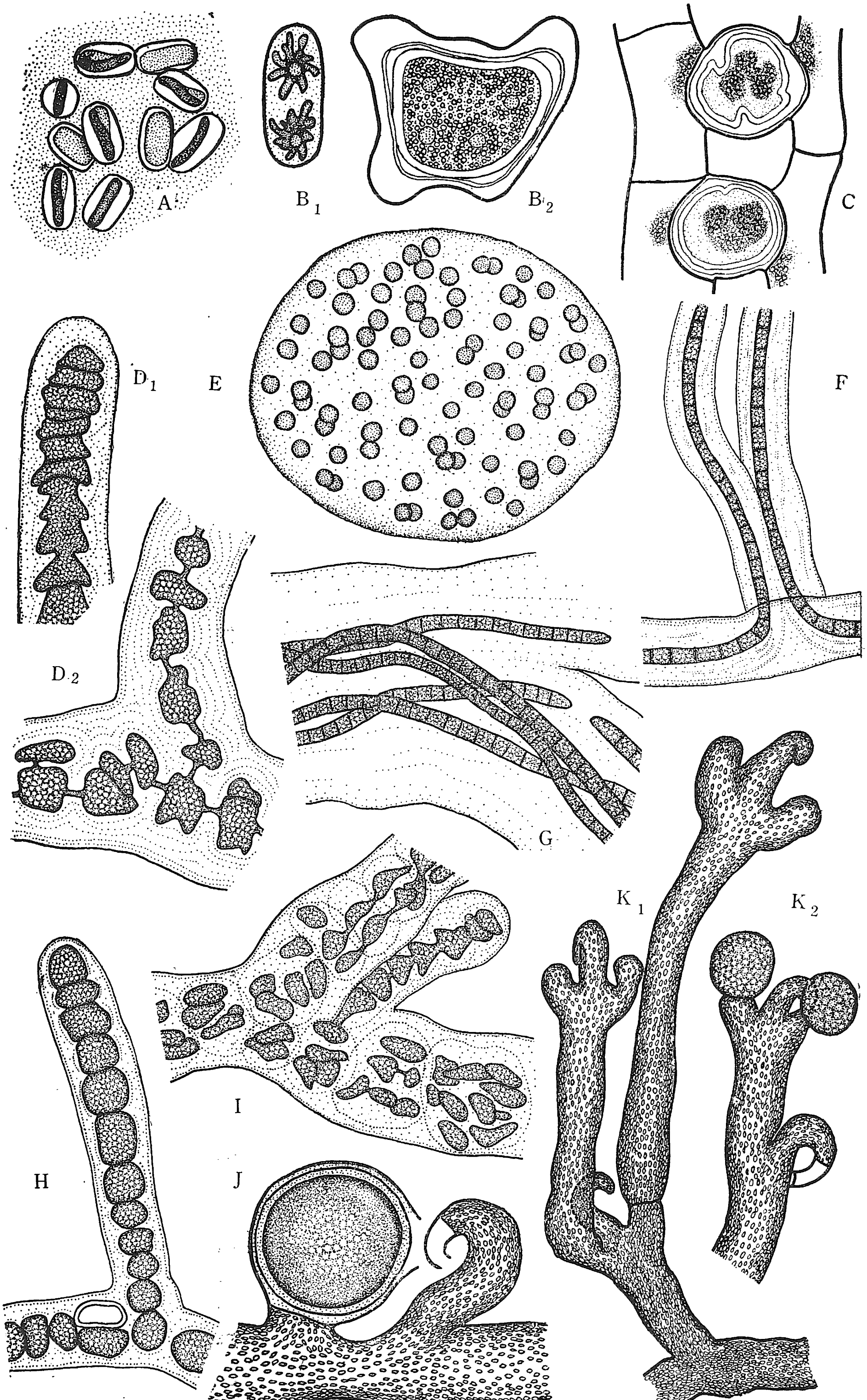
plate I.



Explanation of plate II.

Fig. A. *Mesotaenium* sp.
Figs. B_1 & B_2. *Cylindrocystis brebissonii* Menegh. (B_2. zygospore)
Fig. C. *Zygogonium ericetorum* Kütz.
Fig. D_1 & D_2. *Stigomema ocellatum* Thuret.
Fig. E. *Aphanocapsa grevillei* (Hass.) Rabenh.
Fig. F. *Scytonema mirabile* (Dillw.) Born.
Fig. G. *Schizothrix penicillata* (Kuetz.) Gom.
Fig. H. *Stigonema hormoides* (Kuetz.) Born. et Flah.
Fig. I. *Stigonema minitum* (Ag.) Hass.
Fig. J. *Vaucheria sessilis* (Vauch.) DC. ?
Fig. K. *Vaucheria geminata* (Vauch.) DC. ?

plate II.



Explanation of plate III.

Fig. A. *Ourococcus bicaudatus* Grobéty
Fig. B. *Coccomyxa subglobosa* Pascher?
Fig. C. *Protococcus viridis* Ag.
Fig. D. *Trochiscia aspera* (Reinsch)
Fig. E. *Fritschiella tuberosa* Iyengar
Fig. F. *Stigeoclonium* sp.
Fig. G. *Trentepohlia willei* (Tiff.) Printz
Fig. H. *Phycopeltis irregularis* (Schmid.) Wille
Fig. I. *Mesotaenium* sp.
Fig. J. *Zygogonium ericetorum* Kütz.
Fig. K. *Cylindrocystis* sp.
Fig. L. *Cylindrocystis brebissonii* Menegh. (zygospore)
Fig. M. *Oedoladium* sp.
Fig. N. *Cosmarium furcatospermum* W. & G. S. West var. *koreana* Skv.?
Fig. O. *Stigonema ocellatum* Thuret
Fig. P. *Scytonema mirabile* (Dillw.) Born.
Fig. Q. *Calothrix fusca* Born. et Flah.?
Fig. R. *Aphanocapsa grevillei* (Hass.) Rabenh.
Fig. S. *Stigonema minitum* (Ag.) Hass.
Fig. T. *Stigonema hormoides* (Kuetz.) Born. et Flah.
Fig. U. *Schizothrix penicillata* (Kuetz.) Gom.
Fig. V. *Nostoc* sp.

plate III.