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SOME MARINE ALGÆ FROM THE NORTHERN PART OF THE ARABIAN SEA WITH REMARKS ON THEIR GEOGRAPHICAL DISTRIBUTION

BY

F. BØRGESEN

WITH 2 PLATES

KØBENHAVN
LEVIN & MUNKSGAARD
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The most interesting localities with the richest algal vegetation visited by me during my stay in India in the winter 1927—28 were without doubt Dwarka, and Okha Port situated a little further north. Both these places lie by the Arabian Sea (see the map, plate II) on the coast of Okhamandal in the peninsula Kathiawar belonging to the Kingdom of Baroda.

Thus it was quite natural that I should begin working out my collections from these localities. And as the Herbarium of the Royal Botanic Gardens, Kew, proved to be in the possession of rather considerable and very valuable collections from Karachi which the Director Sir ARTHUR HILL and the Keeper of the Herbarium Dr. A. D. COTTON were so kind as to place at my disposal, I have been able to add a contribution to the knowledge of the interesting algal flora a from a locality from the northern part of the Arabian Sea.

The most valuable of the collections from the Kew Herbarium was made by the late JAMES A. MURRAY who was curator of the Karachi Municipal Museum. His collections originate from the years 1881—1883 and contain a large number of well prepared specimens. Furthermore the Herbarium was in possession of a large album in folio presented to Kew by Miss L. FRERE; in this is to be found a rather large collection of nicely prepared specimens. A third minor collection presented to Kew by Mr. N. M. PAUL, Curator of the Victoria Museum at Karachi, contained,

too, a number of species of much interest. Finally a few specimens were gathered by Vice-Admiral W. J. S. Pullen, Karachi 1859.

I must also mention here that the Assistant Director of the New York Botanical Garden, Dr. M. A. Howe, on learning that I was studying Indian algæ was so kind as to send me for determination a fine and rather large collection of algæ from Karachi. This collection had been made by Mr. A. B. Kotwall. Karachi.

Finally I wish to mention a collection of algæ from Karachi which Mr. K. G. Naik, Sind College, was so very kind as to present me with during my stay in Bombay. This collection was preserved in alcohol and consequently of great value.

After having finished the examination of these as well as of my own collections I thought it to be of some interest to draw up a synoptical systematically arranged list of these species mentioned in various smaller treatises[1]. For

[1] The papers are:

"Some Indian Rhodophyceæ especially from the shores of the Presidency of Bombay", I. Kew Bulletin no 1, 1931. II. ibd. no. 3, 1932. III. ibd. no 3, 1933. IV. ibd. no 1, 1934. In the list of species these papers are referred to as: "K. B."

"Some Indian green and brown algæ especially from the shores of the Presidency of Bombay", I. Journal of the Indian Botanical Society, vol. IX. 1930, p. 151. II. ibd. vol. XI, 1932, p. 51. III. ibd. vol. XII, 1933, p. 1. These papers are referred to as: "J. I. B. S."

"Sur *Platysiphonia* nov. gen. et sur les orgânes mâles et femelles du *Platysiphonia miniata* (Ag.) nov. comb. (*Sarcomenia miniata* (Ag.) J. Ag." in Recueil de Travaux Cryptogamiques dédiés à Louis Mangin. Paris 1931.

"On a new genus of the *Lophotalieæ* (Fam. *Rhodomelaceæ*)". Det Kgl. Danske Videnskabernes Selskab. Biologiske Meddelelser X, 8. København 1933.

And about the algal vegetation at Dwarka: "On *Rosenvingea stellata*, a new Indian alga and on an intersting littoral algal vegetation in which this species is a characteristic constituent". Dansk Botanisk Arkiv, Bd. 5, Nr. 6, København 1928.

the sake of completeness I have added a few until now unpublished species from my collections from Dwarka and Okha Port.

I need not mention that of course this list only contains a small part of the species which may be expected to be found after a more thorough investigation in the northern part of the Arabian Sea. But I am of opinion that the discovery of several species so far only known from such far-off regions as Australia, Japan, Cape and even the northern Atlantic Ocean in the northern part of the Arabian Sea is of considerable plant-geographical interest. I shall enter into these plant-geographical conditions at greater length at the end of this paper.

SYSTEMATICALLY ARRANGED LIST OF THE SPECIES HITHERTO FOUND AT KARACHI, OKHA PORT AND DWARKA

CHLOROPHYCEÆ

I. Ulotrichales.

Fam. 1. ***Ulvaceæ.***

Enteromorpha Link.

1. Enteromorpha flexuosa (Wulf.) J. Ag.

J. Agardh, Till Algernes Systematik. 3die Afd. 1882, p. 126. *Conferva flexuosa* Wulfen in Roth, Catalecta Botanica, fasc. II, 1800, p. 188.

I have collected only a few specimens which I think are referable to this species. At its base the thallus has a tubular cylindrical narrow stipe increasing evenly upwards and becoming inflated and flexuous. When seen from the surface the cells are roundish polygonal about 10—15 μ broad or a little more. They are somewhat irregularly placed with a marked tendency to get themselves arranged in longitudinal series. In transverse sections the inner walls in the lower part of the thallus are about 7—8 μ thick, but thinner in the upper part.

This species shows much likeness to *E. intestinalis*, being a southern substitute for it; compare Collins in "Rhodora", vol. 5, 1903, p. 21.

India: Dwarka.
Geogr. Distrib. Temperate and warm seas.

Ulva L.

1. Ulva Lactuca L.

Linné, Spec. plant., vol. 2, 1753, p. 1173. Bornet et Thuret, Études Phycol., 1878, p. 5, pl. 2—3. Setchell & Gardner, Chlorophyceæ in Mar. Alg. of the Pacific Coast of N. Am., p. 265.

The specimens are rather deeply split and light green of colour. The thallus is about 40 μ thick and the cells almost square with round corners. Occasionally a few rather small perforations of variable size are found in the thallus.

India: Dwarka.
Geogr. Distrib. Widely distributed.

Fam. 2. ***Chætophoraceæ.***

Endoderma Lagerh.

1. Endoderma leptochaete Huber.

Huber, Contributions à la connaissance des Chætophorées (Annales des Sciences nat. 7. sér., Bot., t. 16, p. 319, pl. XV. figs 1—9).

In the cell-wall of *Chætomorpha Linum* I have found an *Endoderma* which seems to be referable to this species. The diameter of the cells was about 8 μ (5—11 μ) thus a little less than mentioned by Huber (5—15 μ). As a rule two pyrenoids are found in each cell, rarely only one or in some cases three. I have not been able to find any hairs in the Indian specimens. But the hairs seem to be very delicate and may easily have been destroyed. If hairs do not exist in the Indian plant it must be compared with *Endoderma strangulans* Howe, The Marine Algæ of Peru (Memoirs of the Torrey Bot. Club, vol. XV, 1914, p. 25) in which plant hairs have not been observed. But in this species pseudo-

parenchymatous discs are often developed, and these I have not found in the Indian plant.

India: Dwarka.
Geogr. Distrib. France.

II. Siphonocladiales.

Fam. 1. ***Valoniaceæ.***

Valonia Ginn.

1. **Valonia ægagropila** C. Ag.

C. Agardh, Spec. Alg., p. 429. J. Agardh, Till Algernes Systematik, 5te Afd. VIII, *Siphoneæ*, p. 99. Kuckuck, Über den Bau und die Fortpflanzung von *Halicystis* Aresch. und *Valonia* Ginn. (Bot. Zeit. 1907).

The Indian specimens resemble very much those I have found at Santa Cruz in the West Indies and on the whole agree quite well, too, with Kuckuck's description and figures.

India: Dwarka.
Geogr. Distrib. West Indies, Mediterranean Sea, Indian and Pacific Oceans.

Dictyosphæria Decsne.

1. **Dictyosphæria** spec.

J. I. B. S. vol. IX. 1930, p. 152.
India: Dwarka.

Fam. 2. ***Boodleaceæ.***

Cladophoropsis Boergs.

1. **Cladophoropsis Sundanensis** Reinbold.

Reinbold, Th., Einige Chlophyceen aus dem Ind. Ocean in Nuova Notarisia, ser. 16. 1905, p. 147. Weber van Bosse, Alg. Siboga, p. 77, fig. 18.

To this species, I think, has to be referred a small *Cladophoropsis* of which I have only material in alcohol (no. 5321). It forms small compact clumps 1—2 cm. long most probably epiphytic and grows in company with *Sphacelaria furcigera*. The breadth of the filaments varies from 60 μ to 120 μ, thus a little more than the measures given by REINBOLD. The length of the cells varies very much, often they are several times longer than broad. I have compared my plant with some specimens from the Kei Islands determined by Madame WEBER v. BOSSE, and they seem to agree quite well with these. The basal filaments are fastened to the substratum by means of rhizoids.

India: Dwarka.
Geogr. Distrib. Malay Archipelago.

Boodlea Murray et De Toni.

1. Boodlea composita (Harv. et Hook. fil.) Brand.

BRAND, F., Über die Anheftung der Cladophoraceen und über vershiedene polynesische Formen dieser Familie (Beihefte z. Bot. Centralblatt, Bd. 18, Abt. 1, Leipzig 1904).

REINBOLD in WEBER VAN BOSSE, Algues du Siboga, p. 70. *Conferva composita* Harv. MS. in Journ. of Botany, Vol. I, 1834, p. 157.

f. *robusta* Boergs.

Boodlea siamensis f. *robusta* Boergs in J. I. B. S. vol. IX, 1930, p. 153—5, fig. 2.

When I referred this fine large form to *Boodlea siamensis* I was not quite content with the determination, and having later on been able to see a preparation of the authentic specimen from Mauritius, leg. TELFAIR, (compare REINBOLD, l. c. p. 70) I have come to the conclusion that the Indian plant has to be referred to *Boodlea composita*. With this species it agrees on account of its rather regular ramification, often with opposite branches. According to BRAND'S

description *Struvea*-like parts of the thallus are often met with in *Boodlea composita*, and such are likewise highly developed in the Indian plant. When compared with the plant from Mauritius, in which opposite branches are very prominent, the Indian one differs somewhat, the uppermost (youngest) branch-systems often having a unilateral ramification and the branches therefore being a good deal curved. Compare my figures (l. c.).

India: Dwarka, Okha Port.

Geogr. Distrib. Sandwich Island, Tangatabu, Mauritius, Red Sea.

Fam. 3. ***Anadyomenaceæ.***

Valoniopsis Boergs. gen. nov.

1. **Valoniopsis pachynema** (Martens) Boergs.

Valonia confervoides Harvey, Alg. Ceylon exsicc. no 73 (nomen nudum). J. Agardh, Till Algernes Systematik, 5te Afdeln. VIII. *Siphoneæ*, 1887, p. 100.

Bryopsis pachynema Martens, Die Preussische Expedition nach Ostasien, Bot. Theil, Die Tange von G. v. Martens, p. 24, pl. IV, fig. 2. (1866).

The plant I am here going to describe was at first called *Valonia confervoides* by Harvey and distributed in his Alg. Ceylon exsicc. no. 73, but no description of the plant was given. Further Harvey has distributed the same alga in his Friendly Isl. Alg. exsicc. no. 101. Of this last mentioned alga I have seen a specimen in Herb. J. Agardh in Lund, whereas a fine specimen of the Ceylon alga is found in the Botanical Museum, Copenhagen. A description of the plant was first given by J. Agardh (1887) l. c., p. 100. Then it was mentioned by Grunow in "Algæ. Reise Fregatte Novara" p. 35 without any description. But already in 1866 it had been described by Martens in "Die Preussische Ex-

pedition nach Ost-Asien". Bot. Theil, Die Tange von G. v. MARTENS, Berlin 1866, p. 24, pl. IV, fig. 2. Without knowing HARVEY's plant MARTENS here called it *Bryopsis pachynema;* besides description a figure of the plant is given. MARTENS says about it: "ist die dickste bis jetzt bekannte *Bryopsis* und hat ziemlich viel Aehnlichkeit mit KÜTZING's *Valonia verticillata* aus Sainte Croix in Westindien".

In Algues du Siboga, I, 1913, Madame Dr. A. WEBER like HARVEY refers it to *Valonia* adopting the specific name of MARTENS.

I have been able to examine well preserved material from Karachi and Ceylon; in the following I shall give a description of it based especially upon fine material gathered by myself near Galle on the south western shore of Ceylon.

The thallus forms low dense tufts on rocks about 3 cm. high. These tufts remind one very much of those of *Valonia ægagropila* (unde nomen generis). The thallus (Fig. 1) consists of cylindrical ramified filaments about 600—700 μ thick; most of the filaments are placed more or less vertically, but many grow out, too, in various directions between the upward directed filaments, and in this way the felted cushions are formed. By means of numerous hapters the cushions are fastened to the rocks.

When a filament is going to be divided its upper end becomes a little thicker, and much cell-content is accumulated in the uppermost part of it (Fig. 1 *a*) forming a dense dark-green half spherical mass which soon becomes separated by a wall, whereupon it begins to grow in length. Soon after the development of the wall two small cupola-like out-growths become visible on both sides of the filament just below the wall (Fig. 1 *b*). In these outgrowths, too,

much cell-content is accumulated, whereafter they are separated in the same way by walls and within a short time begin to grow out. These branches are not exactly opposite, as they seem (always?) to be placed a little nearer together when examined from one side of the filament instead of from the other (compare for instance Fig. 1 *f*). This is the most common way of ramification, but several variations are found. In some cases, as shown in Fig. 2, a new pair of filaments are formed below the formerly developed filaments, or it may also happen that only one filament is developed (Fig. 1 *d*). Another way in which the ramification may take place is that only a single filament is developed (Fig. 1 *e*) and within a short time, under it, another one, and this may be repeated several times (Fig. 1 *d*, *f*). In that way up to four branches placed in an unilateral series may be formed (Fig. 1 *f*). The branches grow out into filaments like the mother filament and continue their growth for some time, and then become divided in the same way.

While, in the specimens from Ceylon, the branching of the thallus took place as described above, some material from Karachi, presented to me by Mr. K. G. Naik, then at Sind College, Karachi, showed a somewhat richer ramification. Fig. 2 is drawn from a piece of the Karachi plant. We see here a fragment of an old filament carrying 5 unilaterally placed filaments developed basipetally. The uppermost branch but one (the top one was damaged) has issued 3 pairs of opposite branches and below on one side has even a fourth branch coming into existence.

While in the above described way of branching, which seems to be the normal one, all branches are placed in nearly the same plane, it happens now and then that an adventitious branch is formed obliquely in relation to the

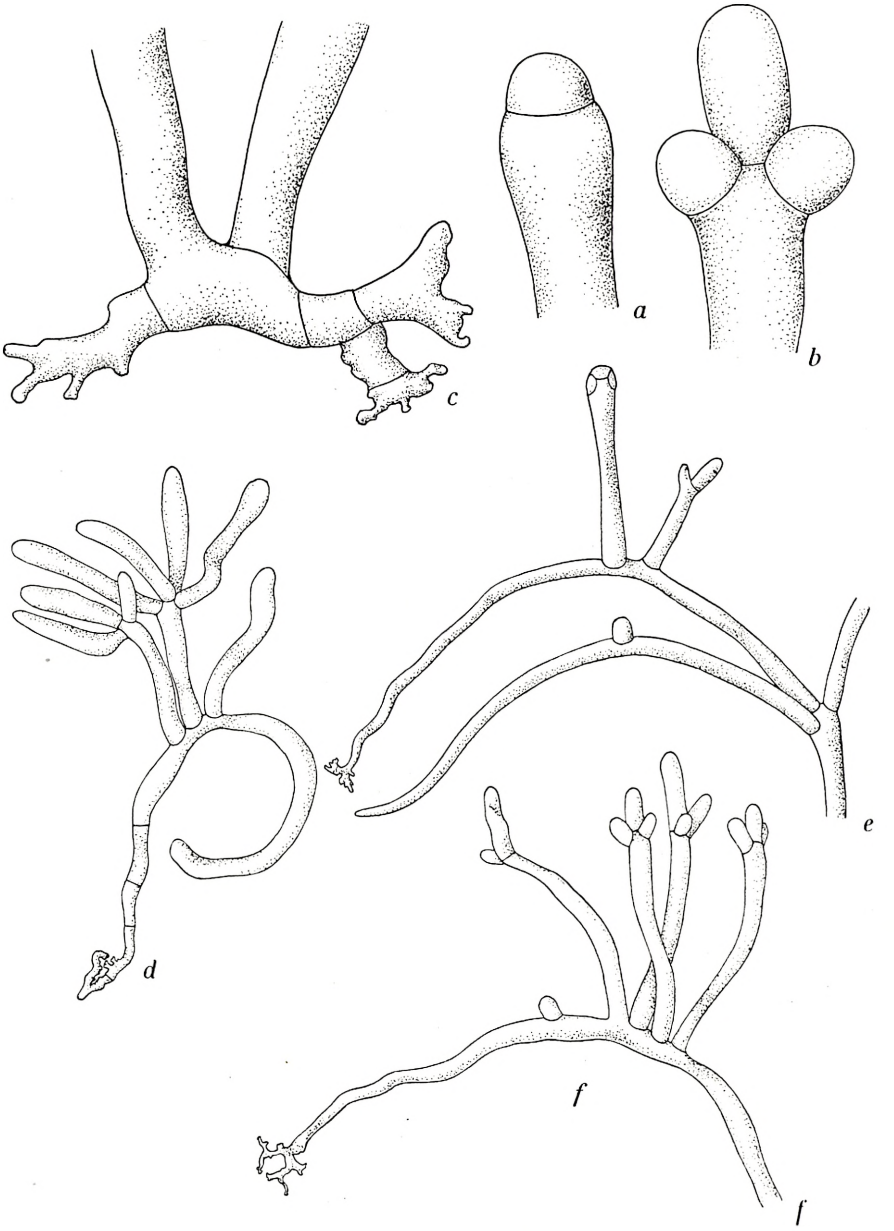


Fig. 1. *Valoniopsis pachynema* (Mart.) Boergs. compare the text.
(*a*, *b*, *c*, about 20:1; *d*, *e*, *f*, about 5:1).

branches formerly given off and when more such branches are forthcoming the ramification gets an umbellate appearance. This feature was not much developed in the material I examined from Karachi and Galle nor does it seem to be common in the form distributed by Harvey in his Ceylon Alg. Exsicc. no. 73. On the other hand it is often present in Harvey's Friendly Isl. Alg. exsicc. no. 101.

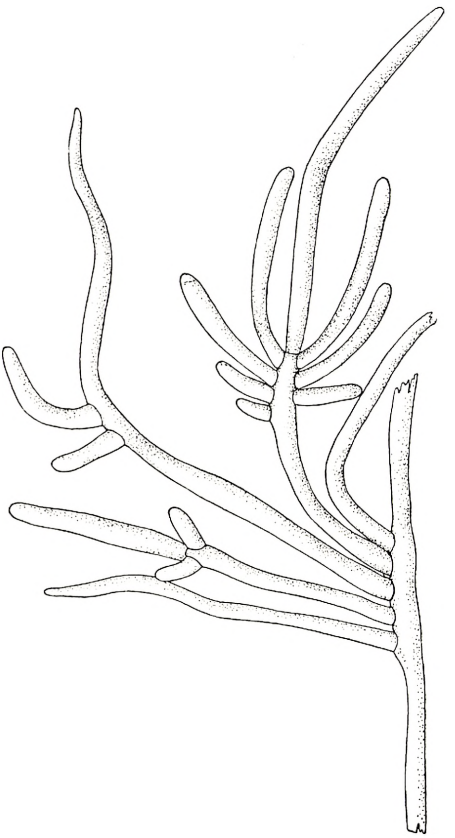


Fig. 2. *Valoniopsis pachynema* (Mart.) Boergs. Part of a plant from Karachi. (About 5:1).

Near the base the filaments are fastened to the substratum by means of vigorous hapters (Fig. 1 *c*). These hapters are very much and irregularly ramified and transverse walls are often present, whereas such never, or at any rate more rarely, occur in the filaments except when they are about to be divided. Hapters are not only developed from the base of the filaments. Several of the branches formed higher up in the thallus bend downwards, become rhizoidlike (Fig. 1 *d*, *e*, *f*) and when they approach a suitable substratum fix themselves to it by means of hapters. In this way the tuft is strengthened and kept together.

Fertile specimens were not observed.

Regarding the cell-contents we find, in the plasma, below the wall a layer of densely placed chromatophores. These are roundish polygonal, generally with elongated corners forming in that way a more or less coherent net. By far most of the chromatophores contain a large pyrenoid, in some even two are present. Under the chromatophores the numerous fairly large roundish nuclei are scattered. The rather thick wall is composed of several layers.

That this plant, hitherto referred to the genus *Valonia*, can not in a natural way be placed in this genus seems quite clear from the description given above. But nevertheless I am willing to admit that some forms of *Valonia* (compare f. inst. KUCKUCK's figures of *Valonia utricularis* and *ægagropila* in his paper on *Valonia* (Bot. Zeitung, 1907) show some likeness to it, but it is only so when considered quite superficially. In his paper KUCKUCK bases his description upon Mediterranean specimens and points out (p. 43) as especially characteristic features of this genus the large vesicle-like assimilating cells ("Blasenzellen") and the large and small wedge-shaped cells occurring on the walls of the large cells. None of these cell forms so characteristic of *Valonia* are found in this plant. Because of its cylindrical filiform thallus and its more regular ramification, to mention only some of the characters, it differs entirely from the latter. MARTENS referred the plant to *Bryopsis*, but in this genus it can not be placed. It must be supposed that it was the more or less featherlike way of branching which induced MARTENS to refer it to *Bryopsis*, but in the development of the branches there is the great difference that in *Bryopsis* the branchlets are acropetally developed, whereas in our plant the branches are basipetally developed, the uppermost

being formed first. It is not necessary to say here that in many other respects *Bryopsis* is very different from the plant treated here.

By its filiform thallus and cæspitose way of growing this plant reminds one much of the genera *Boodlea* and *Cladophoropsis* in the Fam. *Boodleaceæ*, but it differs from these genera by its ramification, by the presence of walls at the base of the branches, and by the want of tenaculæ, and because of this it cannot in a natural way be placed in this family.

Because of the umbellate arrangement of the branches in some specimens it has often been compared with the genus *Ernodesmis* of the Fam. *Siphonocladiaceæ*, but in the plant treated here a basal stem-like cell with annular swellings at its base is quite absent, so it can not be placed in that family either.

According to my view it is surely best to refer it to the Fam. *Anadyomenaceæ*, its digitate way of branching with basipetally developed branches being highly reminiscent of the ramification found in *Anadyomene*, *Rhipidiphyllon* and *Willeella;* and in some of the genera belonging to this family, for instance *Microdictyon* and *Anadyomene*, branches can grow out in other directions than the usual one, which is in the plane of the thallus; compare BITTER, G., Zur Morphologie and Physiologie von Microdictyon umbilicatum (Pringsh. Jahrb., 34, 1899—1900) for instance p. 128 and especially p. 225 and the following pages.

Finally I give a description of the new genus.

Valoniopsis Boergs. nov. gen.

Thallus cæspitosus, rhizoideis ramosis substrato adfixus, e filamentis filiformibus rigidulis, intervallo ramosis, com-

positus. Ramis aut oppositis ad filamenta 1—4 paribus basipetaliter subflabellatim evolutis, aut singulis vel pluribus (ad 4—5) in seriebus secundis, aut interdum magis irregulariter subumbellatim præsentibus.

Willeella Boergs.

1. **Willeella ordinata** Børgs.

J. I. B. S. vol. IX, 1930, 155, figs 3—4, pl. I, fig. 1.

When I examined some more material of this fine plant I found some fertile specimens. The cells in the uppermost parts of the filaments were transformed into zoosporangia (Fig. 3) in a similar way as for instance found by me in *Microdictyon Calodictyon;* compare my fig. 8 in Mar. Alg. from the Canary Island. I. Chlorophyceæ[1]. Near the upper end of the cells two oppositely placed short outgrowths are formed, at the end of which a hole is formed through which the zoospores escape. In cells with branches the outgrowths are formed just below these.

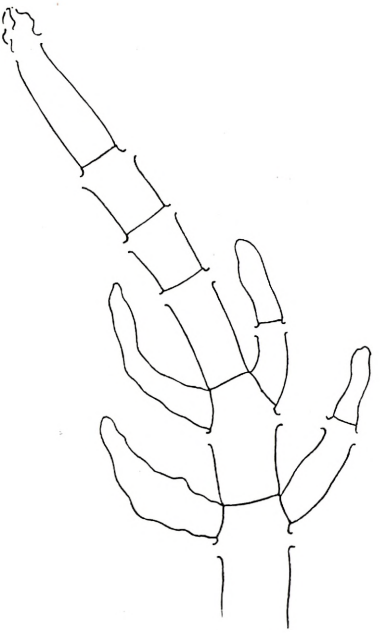


Fig. 3. *Willeella ordinata* Børgs. Summit of a filament with zoosporangia. (About 80:1).

India: Okha Port.

[1] Børgesen in Kgl. Danske Vidensk. Selsk. Biologiske Meddelelser, V, 3 Marine Algæ from the Canary Islands, I Chlorophyceæ, p. 36. København, 1925.

Fam. 4. ***Cladophoraceæ.***

Chætomorpha Kütz.

1. Chætomorpha media (Ag.) Kütz.

J. I. B. S, vol. XI, 1932, p. 51.
India: Manora near Karachi.

2. Chætomorpha Linum (Muell.) Kütz.

KÜTZING, Phycol. germanica, p. 204. HAUCK, Meeresalgen p. 439. *Conferva Linum* Muell. in Flora Danica, tab. 771, fig. 2. For more synonyms compare DE TONI, Sylloge Alg. Vol. I, Chlorophyceæ, p. 269.

The Indian specimens are about 150—200 μ thick, and the length of the cells from about half the breadth up to about 4—5 times as long. The plant forms entangled masses among other algæ.

India: Karachi, K. G. NAIK. Dwarka.
Geogr. Distrib. West Indies. Atlantic coasts of Europe and America, Canary Islands, Red Sea.

Cladophora Kütz.

1. Cladophora spec.

A few species were gathered at Dwarka, but they have not yet been determined.

Fam. 5. ***Dasycladiaceæ.***

Subfam. Acetabularieæ.

Acetabularia Lamouroux.

1. Acetabularia caliculus Quoi et Gaimard.

J. I. B. S., vol. IX, 1930, p. 158.
India: Okha Port.

III. Siphonales.

Fam. 1. ***Bryopsidaceæ.***

Bryopsis Lamouroux.

1. Bryopsis plumosa (Huds.) Ag.

Agardh, Spec. Alg., p. 448. Harvey, Phycol. Brit., pl. III. J. Agardh, Till Algernes Systematik, VIII, *Siphoneæ*, p. 24.

The Indian specimens form large tufts about 10 cm. high. They agree very well with Harvey's figure quoted above, a form which J. Agardh l. c. called *arbuscula*.

India: Dwarka; Okha Port (cast ashore).
Georg. Distrib. Atlantic Ocean, Cape, Australia etc.

2. Bryopsis hypnoides Lamour.

Lamouroux, Mémoire sur trois nouveaux genres de la famille des Algues marines (Journ. de botanique, 1809, p. 135, tab. I, fig. 2 a—b). J. Agardh, Till Algernes Systematik, VIII, *Siphoneæ* (Lunds Univers. Årsskr., t. 23, 1887, p. 27).

The Indian specimens form soft light green tufts up to about 9 cm. high. They show some likeness to a specimen of Le Jolis, Algues marines de Cherbourg, no. 61 found in the Botanical Museum, Copenhagen.

India: Dwarka; Okha Port (cast ashore).
Geogr. Distrib. Warmer Atlantic Ocean, Australia.

Fam. 2. ***Codiaceæ.***

Subfam. 1. Codieæ.

Codium Stackh.

1. Codium tomentosum (Huds.) Stackh.

J. I. B. S., vol. IX, 1930. p. 159.
India: Dwarka.

2. Codium elongatum Ag.

J. I. B. S., vol. IX, 1930, p. 159.
India: Dwarka, Okha Port.

Subfam. 2. Udoteæ.

Udotea Lamouroux.

1. Udotea indica A. & E. S. Gepp.

J. I. B. S., vol. IX, 1930, p. 160, fig. 5, pl. I, figs. 2—3.
India: Dwarka; Karachi, J. A. Murray.

Halimeda Lamouroux.

1. Halimeda Tuna (Ell. et Sol.) Lamx.

J. I. B. S., vol. IX, 1930, p. 161, fig. 6.
India: Dwarka.

Fam. 3. ***Caulerpaceæ.***

Caulerpa Lamouroux.

1. Caulerpa sertularioides (Gmel.) Howe.

J. I. B. S. Vol. XI, 1932, p. 59.
India: Dwarka.

2. Caulerpa taxifolia (Vahl) Ag.

J. I. B. S., vol. XI, 1932, p. 58.
India: Okha Port, Karachi.

3. Caulerpa scalpelliformis (R. Br.) Web. v. B.

J. I. B. S., vol. XI, 1932, p. 55, fig. 1, pl. I.
India: Dwarka, Karachi.

4. Caulerpa racemosa (Forssk.) Web. v. B.

J. I. B. S., vol. XI, 1932, p. 59, fig. 2—4.
India: Dwarka.

Fam. 4. ***Vaucheriaceæ.***

Vaucheria De Candolle.

1. **Vaucheria piloboloides** Thur.

J. I. B. S., vol. XI, 1932, p. 63.
India: Dwarka.

Fam. 5. ***Phyllosiphonaceæ.***

Ostreobium Born. et Flah.

1. **Ostreobium Reineckei** Bornet.

Bornet in Engler's Botan. Jahrbücher, 23, 1896/7 p. 269. Setchell, W. A., Vegetation of Rose Atoll in Department of Marine Biology of the Carnegie Instit. of Washington, vol. 20, 1924, p. 250, fig. 55.

In a piece of a shell a boring alga was found which seems to agree quite well with the description of this species and the figure of Setchell. The thinner filaments are from 3—8 μ thick but thicker swelled parts are abundantly present. The ends of the filaments were often somewhat dilatate and colourless, perhaps = emptied sporangia. The walls are rather thick and the ends of the filaments are not reticularly united.

India: Dwarka.
Geogr. Distrib. Samoa Islands, Malay Archipelago, West Indies.

PHÆOPHYCEÆ

I. Ectocarpales.

Fam. 1. ***Ectocarpaceæ.***

Ectocarpus Lyngb.

1. Ectocarpus Mitchellæ Harv.

J. I. B. S., vol. IX, p. 165, fig. 8.
India: Dwarka.

Fam. 2. ***Mesogloeaceæ.***

Subfam. 1. Myriogloeeæ.

Myriogloea Kuck.

1. Myriogloea Sciurus (Harv.) Kuck.

J. I. B. S., vol. XI, 1932, p. 63, fig. 6.
India: Dwarka.

Fam. 3. ***Corynophlaeaceæ.***

Gonodia Nieuwland[1].

1. Gonodia arabica (Kütz.) Boergs. n. comb.

Myriactis arabica (Kütz.) Kuck. Fragmente einer Monographie der Phæosporeen. Nach dem Tode des Verfassers herausg. von W. Nienburg. (Wissensch. Meeresunters. N. F. Abt. Helgoland. 17 Bd. 1929, p. 39). *Phycophila arabica* Kütz., Tab. Phyc., vol. VIII, tab. 1, fig. 2.

Upon some old indeterminable fragments, most probably of a *Cystophyllum*, I have found a small brown alga which

[1] Nieuwland, J. A., Critical Notes on new and old genera of plant — IX. The American Naturalist, vol. V, Notre Dame 1917—18, p. 30.

seems referable to this species according to KUCKUCK's figures and somewhat fragmentary description. Whereas KÜTZING's specimen originated from the Arabian Sea, KUCKUCK based his description upon a specimen he had collected himself at Tanger. The plant forms small pea-

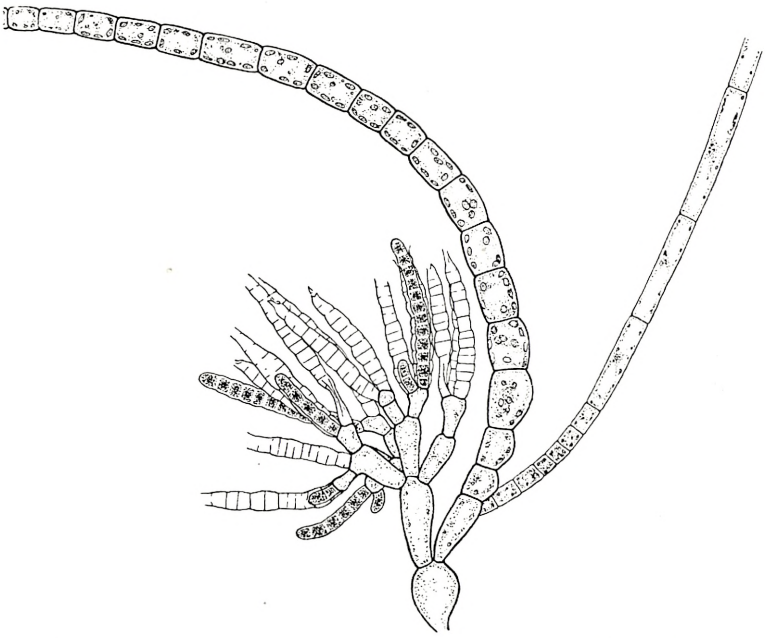


Fig. 4. *Gonodia arabica* (Kütz.) Boergs. Part of the thallus with plurilocular sporangia and an erect filament with a hair at its base. (About 260:1).

like dense clumps on the host. As a rule it is developed from the cryptostomata. The basal disc is not much developed, and some of the cells seem too to penetrate into the tissue of the host. From the basal cells erect filaments with limited growth arise. In the basal part these filaments are much ramified. The branches are densely aggregated and form a rather large dense colourless kernel about 600 μ broad. The cells are larger near the base and more or less

inflated or irregularly shaped; upwards the cells become gradually smaller, lengthen and carry at the periphery numerous almost cylindrical plurilocular sporangia (Fig. 4). These are transversely divided; vertical walls I have not seen. The sporangia are opened by means of a porus in the upper end. Young sporangia are very often developed from the base of an old emptied one. The sporangia are about 22 μ broad and 90 μ long. Above the sporangia the upper ends of the assimilating shoots and the colourless ends of the rather abundantly found hairs protruded (Fig. 4). The cells of the assimilating shoots are divided intercalarily; their height is up to about 1 mm long and their breadth about 20 μ and the length of the cells is $1^1/_2$—2 times the breadth. The hairs have trichothallic growth. Moreover in the Indian material I have in a few cases found plurilocular sporangia developed from the upper ends of the assimilating shoots (Fig. 5). These sporangia which are developed either from the ends of cells or from the middle of these are of rather variable length, often quite short or sometimes a little longer. In the plant from Tanger Kuckuck has too, even though rarely, found sporangia in the

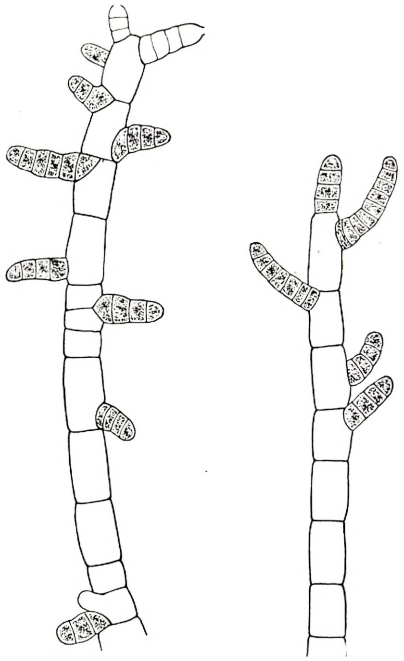


Fig. 5. *Gonodia arabica* (Kütz.) Boergs. Erect assimilating filaments with plurilocular sporangia. (About 400 : 1).

upper ends of the short shoots. When compared with KUCKUCK's figure (Fig. 37) the sporangia in the African plants are shorter[1].

India: Dwarka.
Geogr. Distrib. Tanger, Arabian Sea.

Fam. 4. ***Spermatochnaceæ.***

Subfam. 1. Spermatochneæ.

Nemacystus Derb. et Sol.

1. Nemacystus decipiens (Sur.) Kuck.

J. I. B. S., XI, 1932, p. 65, fig. 7.
India: Dwarka.

Fam. 5. ***Scytosiphonaceæ.***

Rosenvingea Boergs.

1. Rosenvingea intricata (J. Ag.) Boergs.

J. I. B. S., vol. IX. p. 167, fig. 9.
India: Dwarka, Okha Port.

Fam. 6. ***Encoeliaceæ.***

Colpomenia Derb. et Sol.

1. Colpomenia sinuosa (Roth) Derb. et Sol.

DERBÈS A., & A. SOLIER, Mém. sur quelques points de la Physiol. des Algues, p. 11. BOERGESEN, Mar. Alg. D. W. I., p. 176, fig. 138. *Ulva sinuosa* Roth, Catalecta Bot., III, p. 327, tab. XII, fig. a. *Asperococcus sinuosus* Bory, Expédition scientif. du Morée, t. III, p. 326 (non vidi). Nouv. Flore du Péloponnèse et des Cyclades, 1835, p. 76. J. AGARDH, Spec. Alg., I, p. 75. *Encoelium sinuosum* Ag.,

[1] The *Elachista* spec. mentioned in my paper on the "Marine Algæ from Easter Island" (SKOTTSBERG, "The Natural History of Juan Fernandez and Easter Island" vol., II, p. 261, fig. 10) seems to come very near to this species.

Spec. Alg., I, p. 146; Systema, p. 362. Kützing, Spec. Alg., 552; Tab. Phycol., vol. IX, pl. 8. *Hydroclathrus sinuosus* Zan., Icon. phyc. adriat., I, p. 109. Mitchell in Murray, Phyc. Mémoirs, p. 53, pl. XIV.

Specimens with plurilocular sporangia are found in the littoral zone on exposed shore.

India: Dwarka; Bombay.
Geogr. Distrib. Widely spread in warmer seas.

2. Colpomenia stellata (Boergs.) Boergs.

J. I. B. S., vol. IX, p. 168.
India: Dwarka.

Hydroclathrus Bory.

1. Hydroclathrus cancellatus Bory.

Bory, Dict. class. VIII, p. 419 (non vidi). Harvey, Phycologia Australica, pl. 98. Mitchell in Murray, Phyc. Memoirs, p. 53, pl. XV, figs. 2—4. Vickers, Phycologia Barbadensis, Part II, pl. 23. Börgesen, Mar. Alg. D. W. I., vol. I, p. 177, fig. 139. *Asperococcus cancellatus* Endl., Mantissa Botanica altera, Suppl. 3, 1843, p. 26. *Halodictyon cancellatum* Kütz., Phycologia generalis, 1843, p. 336. *Encoelium clathratum* Ag., Spec. Alg., p. 412. *Stilophora clathrata* Ag. in "Flora", 1827, p. 642. *Asperococcus clathratus* J. Ag., Spec. Alg. I, p. 75.

Found in the littoral region on exposed coast.

India: Dwarka.
Geogr. Dijstrib. Seems to occur in most warm seas.

II. Sphacelariales.

Fam. 1. ***Sphacelariaceæ.***

Sphacelaria Lyngb.

1. Sphacelaria tribuloides Meneghini.

Meneghini, Lettere ad Corinaldi p. 2, after De Toni, Sylloge Alg., vol. III, p. 502. Sauvageau, C., Remarques sur les Sphacelariacées, Journ. de Bot. vol. XV, 1901, p. 123.

The plant forms dense dark-brown tufts about $1^1/_2$ cm high; the filaments are about 45 μ broad and the joints almost as long as broad or a little longer. The propagula were numerous, sporangia were not observed.

India: Dwarka.

Geogr. Distrib. Mediterranean Sea, Red Sea, South Africa, South Australia, Malayan Archipelago, West Indies.

2. **Sphacelaria furcigera** Kütz.

Kützing, Tab. Phycol. vol. V, p. 27, tab. 90. B. Askenasy, Alg. Exp. Gazelle, p. 21. Reinke, Vergl. Anat. u. Morphol. Sphacelar., p. 14, tab. 4, figs. 5—13. Sauvageau, C., Remarques sur les Sphacélariacées, p. 145.

Felted together with a tuft of *Cladoporopsis sundanensis* I have found a small tuft of this species. From Bombay I have in my collection large and well developed specimens of this species.

India: Dwarka; Bombay.

Geogr. Distrib. Atlantic Ocean, Indian and Pacific Ocean.

III. Dictyotales.

Fam. 1. ***Dictyotaceæ.***

Spathoglossum (Kütz.) J. Ag.

1. **Spathoglossum variabile** Fig. et De Not.

Figari et De Notaris, Nuovi materiali per l'Algologia del Mar rosso, Torino 1851, p. 28, pl. 1, fig. 4 (not seen). Zanardini, Plant Mar. Rubr. huc. collect. enumeratio, p. 38. J. Agardh, Anal. algol., cont. I, p. 36. *Spathoglossum lubricum* Fig. et de Not. ibidem, p. 28, pl. I, fig. 1. Kützing, Tab. Phycol., vol. IX, tab. 48, fig. 1.

A specimen which I have found cast ashore at Okha Port is, I think, referable to this species. It agrees very well with Kützing's above quoted figures, but it is a good deal

larger, about 27 cm high. It is several times subdichotomously divided. The lobes are cuneate of shape and separated by incisions with roundish bases. The cells in the young parts of the thallus, when seen from above, are almost quadrangular and placed in rows, but they soon get a more irregular shape and are irregularly placed. Groups of hairs and fructiferous organs are found scattered over the thallus.

I have several other specimens of *Spathoglossum*, but I have not been able to refer them to any of the described species. Several of J. Agardh's species are, I am sure, based upon very little material. In Agardh's Herbarium at any rate very little material is present of most of these species.

India: Okha Port (cast ashore).
Geogr. Distrib. Red Sea.

Stoechospermum Kütz.

1. Stoechospermum marginatum (Ag.) Kütz.

J. I. B. S., vol. XI, 1932, p. 67, fig. 8.
India: Dwarka.

Zonaria J. Ag.

1. Zonaria variegata (Lamx.) Ag.

J. I. B. S., vol. IX, 1930, p. 169.
India: Dwarka.

Padina Adans.

1. Padina Commersonii Bory.

J. I. B. S., vol. IX, 1930, p. 170.
India: Dwarka.

Dictyopteris Lamx.

1. Dictyopteris australis Sond.

J. I. B. S., vol. IX, 1930, p. 173.

India: Dwarka, Okha Port, Karachi (Capt. PULLEN, according to HARVEY, Synoptic Catalogue in Phycologia Australica, vol. V, p. X).

Dictyota Lamx.

1. Dictyota Bartayresiana Lamour.

LAMOUROUX, Exposition des caractères du genre *Dictyota* in Journ. de Bot., t. II, 1809, p. 43 (not seen). J. AGARDH, Spec. Alg., vol. I, p. 94. Analecta Algol., cont. I, p. 66.

The lobes of the specimens referred to this species have generally acute summits. The fructiferous organs occur scattered over the surface of the thallus. The Indian specimens form loose clumps coming into existence by means of numerous rhizoids breaking out in rows here and there from the edges of the thallus and connecting the lobes of the thallus.

India: Dwarka.

Geogr. Distrib. West Indies, Red Sea, Malayan Archipelago, Australia.

IV. Fucales.

Fam. 1. ***Fucaceæ.***

Subfam. 1. Cystosiro-Sargasseæ.

Cystophyllum J. Ag.

1. Cystophyllum muricatum (Turn.) J. Ag.

J. AGARDH, Spec. Alg. I, p. 231. DE TONI, Sylloge Algarum, vol. III, Fucoideæ, p. 154, where literature is quoted. *Fucus muricatus* Turner, Hist. Fuc., II, p. 108, tab. 112.

var. *virgata* (Endl. et Dies.) J. Ag., l. c.

To this variety, I think, is referable a specimen from Karachi with a smooth stem. But the specimen is rather young. And the same is the case with a specimen which I have gathered at Dwarka.

India: Karachi, A. B. Kotwall. Dwarka.

Geogr. Distrib. The Persian Bay. The typical form known from South India, Malayan Archipelago, Australia.

Sargassum Ag.

1. **Sargassum tenerrimum** J. Ag.

J. I. B. S., vol. XII, 1933, p. 10, fig. 6, pl. II.

India: Dwarka.

RHODOPHYCEÆ

A. Protoflorideæ.

I. Bangiales.

Fam. 1. ***Bangiaceæ.***

Erythrotrichia Aresch.

1. Erythrotrichia carnea J. Ag.

K. B. no. 3. 1932, p. 113.
India: Okha Port.

Goniotrichum Kütz.

1. Goniotrichum elegans (Chauv.) Le Jolis.

K. B. no. 3, 1933, p. 113.
India: Dwarka.

B. Florideæ.[1]

I. Nemalionales.

Fam. 1. ***Chantransiaceæ.***

Acrochætium Nægl.

1. Acrochætium crassipes Boergs.

K. B. 1931, no. 1, p. 2, fig. 1.
India: Dwarka.

2. Acrochætium erectum Boergs.

K. B. 1932, no. 3, p. 114, fig. 1.
India: Dwarka.

[1] The grouping in the *Florideæ* is based upon KYLIN's "Uebersicht über das System der Florideen" in HARALD KYLIN: Die Florideenordnung Gigartinales (Lunds Universitets Årsskrift. N. F. Avd. 2. Bd. 28. Nr. 8, 1932, p. 71).

3. Acrochætium Dwarkense Boergs.

K. B. 1932, no. 3, p. 114, fig. 2.
India: Dwarka.

Fam. 2. ***Helminthocladiaceæ.***

Liagora Lamour.

1. Liagora ceranoides Lamx.

K. B. 1931, no. 1, p. 3.
India: Dwarka.

Helminthocladia J. Ag.

1. Helminthocladia australis Harv.

K. B. 1931, no. 1, p. 7.
India: Okha Port.

Fam. 3. ***Chætangiaceæ.***

Scinaia Bivona.

1. Scinaia Hatei Boergs.

K. B. 1931, no. 1, p. 5, fig. 3, 4. pl. I, fig. 2.
India: Dwarka, Okha Port, Karachi.

2. Scinaia indica Boergs.

K. B. 1931, no. 1, p. 4, fig. 2, pl. I, fig. 1.
India: Dwarka, Okha Port.

Gloiophloea J. Ag.

1. Gloiophloea fascicularis Boergs.

K. B. 1934, no. 1, p. 2, fig. 1, 2, pl. I.
India: Karachi.

Galaxaura Lamour.

1. Galaxaura oblongata Lamx.

K. B. 1931, no. 1, p. 3.
India: Dwarka, Karachi.

Fam. 4. ***Bonnemaisoniaceæ.***

Asparagopsis Mont.

1. Asparagopsis Sandfordiana Harv.

K. B. 1933, no. 3, p. 114.
India: Dwarka, Karachi.

II. Gelidiales.

Fam. 1. ***Gelidiaceæ.***

Gelidium Lamx.

1. Gelidium pusillum (Stackh.) Le Jolis.

Le Jolis, Liste, p. 139. Bornet, Alg. de Schousboe, p. 268. Børgesen, F., Marine Alg. Canary Islands, Rhodomelaceæ, part 1, p. 83, fig. 44 (Biologiske Meddelelser, VI. 1927. København). *Fucus pusillus* Stackh., Nereis, 1795, p. 17, fig. 6. *Acrocarpus pusillus* Kütz., Tab. Phycol., vol. 18, tab. 37.

This species formed a dense low felted cushion on a stone gathered in the upper littoral zone.

India: Dwarka.
Geogr. Distrib. Atlantic coast of Europe, Morocco, Mediterranean Sea, West Indies, Red Sea, Malayan Archipelago, Japan, Easter Island etc.

Echinocaulon Kütz.

1. Echinocaulon acerosum (Forssk.) Boergs.

K. B. 1933, no. 3, p. 116.
India: Dwarka.

III. Cryptonemiales.

Fam. 1. ***Rhizophyllidaceæ.***

Chondrococcus Kütz.

1. Chondrococcus Hornemanni (Mert.) Schmitz.

K. B. 1933, no. 3, p. 117.
India: Karachi.

Fam. 2. ***Squamariaceæ.***

Peyssonnelia Decsne.

1. Peyssonnelia spec.

A few small sterile specimens fixed to stones are present in my collection from Dwarka. The thallus is about 100 μ thick. Unicellular rhizoids were numerous. The surface of the thallus was rather smooth and the margin somewhat sinuate and more or less free.

India: Dwarka.

Fam. 3. ***Corallinaceæ.***

Subfam. 1. Melobesieæ.

I am sorry to say that my collection of *Lithothamnion* and related genera from Dwarka have not yet been determined.

Subfam. 2. Corallineæ.

Amphiroa Lamour.

1. Amphiroa fragilissima (L.) Lamour.

K. B. 1934, no. 1, p. 7.

A specimen of this species is present in my collection from Dwarka. In this specimen the joints are generally swollen at the top as well as at the base.

India: Dwarka.

2. Amphiroa anceps (Lamk.) Decsne.

K. B. 1934, no. 1, p. 7.
India: Karachi. Dwarka.

Corallina L.

1. Corallina officinalis L.

K. B. 1934, no. 1, p. 7.
India: Karachi.

Jania Lamour.

1. Jania rubens (L.) Lamx.

K. B. 1934, no. 1, p. 7.
India: Dwarka.

Fam. 4. ***Grateloupiaceæ.***

Grateloupia C. Ag.

1. Grateloupia indica Boergs.

K. B. 1932, no. 3, p. 119, pl. II.
India: Okha Port.

Halymenia (Ag.) J. Ag.

1. Halymenia porphyroides Boergs.

K. B. 1932, no. 3, p. 120, fig. 8, pl. III.
India: Dwarka, Okha Port, Karachi.

2. Halymenia venusta Boergs.

K. B. 1932, no. 3, p. 124, fig. 11, pl. V.
India: Dwarka.

3. Halymenia polydactyla Boergs.

K. B. 1932, no. 3, p. 122, fig. 10, pl. IV.
India: Karachi, Okha Port, Dwarka.

Cryptonemia J. Ag.

1. Cryptonemia undulata Sonder.

K. B. 1932, no. 3, p. 125.
India: Karachi, Okha Port, Dwarka.

2. Cryptonemia Lomation (Bertel.) J. Ag.

K. B. 1934, no. 1, p. 8.
India: Karachi.

IV. Gigartinales.

Fam. 1. ***Solieriaceæ.***

Solieria J. Ag.

1. Solieria robusta (Grev.) Kylin.

K. B. 1934, no. 1, p. 10.
India: Dwarka, Okha Port, Karachi.

Sarconema Zan.

1. Sarconema scinaioides Boergs.

K. B. 1934, no. 1, p. 12, fig. 9, pl. II.
India: Karachi.

2. Sarconema furcellatum Zanard.

K. B. 1932, no. 3, p. 126, fig. 12a, b. K. B., 1934, no. 1. p. 10.
India: Karachi.

3. Sarconema furcatum Boergs.

K. B. 1934, no. 1, p. 12, fig. 8, pl. II.
India: Karachi.

4. Sarconema filiforme (Sond.) Kylin.

K. B. 1934, no. 1, p. 11, fig. 7.
India: Karachi.

Meristotheca J. Ag.

1. Meristotheca papulosa (Mont.) J. Ag.

K. B. 1934, no. 1, p. 13, figs 10, 11.
India: Karachi.

Fam. 2. ***Rhodophyllidaceæ.***

Cystoclonium Kütz.

1. Cystoclonium purpureum (Huds.) Batt.

K. B. 1934, no. 1, p. 16, fig. 12, pl. IV.
India: Karachi.

Calliblepharis Kütz.

1. Calliblepharis fimbriata Kütz.

K. B. 1932, no. 3, p. 128.
India: Karachi.

Fam. 3. ***Hypneaceæ.***

Hypnea Lamour.

1. Hypnea musciformis (Wulf.) Lamour.

K. B. 1934, no. 1, p. 17.
India: Karachi.

2. Hypnea Valentiæ (Turn.) Mont.

K. B. 1934, no. 1, p. 17.
India: Karachi.

3. Hypnea spicifera (Suhr) Harv.

K. B. 1934, no. 1, p. 18.
India: Karachi.

Fam. 4. ***Plocamiaceæ.***

Plocamium Lamour.

1. Plocamium coccineum (Huds.) Lyngb.

K. B. 1933, no. 3, p. 123.
India: Karachi.

2. Plocamium Telfairiæ Harv.

K. B. 1933, no. 3, p. 123.
India: Karachi.

Fam. 5. ***Sarcodiaceæ.***

Sarcodia J. Ag.

1. Sarcodia dichotoma Boergs.

K. B. 1933, no. 3, p. 122, fig. 8, pl. V.
India: Karachi.

Fam. 6. ***Gracilariaceæ.***

Gracilaria Grev.

1. Gracilaria confervoides (L.) Grev.

Greville, Alg. Brit., p. 123. Harvey, Phycol. Brit., pl. 65. *Fucus confervoides* L., Sp. Plant. II, 1629. For more synonyms compare De Toni, Syll. Alg. vol. IV, p. 431.

Of this very widely distributed species I have seen a specimen from Karachi.

India: Karachi, A. B. Kotwall.
Geogr. Distrib. Most warm seas.

2. Gracilaria foliifera (Forssk.) Boergs.

K. B. 1933, no. 3, p. 124.
India: Okha Port.

3. Gracilaria corticata J. Ag.

K. B. 1933, no. 3, p. 124.
India: Karachi, Dwarka.

4. Gracilaria arcuata Zan.

K. B. 1934, no. 1, p. 9, pl. III.
India: Karachi.

Corallopsis Grev.

1. Corallopsis Cacalia J. Ag.

K. B. 1934, no. 1, p. 8, fig. 6.
India: Okha Port.

Fam. 7. ***Phyllophoraceæ.***

Ahnfeltia Fries.

1. Ahnfeltia plicata (Huds.) Fr.

K. B. 1933, no. 3, p. 117.
India: Karachi.

V. Rhodymeniales.

Fam. 1. ***Rhodymeniaceæ.***

Subfam. 1. Rhodymenieæ.

Botryocladia Kylin.

1. Botryocladia leptopoda (J. Ag.) Kylin.

Kylin, Die Florideenordnung Rhodymeniales (Lunds Universitets Årsskrift N. F. Avd. 2. Bd. 27, 1931, p. 17, tab. 6, fig. 14). *Chrysymenia uvaria* var. *leptopoda.* J. Ag., Epicrisis p. 324. *Chrysymenia leptopoda* (J. Ag.) Weber, Algues Siboga, p. 467, fig. 200. *Chrysymenia uvaria* Okamura, Icon. Jap. Alg. pl. 184.

forma *luxurians* Børgs.

Chrysymenia Uvaria (L.) J. Ag. forma luxurians Børgs. in Kew Bulletin, no. 1, 1931, p. 8, fig. 5, pl. II, fig. 1.

In the paper quoted above Kylin divides the comprehensive genus *Chrysymenia* into several genera, giving the groups into which J. Agardh divided this genus (l. c.) generic value. In addition Kylin refers the Indian plant found by me to *Botryocladia leptopoda* = (*Chrysymenia uvaria* var. *leptopoda* J. Ag.) of which a small plant from northeast Australia is found in J. Agardh's herbarium in Lund. As to Agardh's description of this variety it must be said that it is not very good, for instance the extremely variable size of the vesicles is not mentioned. Hence, when determining my material I did not pay any attention to this variety. My plant when compared with it is much more richly provided with vesicles and seems on the whole to be much more luxuriantly developed; compare also Okamura's above quoted figure (pl. 184, fig. 1) in which the vesicles are placed rather scattered. In the Indian specimens the vesicles are generally present in such great numbers that they cover the branches entirely. It is, too, very characteristic of the Indian plant that the size of the vesicles

varies much. Quite small vesicles and rather big ones up to 4—5 mm in diameter are found mingled together, young ones being developed in between the older ones. The wall of the vesicles is about 60 μ thick. As pointed out by Kylin, it consists of two layers of cells. Innermost large cells are found on which now and then a single or, what is rare, a few gland cells are found facing the cavity. Above the large cells near the periphery there is a layer of small cells of somewhat variable size. Kylin often found it incomplete; in the Indian specimens examined by me it formed a dense cover. Besides the specimen from Australia another specimen from South-Arabia, as mentioned by Kylin, is found in Herb. J. Agardh.

India: Dwarka.
Geogr. Distrib. Arabian Sea, East Australia, Japan.

Coelarthrum Boergs.

1. Coelarthrum Muelleri (Sond.) Boergs.

K. B. 1931, no. 1, p. 9, figs. 6, 7.
India: Karachi.

Fam. 2. ***Champiaceæ.***

Champia Desv.

1. Champia compressa Harv. var. scindica (Harv.) Boergs.

K. B. 1933, no. 3, p. 117, figs. 3, 4; pl. V.
India: Karachi.

2. Champia somalensis Hauck.

K. B. 1933, no. 3, p. 119, figs. 5, 6.
India: Dwarka.

3. Champia indica Boergs.

K. B. 1933, no. 3, p. 120, fig. 7, pl. VI.
India: Dwarka, Okha Port, Karachi.

4. Champia parvula (Ag.) Harv.

K. B. 1933, no. 3, p. 122.
India: Okha Port.

Rhodymenia Grev.

1. Rhodymenia australis Sond.

Sonder in Bot. Zeit. 1845, p. 56. HARVEY, Phycologia Australica, tab. 146. *Acropeltis australis* Kütz., Tab. Phycol., vol. 19. tab. 34.

The specimens from Okha Port are small and sterile and the determination of them therefore not quite certain; from Bombay I have larger but sterile specimens which Mr. S. C. DIXIT has been so kind as to give me.

India: Okha Port, Bombay.
Geogr. Distrib. West Australia.

VI. Ceramiales.

Fam. 1. Ceramiaceæ.

Subfam. 1. Ceramieæ.

Ceramium (Roth) Lyngb.

1. Ceramium rubrum (Huds.) Ag. var. **virgata** Ag.

K. B. 1934, no. 1, p. 19.
India: Karachi.

2. Ceramium miniatum Suhr.

K. B. 1934, no. 1, p. 18.
India: Karachi.

Centroceras Kütz.

1. Centroceras clavulatum (Ag.) Mont.

K. B. 1934, no. 1, p. 18.
India: Karachi, Dwarka.

Subfam 2. Spyridieæ.

Spyridia Harv.

1. Spyridia alternans Boergs.

K. B. 1933, no. 3, p. 125, fig. 9, pl. VII.
India: Karachi.

2. Spyridia aculeata (Schimp.) Kütz. var. **inermis** Boergs.

K. B. 1931, no. 1, p. 15.
India: Dwarka.

Subfam. 3. Spongoclonieæ.

Haloplegma Mont.

1. Haloplegma Duperreyi Mont.

K. B. 1931, no. 1, p. 14, fig. 9.
India: Okha Port.

Subfam. 4. Griffithsieæ.

Griffithsia C. Agardh.

1. Griffithsia tenuis C. Ag.

K. B. 1931, no. 1, p. 11.
India: Dwarka, Okha Port.

2. Griffithsia flabelliformis Harv. (?).

Harvey in London Journal 1844, p. 540. *Griffithsia tasmanica* Kütz., Tab. Phycol. vol. XII, pl. 19. Askenasy, Alg. Exp. Gazelle, p. 36, tab. IX, figs 2, 3. *Griffithsia grandis* Kütz., Tab. Phycol., vol. XII, pl. 19.

At Dwarka a large *Griffithsia* was common, but although I have studied very much material all was sterile, and an exact determination is therefore out of the question. Nevertheless I feel sure that the Indian specimens are to be referred to *Gr. flabelliformis* Harv., as the vegetative thallus seems to agree perfectly with Harvey's description as well as

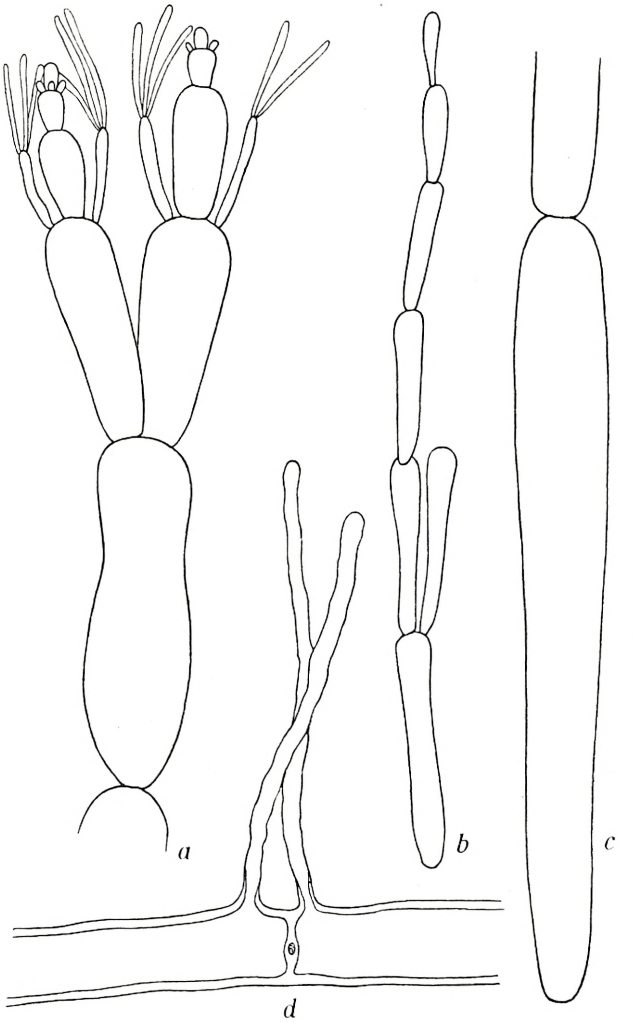


Fig. 6. *Griffithsia* spec. *a*, *b*, parts of the thallus near the apex; c, cell from near the base, *d*, part of thallus with rhizoids (*a*, about 150:1, *b*, *c*, *d* about 35:1).

with ASKENASY'S. When compared with KÜTZING'S figures of *Gr. tasmanica* and *Gr. grandis* the Indian specimens seem to have an intermediate position between these, the cells higher up in the thallus, reaching a breadth of about 2 mm,

thus being broader than those found in *Gr. tasmanica* and not quite so large as the cells in *Gr. grandis*.

India: Dwarka, Okha Port.

Geogr. Distrib. Tasmania, New Zealand, St. Paul.

3. Griffithsia spec.

This fine Griffithsia (Plate I) was found cast ashore at Okha Port. As the figure shows, it forms erect tufts, the branches being almost parallel and the filaments as well as the branches being straight and upward directed. The filaments are repeatedly furcated. The cells in the filaments are nearly cylindrical. Near the base the cells are about 250 μ thick and often very long, 2—3 mm or sometimes more (Fig. 6 *c*). Upwards the cells become gradually shorter and thinner. In the upper ends of the filaments the cells are almost oval and often a little broader at their upper ends (Fig. 6 *a*, *b*). Round the young cells a whorl of very perishable, a few times furcated hairs occur. Dwarf shoots are not present.

This plant is no doubt related to *Griffithsia subcylindra* Okam.[1] but the habit of the two plants seems to be rather different, and hairs are not recorded to be present in the Japanese plant. The Indian plant being sterile I prefer to let it remain unnamed.

India: Okha Port.

Fam. 2. ***Delesseriaceæ.***

Sufam. 1. Delesserieæ.

Hypoglossum Kütz.

1. Hypoglossum spathulatum Kütz.

K. B. 1932, no. 3, p. 128, fig. 13.

India: Okha Port.

[1] Okamura, K., On the Algæ from the Island Hatidyo (Records of Oceanographic Works in Japan, Vol. II, no, 2, p. 99, pl. 8, Tokyo 1930).

Membranoptera Stackh.

1. **Membranoptera Murrayi** Boergs.

K. B. 1933, no. 3, p. 130, figs 13—14, pl. VIII.
India: Karachi.

Subfam. 2. Nitophylleæ.

Myriogramme Kylin.

1. **Myriogramme okhaensis** Boergs.

K. B. 1931, no. 1, p. 22, fig. 14, pl. II, fig. 3.
India: Okha Port, Karachi.

Nitophyllum Grev.

1. **Nitophyllum punctatum** (Stackh.) Grev.

K. B. 1934, no 1, p. 19.
India: Karachi.

Subfam. 3. Sarcomenieæ.

Platysiphonia Boergs.

1. **Platysiphonia miniata** (Ag.) Boergs.

BØRGESEN, Sur *Platysiphonia* nov. gen. et sur les organes mâles et femelles du *Platysiphonia miniata* (Ag.) J. Ag. (Recueil de Travaux Cryptogamiques dédiés à LOUIS MANGIN, Paris 1931). *Sarcomenia miniata* (Ag.) J. Agardh, BØRGESEN in K. B. 1931, no. 1.

When I mentioned this species in the Kew Bulletin (l. c.) I based my description on a tetrasporic specimen, later on I succeeded in finding sexual plants and after having examined these I came to the conclusion that it was most correct to place this species and some related ones as belonging to a special genus: *Platysiphonia.*

India: Okha Port.

Cottoniella Boergs.

1. **Cottoniella fusiformis** Boergs.

K. B. 1931, no. 1, p. 20.
India: Karachi.

Claudea Lamour.

1. Claudea elegans Lamour.

K. B. 1933, no. 3, p. 132.
India: Karachi.

Fam. 3. ***Rhodomelaceæ.***

Subfam. 1. Laurencieæ.

Laurencia Lamour.

1. Laurencia cruciata Harv.

K. B. 1933, no. 3, p. 135.
India: Dwarka.

2. Laurencia pannosa Zan.

K. B. 1933, no. 3, p. 135.
India: Dwarka.

3. Laurencia virgata J. Ag.

K. B. 1934, no. 1, p. 21.
India: Karachi.

4. Laurencia hypnoides Børgs.

K. B. 1934, no. 1, p. 20.
India: Karachi.

5. Laurencia obtusa (Huds.) Lamx.

var. *divaricata* and var. *majuscula* Harv.
K. B. 1933, no. 3, p. 135 and K. B. 1934, no. 1, p. 20.
India: Dwarka.

6. Laurencia filiformis (Ag.) Mont.

K. B. 1934, no. 1, p. 20.
India: Karachi.

7. Laurencia platyclada Boergs.

K. B. 1934, no 1, p. 21, fig. 13, pl. III.
India: Karachi.

8. **Laurencia pedicularioides** Boergs.

K. B. 1933, no. 3, p. 136, pl. 9.
India: Dwarka.

Subfam. 2. Chondrieæ.

Chondria (C. Ag.) Harv.

1. **Chondria tenuissima** (Good. et Woodw.) Ag.

K. B. 1933, no. 3, p. 132.
India: Karachi.

2. **Chondria cornuta** Boergs.

K. B. 1932, no. 3, p. 130, fig. 15.
India: Karachi.

3. **Chondria dasyphylla** Ag.

K. B. 1932, no. 3, p. 132; 1933, no. 3, p. 133.
var. *stellata* Boergs.
K. B. 1933, p. 133, fig. 15, 16, pl. IX.
India: Dwarka.

Acanthophora Lamour.

1. **Acanthophora dendroides** Harv.

K. B. 1934, no. 1, p. 22, fig. 14, pl. IV.
India: Dwarka.

2. **Acanthophora Delilei** Lamx.

K. B. 1933, no. 3, p. 134.
Some of the sterile material referred to this species is perhaps *A. muscoides.*
India: Karachi, Okha Port.

Subfam. 3. Polysiphonieæ.

Polysiphonia Grev.

1. **Polysiphonia ferulacea** Suhr.

K. B. 1931, no. 1, p. 16.
India: Dwarka.

2. Polysiphonia elongata (Huds.) Harv.

K. B. 1934, no 1, p. 25.
India: Karachi.

3. Polysiphonia variegata (Ag.) Zan.

K. B. 1934, no. 1, p. 26.
India: Karachi, Okha Port.

Roschera Sonder.

1. Roschera glomerulata (C. Ag.) Web. v. B.

K. B. 1931, no. 1, p. 17, fig. 11.
India: Dwarka, Okha Port.

Subfam. 4. Lophotalieæ.

Lophocladia Schmitz.

1. Lophocladia Lallemandi (Mont.) Schmitz.

K. B. 1934, no 1, p. 28.
India: Okha Port.

Spirocladia Boergs.

1. Spirocladia barodensis Boergs.

Kgl. Danske Vidensk. Selskabs Biologiske Meddelelser, X, 8. København 1933.
India: Okha Port.

Subfam. 5. Herposiphonieæ.

Herposiphonia Naegl.

1. Herposiphonia tenella Nägl.

K. B. 1932, no. 3, p. 130.
India: Dwarka.

Subfam. 6. Polyzonieæ.

Leveillea Decsne.

1. Leveillea jungermannioides (Mart. et Her.) Harv.

Harvey in Mar. Bot. West Austr., 1855, p. 539. Falkenberg, Rhodomelaceen, p. 392, pl. 6, figs. 1—13; pl. 14, figs. 18—27. *Amansia jungermannioides* Martens et Hering in Flora, 1836, p. 485. For more litterature see De Toni, Syll. Alg. vol. IV, p. 1033.

The specimens found at Dwarka were all large but sterile. At Tuticorin I have found only a few small specimens provided with tetrasporangia. As described by Falkenberg, l. c., p. 398 the tetrasporangia are developed in the basal part of the young long shoots; the fertile specimens were gathered in March.

India: Dwarka.
Geogr. Distrib. Red Sea, Indian Ocean, Australia.

Subfam. 7. Pterosiphonieæ.

Pterosiphonia Falkenb.

1. Pterosiphonia cloiophylla (Ag.) Falkb.

K. B. 1934, no. 1, p. 29.
India: Karachi.

Subfam. 8. Dasyeæ.

Heterosiphonia Mont.

1. Heterosiphonia Muelleri (Sond.) De Toni.

K. B. 1931, no. 1, p. 18, fig. 12, pl. II, fig. 2.
India: Dwarka, Okha Port.

2. Heterosiphonia Wurdemanni (Baill.) Falkb.

forma *laxa* Boergs. K. B. 1934, no. 1, p. 29.
India: Okha Port.

Dasya C. Ag.

1. Dasya flagellifera nov. spec.

Frons ad 14 cm alta, in exsiccatis violacea-purpurea, mollissima, filiformis et teretiuscula, quoquoversum ramosa et penicillata, articulata et polysiphonia, articulis diametro fere æqualibus e cellulis pericentralibus quinis et cellula una centrali compositis. Frons corticata, in juvenili parte plantæ nuda. Rami irregulariter ordinati, in parte basali thalli longiores, sursum gradatim breviores. Penicilli, in parte adultiori thalli desunt, ramosi, monosiphonii, articulati, e cellulis in parte basali æque longis ca. 70—80 μ latis, ad apicem gradatim tenuioribus, partibus superioribus penicillorum flagriformibus, 2—3 μ latis, formatis. Penicilli curvati ad summam thalli vertentes. Stichidia in ramulis formata, ovato-lanceolata, pedicello uniarticulato munita.

Cystocarpia et antheridia ignota.

India: Okha Port, BØRGESEN no. 5549 (type), cast ashore.

The *Dasya* (Plate I) described above is an easily recognizable plant because of the flagella-like ends of the penicilli (Figs. 7, 8). These are curved upwards in such a way that the thin flagella-like upper ends become nearly parallel to the main stem. The largest specimen (I have found only two) reaches a height of nearly 14 cm, the main branches are about 1 mm thick. While the young branches are naked the older ones soon become corticated by means of rhizoids growing out from the pericentral cells and running down along the walls of these. In the young filaments not yet covered with cortex the segments are a little longer than their breadth; for instance one filament was 110 μ thick and the segments about 140 μ long; in the older filaments, densely covered with cortex, the segments

become longer in proportion to the increased thickness of the branch.

The plant (Plate I) is much and rather irregularly ramified, some of the penicilli now and then being transformed into branches, and furthermore adventitious branches are often formed from the older branches. While in the old parts of the thallus the branches are naked, the penicilli being shed, the younger and young parts are densely covered by these. The basal segment of each penicillus becomes plurisiphonous and enters as a segment into the sympodium of the main stem; all other segments in the ramified penicillus remain unicellular. The divergence between the ramuli is rather irregular, about $^1/_3$, but up to nearly $^1/_2$. The basal cells in the penicilli are the largest ones, about 70—80 μ thick, upwards the cells decrease rather quickly in size and all the branchlets of the penicillus end in long flagellate, upward directed filaments.

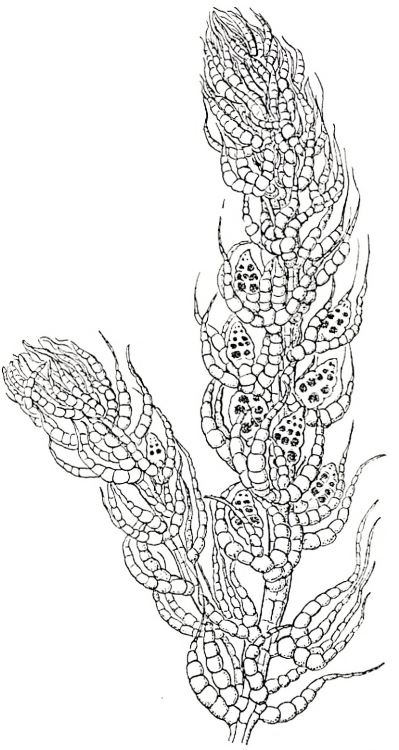


Fig. 7. *Dasya flagellifera* Boergs. Part of the thallus with stichidia. (About 40:1).

The stichidia (Fig. 7, 8) are formed by one of the branchlets in the penicilli; the basal cell in the branchlet remains unicellular forming a short stipe, while the other cells become plurisiphonous. When young the stichidia

are ovate-oblong of shape, becoming subcylindrical when they get older. The sporangia are about 130 μ broad. Only tetrasporic plants were found.

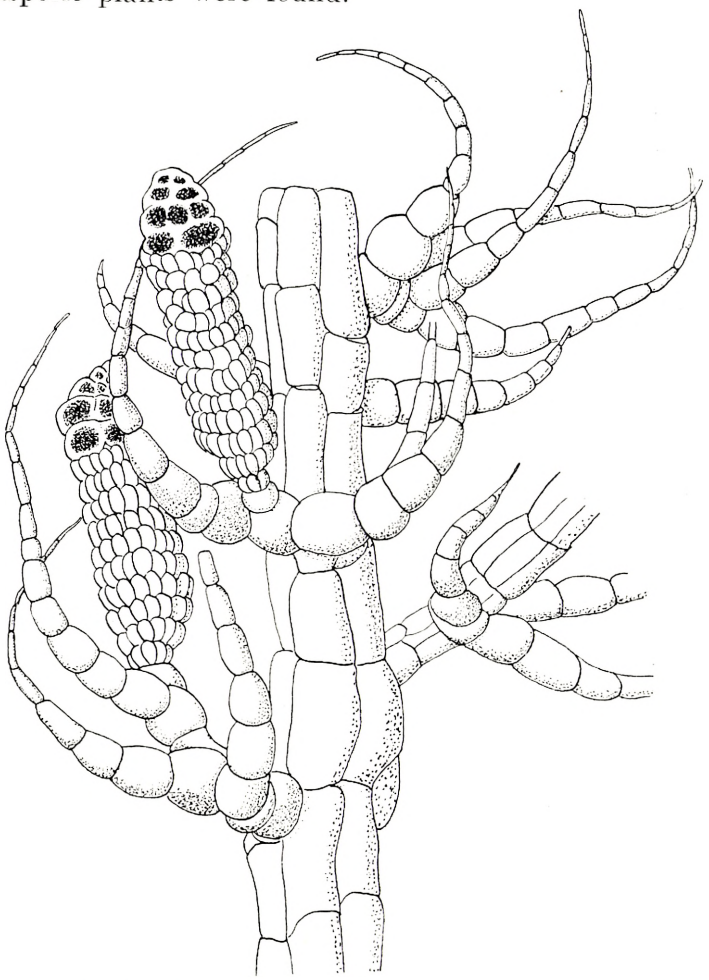


Fig. 8. *Dasya flagellifera* Boergs. Part of the thallus with stichidia. (About 150:1).

Dasya spec.

Besides the above described species a few others are found in my collections from Dwarka and Okha Port, one

of these resembling *D. punicea* very much, but the material is so poor that a determination was not possible.

Genera incertæ sedis.

Falkenbergia Schmitz.

1. Falkenbergia rufanulosa (Harv.) Schmitz.

K. B. 1933, no. 3, p. 132.

India: Dwarka.

TABLE OF SPECIES SHOWING THEIR GEOGRAPHICAL DISTRIBUTION

I wish to mention that in order to work out this list the very comprehensive table of distribution of the Malayan Algæ prepared by Madame WEBER v. BOSSE in her most valuable work on the Algæ of the Siboga-Expedition has been of very great help to me.

On account of varying definitions of species, uncertain information about localities etc. mistakes may of course occur.

	Atlantic Ocean			Cape	Indian Ocean				Pacific			
	West India, America	Europe, Africa	Mediterranean		Red Sea	Africa, India, Ceylon	Malayan Archipelago	S. W. Australia	Japan	N. E. Australia	Polynesia	America
Chlorophyceæ.												
Enteromorpha fleuxuosa (Wulf.) J. Ag...	+	+	+	+	+		+	+	+		+	+
Ulva Lactuca L.	+	+	+	+	+	+	+	+	+		+	+
Endoderma leptochæte Huber		+										
Valonia ægagropila C. Ag.	+	+	+		+	+	+				+	
Cladophoropsis Sundanensis Reinb.							+					
Boodlea composita (H. et H.) Brand.		+				+	+		+		+	

	Atlantic Ocean			Cape	Indian Ocean				Pacific			
	West India, America	Europe, Africa	Mediterranean		Red Sea	Africa, India, Ceylon	Malayan Archipelago	S. W. Australia	Japan	N. E. Australia	Polynesia	America
Valoniopsis pachynema (Mart.) Boergs.	+					+	+			+	+	
Willeella ordinata Boergs.[1]												
Chætomorpha media (Ag.) Kütz	+						+	+	+		+	+
— Linum (Muell.) Kütz.	+	+	+	+	+	+	+		+		+	+
Acetabularia caliculus Quoi et Gaimard	+					+		+	+			
Codium tomentosum (Huds.) Stackh.	+	+	+	+	+	+	+	+	+		+	+
— elongatum Ag.	+	+	+	+	+	+	+		+	+		+
Udotea indica A. & E. S. Gepp.						+						
Halimeda Tuna (Ell. et Sol.) Lamx.	+	+	+		+	+	+		+		+	+
Bryopsis plumosa (Huds.) Ag.	+	+	+	+			+	+	+		+	+
— hypnoides Lamour.	+	+						+	+			
Caulerpa sertularioides (Gmel.) Howe	+	+			+	+	+	+	+	+	+	+
— taxifolia (Vahl) Ag.	+	+			+	+	+		+	+	+	
— scalpelliformis (R. Br.) Web. v. B.		+			+	+	+	+	+	+		
— racemosa (Forssk.) Web. v. B.	+	+	+	+	+	+	+	+	+	+	+	
Vaucheria piloboloides Thur.		+	+									
Ostreobium Reineckei Born.	+						+				+	
Phæophyceæ.												
Ectocarpus Mitchellæ Harv.	+	+										+
Myriogloea Sciurus (Harv.) Kuck.				+						+		
Gonodia arabica (Kütz.) Boergs.		+				+						
Nemacystus decipiens (Sur.) Kuck.									+			
Rosenvingea intricata (J. Ag.) Boergs.	+	+					+				+	
Colpomenia sinuosa (Roth) Derb. et Sol.	+	+	+		+	+	+	+	+	+	+	+
— *stellata* (Boergs.) Boergs.												
Hydroclathrus cancellatus Bory.	+	+		+	+	+	+	+	+	+	+	+
Sphacelaria tribuloides Menegh.	+	+	+	+	+		+	+				
— furcigera Kütz.	+	+	+	+	+	+	+	+	+	+	+	+
Spathoglossum variabile Fig. et De Not.					+		+					
Stoechospermum marginatum (Ag.) Kütz.					+	+						
Zonaria variegata (Lamx.) Ag.	+	+			+	+	+			+	+	
Padina Commersonii Bory	+				+	+	+	+	+	+	+	
Dictyopteris australis Sond.						+		+		+		
Dictyota Bartayresiana Lamour.	+	+			+	+	+	+				

[1] Endemic species in italics.

	Atlantic Ocean			Cape	Indian Ocean				Pacific			
	West India, America	Europe, Africa	Mediterranean		Red Sea	Africa, India, Ceylon	Malayan Archipelago	S. W. Australia	Japan	N. E. Australia	Polynesia	America
Cystophyllum muricatum (Turn.) J. Ag.							+	+		+	+	
Sargassum tenerrimum J. Ag.						+						
Rhodophyceæ.												
Erythrotrichia carnea J. Ag.	+	+	+				+					+
Goniotrichum elegans (Chauv.) Le Jolis	+	+	+		+	+	+		+		+	+
Acrochætium crassipes Boergs.	+											
— *erectum* Boergs.												
— *Dwarkense* Boergs.												
Asparagopsis Sandfordiana Harv.								+	+			
Liagora ceranoides Lamx.	+	+			+	+	+	+	+			
Helminthocladia australis Harv.								+	+			
Scinaia Hatei Boergs.												
— *indica* Boergs.												
Gloiophloea fascicularis Boergs.												
Galaxaura oblongata Lamx.	+	+	+		+	+	+		+			
Gelidium pusillum (Stackh.) Le Jolis	+	+	+		+		+	+	+		+	+
Echinocaulon acerosum (Forssk.) Boergs.	+	+	+		+	+	+		+		+	
Chondrococcus Hornemanni (Mert.) Schmitz				+	+	+	+	+	+		+	+
Amphiroa fragilissima (L.) Lamour.	+	+	+			+	+		+		+	+
— anceps (Lamk.) Decsne.	+			+		+	+	+			+	
Corallina officinalis L.	+	+	+	+					+			+
Jania rubens (L.) Lamx.	+	+	+	+	+	+	+		+		+	
Grateloupia indica Boergs.												
Halymenia porphyroides Boergs.				+								
— *venusta* Boergs.												
— *polydactyla* Boergs.												
Cryptonemia undulata Sonder.								+				
— Lomation (Bertel) J. Ag.		+	+				+					
Solieria robusta (Grev.) Kylin							+	+	+			
Sarconema furcellatum Zanard.					+	+						
— *scinaioides* Boergs.												
— furcatum Boergs.												
— filiforme (Sond.) Kylin.								+				
Meristotheca papulosa (Mont.) J. Ag.					+							

	Atlantic Ocean			Cape	Indian Ocean				Pacific			
	West India, America	Europe, Africa	Mediterranean		Red Sea	Africa, India, Ceylon	Malayan Archipelago	S. W. Australia	Japan	N. E. Australia	Polynesia	America
Cystoclonium purpureum (Huds.) Batt.	+	+										
Calliblepharis fimbriata Kütz.				+								
Hypnea musciformis (Wulf.) Lamour.	+	+	+	+	+	+	+	+	+		+	+
— Valentiæ (Turn.) Mont.	+		+		+	+	+		+		+	
— spicifera (Suhr) Harv.				+								
Plocamium coccineum (Huds.) Lyngb.	+	+	+	+				+	+			+
— Telfairiæ Harv.						+		+	+	+		
Sarcodia dichotoma Boergs.												
Gracilaria confervoides (L.) Grev.	+	+	+	+		+	+	+	+	+	+	+
— foliifera (Forssk.) Boergs.	+	+	+	+	+	+	+		+		+	
— corticata J. Ag.					+	+						
— arcuata Zan.			+		+		+		+		+	
Corallopsis Cacalia J. Ag.					+	+	+		+		+	
Ahnfeltia plicata (Huds.) Fr.	+	+										+
Botryocladia leptopoda (J. Ag.) Kylin						+			+	+		
Coelarthrum Muelleri (Sond.) Boergs.								+	+			
Champia compressa Harv.				+		+	+	+	+		+	
— somalensis Hauck						+						
— *indica* Boergs.												
— parvula (Ag.) Harv.	+	+	+				+	+	+		+	
Rhodymenia australis Sond.								+				
Ceramium rubrum (Huds.) Ag. var. virgata Ag.	+	+										
Ceramium miniatum Suhr.								+				Peru
Centroceras clavulatum (Ag.) Mont.	+	+	+	+	+	+	+	+	+	+	+	+
Spyridia alternans Boergs.												
— aculeata (Schimp.) Kütz. var. inermis Boergs.	+	+	+		+							
Haloplegma Duperreyi Mont.	+	+		+		+	+	+			+	
Griffithsia tenuis C. Ag.	+	+	+			+		+	+		+	
— flabelliformis Harv. (?)								+			+	
Hypoglossum spathulatum Kütz.							+	+		+		
Membranoptera Murrayi Boergs.												
Myriogramme Okhaensis Boergs.												
Nitophyllum punctatum (Stackh.) Grev.	+	+	+									
Platysiphonia miniata (Ag.) Boergs.		+		+								

	Atlantic Ocean			Cape	Indian Ocean				Pacific			
	West India, America	Europe, Africa	Mediterranean		Red Sea	Africa, India, Ceylon	Malayan Archipelago	S. W. Australia	Japan	N. E. Australia	Polynesia	America
Cottoniella fusiformis Boergs.		+										
Claudea elegans Lamour.							+	+				
Laurencia cruciata Harv.								+				
— pannosa Zan.					+		+					
— virgata J. Ag.				+								
— hypnoides Boergs.					+							
— obtusa (Huds.) Lam.												
— — var. majuscula Harv.						+		+	+			
— — var. divaricata (J.Ag.) Yam.					+							
Laurencia filiformis (Ag.) Mont.								+				
— *patyclada* Boergs.												
— *pedicularioides* Boergs.												
Chondria tenuissima (Good. et Woodw.) Ag.	+	+	+				+	+	+			
— *cornuta* Boergs.												
— dasyphylla Ag.	+	+	+		+	+	+	+	+			
— — var. *stellata* Boergs.												
Acanthophora dendroides Harv.						+	+	+				
— Delilei Lamx.			+		+							
Polysiphonia ferulacea Suhr.	+	+					+	+	+		+	
— elongata (Huds.) Harv.	+	+	+									
— variegata (Ag.) Zan.	+		+									
Roschera glomerulata (Ag.) Web. v. B.						+	+	+	+	+	+	
Lophocladia Lallemandi (Mont.) Schmitz			+		+	+	+	+	+			
Spirocladia Barodensis Boergs.												
Herposiphonia tenella Nägl.	+	+	+			+	+				+	
Leveillea jungermannioides (Mart. & Her.) Harv.					+	+	+	+	+		+	
Pterosiphonia cloiophylla (Ag.) Falkb.				+								
Heterosiphonia Muelleri (Sond.) De Toni							+	+				
— Wurdemanni (Baill.) Falkb. f. laxa Boergs.	+	+	+				+					
Dasya flabellifera Boergs.												
Falkenbergia rufolanosa (Harv.) Schmitz.							+	+	+			

SOME PLANT GEOGRAPHICAL CONSIDERATIONS

With a map (plate II) showing the distribution of some of the species.

In view of the fact that this investigation can only be based upon the very small number of species till now found in the northern Arabian Sea, in proportion to what more thorough investigations ought to produce the result must of course temporarily be considered rather incomplete, and the figures mentioned must only be taken as quite preliminary; but nevertheless this comparison seems to me to give something of interest.

I have several times before pointed out the striking fact that several characteristic species hitherto only known from West- and South-Australia have now also been found in the northern part of the Arabian Sea. It is therefore of interest first to examine how many of the species found in the northern Arabian Sea are also present in West- and South-Australia. But before starting this comparison I wish to point out that of the 137 species and varieties mentioned in the list, 22 are described as new and must therefore for for the present be considered endemic; and to these must further be added *Udotea indica* A. & E. S. Gepp which till now has been found nowhere else. When these 23 species are deducted 114 species are left. Of these 114 species 54 or 47.4 $^0/_0$ are also found in West- and South-Australia and if the whole of Australia is considered the common number will rise to 60 species or 52.6 $^0/_0$, i. e. a little more than half. Among the species in common are several characteristic Australian species: *Dictyopteris australis, Cryptonemia undulata, Sarconema filiforme, Claudea elegans*

(a fragment of this species has according to M^me^ WEBER VAN BOSSE been found at Ambon), *Laurencia cruciata* and *Laurencia filiformis*, *Heterosiphonia Muelleri* (also found in a few places in the Malayan Archipelago), *Ceramium miniatum* (also known from Peru). While these characteristic species with the exceptions mentioned have so far been known only from Australia, I shall in this connection mention some other Australian species which are also known from Japan and nowhere else until they were now found in the northern part of the Arabian Sea also, namely: *Coelarthrum Muelleri*, *Botryocladia leptopoda*, *Helminthocladia australis*, *Asparagopsis Sandfordiana*, *Plocamium Telfairiæ* (also known from Mauritius), besides *Solieria robusta*, *Falkenbergia rufolanosa* and *Laurencia obtusa majuscula* (the 3 last mentioned also found in the Malayan Archipelago). The occurrence of these species, almost all large and characteristic, so far from their earlier known habitats must be said to be highly interesting. To be sure it must be considered that the climatic conditions under which the algæ live in the above-mentioned areas may be supposed to be somewhat alike since in the Arabian Sea the Tropic of Cancer passes just between the localities I have examined, as Karachi lies at about 25° n. lat. and Dwarka and Okha Port a little north of 22° n. lat., and the Tropic of Capricorn passes about the middle of the West coast of Australia. But even if the climatic conditions seem to be much the same and thus must be supposed to create the conditions requisite for a somewhat similar algal flora, the whole tropical belt comes in between as an obstruction. In this connection I shall only point out that already at Bombay the conditions are very different from those at Dwarka and the algal flora accordingly quite different. And the tropical Malayan algal flora must

be said to be so well known in consequence of M^me^ WEBER's thorough investigations that most likely rather few of the above-mentioned species or none at all will be found here except the few species already mentioned.

With Japan there are 55 species (48 %) in common. Besides the above-mentioned species in common with Australia and now also found in the northern part of the Arabian Sea I shall further mention *Nemacystus decipiens* till now only known from Japan where it is a common species and used for food by the population.

With the Cape there is a somewhat smaller number of the species till now found in the Arabian Sea in common, viz. 28 (24.5 %). But among these 28 species are several characteristic species which till now have only been known from the Cape or have their main distribution there, such as *Calliblepharis fimbriata, Hypnea spicifera, Halymenia porphyroides, Laurencia virgata, Pterosiphonia cloiophylla* as well as *Myriogloea Sciurus* (also known from Australia) and *Platysiphonia miniata* (also known from Cadiz).

With the Malayan Archipelago there are 63 species in common or 55 %. By far the most of these species have a large distribution inside the tropical and subtropical belt.

With southern India, Ceylon as well as tropical Africa the number of species in common is 53 or 46.6 %, rather a small number, but it must be considered that most of the areas in question have been comparatively little examined or the collections made there are in most cases not worked out yet.

With the Red Sea there are 44 species or 38.5 % in common; among these I shall just mention *Meristotheca papulosa* which appears to come very near to *Meristotheca japonica;* besides *Laurencia obtusa* var. *divaricata, Laurencia hyp-*

noides and furthermore *Sarconema furcellatum* (also known from Somali-Land) and *Laurencia pannosa*, also known from the Malayan Archipelago.

If we at last pass on to the Mediterranean and the Atlantic Ocean the number of species in common with them is 68 or 59.6 %. This large number is of course principally due to the fact that these areas of the sea belong to the best known and if the list is examined a little more carefully it will be seen that by far the most of the species common to the localities are tropical or subtropical species with a large distribution. But it cannot be denied that among these species some are found which deserve to be noticed a little more carefully. Thus the presence of *Cystoclonium purpureum* in the Arabian Sea seems strange. *Cystoclonium purpureum* is an alga occurring from the coasts of the Murman and White Sea down to the coasts of France and by Jónsson and myself in our paper "On the distribution of the marine Algæ of the Arctic Sea and of the northernmost part of the Atlantic" (Botany of the Færöes, Part III, Copenhagen 1908, Appendix) referred to the cold-boreal group; it is reported from the Adriatic Sea but its presence there is rather uncertain. It is consequently rather remarkable to find it in the northern part of the Arabian Sea. The same is the case with *Ceramium rubrum virgatum* which, according to what Dr. H. E. Petersen who has made the study of the genus *Ceramium* a speciality, has most kindly communicated to me about the Indian plant, is quite identical with the form which is found for instance along the coasts of the Faeröes. *Ceramium rubrum virgatum* is according to J. Agardh (Species Alg., vol. II, p. 128) distributed from the Arctic Sea southwards to Spain (Cadiz) and furthermore it is said to be known from Brazil and "in mari australi"; whether the plants

from the last mentioned localities are the same as the northern form is, however, uncertain and can only be proved through examination of original specimens.

Further *Polysiphonia elongata* must be mentioned as very common along the coast of the northern Atlantic Ocean where on the European side it extends as far as till North Africa. In the Arctic Sea it is known from West Greenland and Spitzbergen and accordingly referred by Jónsson and myself to the boreal-arctic group; it is reported from Brazil but at all events skips West India and tropical Central America; moreover it has been found in the Mediterranean and the Black Sea. Then there is *Ahnfeltia plicata* which is found in several localities in the Arctic Sea to which in 1933 was added East Greenland where it has been found by mag. sc. Søren Lund in Hurry Inlet. In Jónsson's and my paper it is referred to the boreal-arctic group. In the North Atlantic it extends to the coasts of Spain; it is reported from Brazil and the Kerguelen Islands. Finally *Corallina officinalis* must be mentioned; it is found at the shores of the Murman and White Sea, and round Iceland, passing southwards along the European coasts; furthermore in the Mediterranean and the Black Sea and at Japan. In Jónsson's and my paper it is referred to the cold-boreal group.

Concerning *Membranoptera Murrayi* I should like, while I am mentioning these northern species, to point out that, if I, when I described it as a new species, had been aware that several northern species were found in the Arabian Sea I should most certainly not have separated it from *Membranoptera alata* to which the North Indian plant is very related. Regarding the distribution of *Membranoptera alata* it is known from Arctic North America, South West

Iceland and Finmark in the North, passing through the North Atlantic to the coasts of France, and has moreover been found in Kamtschatka. In JÓNSSON's and my paper it is referred to the cold-boreal group.

Of species with a western distribution I have still to mention *Nitophyllum punctatum* distributed in the Atlantic and the Mediterranean Sea and *Polysiphonia variegata* and *Heterosiphonia Wurdemanni* known from the West Indies and the Mediterranean Sea, the latter found also in the Malayan Archipelago.

In connection with my statement above concerning *Membranoptera Murrayi* I may further point out that, several other of the species described as new must be said to be very closely related to earlier described species. As to these facts I refer the reader to my description of the species in question, only mentioning here that *Scinaia indica, Halymenia venusta* and *Champia indica* come very near to *Scinaia moniliformis* J. Ag., *Halymenia Harveyana* J. Ag. and *Champia affinis* (H. et H.) J. Ag. from South Australia and that *Halymenia polydactyla* is nearly related to *Halymenia Agardhii* from the West Indies and Japan. On the other hand, several of the species which I thought I could refer to earlier described species have often shown small divergences, but for want of reliable (type specimens) and sufficient material of these species for comparison with the Indian specimens, and since I have often had in the Indian material only a single or very few specimens for examination, I have preferred to refer these specimens to earlier known species, at the same time pointing out these divergences. To such species must be reckoned for instance: *Agardhiella robusta, Botryocladia leptopoda, Coelarthrum Muelleri, Heterosiphonia Muelleri, Platysiphonia miniata* and *Hypnea spicifera*.

On account of the long isolation to which the algal flora in the northern part of the Arabian Sea has been exposed and through which the external conditions have of course been altered more or less it is, however, not to be wondered at that a differentiation has taken place more or less and that the species here show bigger or smaller divergences from the nearly-related forms from the distant localities where they are now met with.

But how are we to explain this strange discontinuous distribution? If it had to be explained by means of the existing conditions it would be difficult or rather, impossible. So much can be said at all events that the present nearly related algal floras now living so far from each other must be supposed to originate from an area which in former times they had in common. Whether an earlier existing Gondwanaland[1] will be taken as a starting point or WEGENER'S[2] ingenious hypothesis[3] on the origin of the continents and oceans is to be adopted, will be of minor importence.

Already SVEDELIUS has in his well known work: "On the discontinuous geographical distribution of some tropical and subtropical marine Algae"[4] examined the distribution

[1] On this question compare ARGAND, É., La Tectonique de l'Asie (Congrès Géologique International. Comptes rendus de la XIII[e] Session, en Belgique 1922, Liège 1924, pp. 313—221, fig. 6).

[2] WEGENER, ALFRED, Die Entstehung der Kontinente und Ozeane. 4te umgearbeitete Auflage. Die Wissenschaft, Bd. 66. Braunschweig 1929.

[3] As might be expected, this bold hypothesis brought about a lively discussion among geologists and zoologists as well as botanists, and while several scientists have accepted it, it has of course also met with much criticism among botanists too. See Handwörterbuch der Naturwissenschaften, zweite Aufl., 4ter Bd. Geographie der Pflanzen, 2. Genetische Pflanzengeographie (Epiontologie) von C. SCHRÖTER mit Beiträgen von F. FIRBAS 1934.

[4] In Arkiv för Botanik, Bd. 19, Stockholm 1924.

of several groups and species of algæ in the Indian Ocean in connection with their (or nearly related forms') distribution in the Mediterranean Sea and speaks of a former centre in the Indian Ocean common to the species that have now migrated to the Mediterranean.

Regarding the remarkable presence of the north-European species in the Arabian Sea they must be supposed, if really present there, to have come there from the north-west when open connections with the Indian Ocean still existed, in quite the same way as SVEDELIUS, as mentioned above, is of opinion that several forms in the Mediterranean have come there from the southeast. HAMEL[1] and later FELDMANN[2] because of new discoveries of Indo-Pacific algæ in the Mediterranean have expressed their opinion in accordance with SVEDELIUS.

It is of course another question how it has been possible for these northern algæ to live so near the tropical zone.

First it must be pointed out that our knowledge of the oceanographical conditions in the northern part of the Arabian sea seems yet to be rather incomplete. According to the chart of Deutsche Seewarte the temperature of the coldest month, February, is near Karachi about 22° C. and in the warmer months about 3° higher, temperatures which must be said to be very high or rather too high for these northern species. But of course areas with colder water may be found in some localities. As during the north east monsoon the wind in the Arabian Sea blows from the shore and consequently the surface water is carried away from land, it must be supposed that some upwelling of

[1] HAMEL, G., Origine de la Flore de la Méditerranée orientale. Travaux Cryptogamiques dédiés à Louis Mangin. Paris 1931, p. 311.

[2] FELDMANN, J., Note sur quelques Algues marines de Tunisie. Station Océanographiques de Salammbô. Notes No. 24, Tunis 1931.

cold water from the deep takes place, but nothing more definite seems to be known about this, especially regarding the conditions near Karachi. Nevertheless some observations from other localities in the Arabian Sea seem to indicate that something similar may also take place there.

Quite recently in "Nature", Jan. 20, 1934, pp. 87—88 the leader of "The John Murray Expedition to the Arabian Sea", Lieut.-Col. R. B. Seymour Sewell has given a preliminary communication of some of the results obtained. He writes: "At three places along the Arabian coast, lines of stations were run in order to detect if possible, any upwelling of cold antarctic bottom-water; but so far as our observations go, there was no sign of any such phenomenon. On two occasions, off Ras Sukra and Ras Madraka, at the two ends respectively of Sukra Bay, there was a definite fall in the temperature of the surface water by as much as 2.5°; this apparently was not due to the upwelling of deep water, but was probably caused by water upwelling from only moderate depths under the influence of the tidal currents". When this takes place off the Arabian coast it may as well take place off the Indian coast near Karachi, where these northern Algæ have been found. Further south they surely do not exist; in any case I have not come across any of them in my material from Dwarka and Okha Port. But here too the temperature of the sea seems to be rather low. Thus Hornell in his work on the marine zoology of Okhamandal mentions several times the low temperature of the sea, for instance p. 3 where he writes: "The cause of the unsatisfactory diving lay in the chilliness of the December and January winds and the comparatively low temperature of the water".

The algal flora at present found in the northern part of

the Arabian Sea may be said in some measure to form a parallelism to the algal flora of the West Indies, as the algal floras of both these areas show a considerable likeness to areas at present very distant, the West Indian algal flora showing great likeness to that of the Indo-Pacific Ocean.

Already GEORGE MURRAY mentioned this strange resemblance. In "Phycological Memoirs", part. II, 1893, p. 68 he writes: "We have here two tropical marine floras cut off from each other by a permanent continental area, and communicating only via the Cape". Regarding the genus *Caulerpa* SVEDELIUS[1] pointed this out in 1905 in his valuable work on the *Caulerpas* of Ceylon, arriving at the conclusion that this great resemblance is due to former open connections with the Pacific, and OSTENFELD[2] (1915) in his paper on the distribution of the seagrasses and I myself[3] regarding the whole flora in the concluding comments in my West Indian algal flora have come to the same conclusion in accordance with the hypothesis of SVEDELIUS.

In quite the same way as the West-Indian algal flora was completely cut off from any connection with the closely related Indian-Pacific algal flora by the formation of Central America, thus the algal flora at present found in the northern part of the Arabian Sea and which shows relationships to the north-west with that of the Mediterranean Sea and the North-Atlantic and towards the south and east with the Cape, Australia and Japan must have been cut off partly by an altered distribution of land and

[1] SVEDELIUS, N., Ecological and Systematic Studies of the Ceylon Species of Caulerpa. Ceylon Marine Biological Reports, no. 4, June 1906.

[2] OSTENFELD, C. H., On the geographical distribution of the Sea-Grasses. Proced. Roy. Soc. Victoria, vol. 27, N. S. Pt. 2, Melbourne 1915.

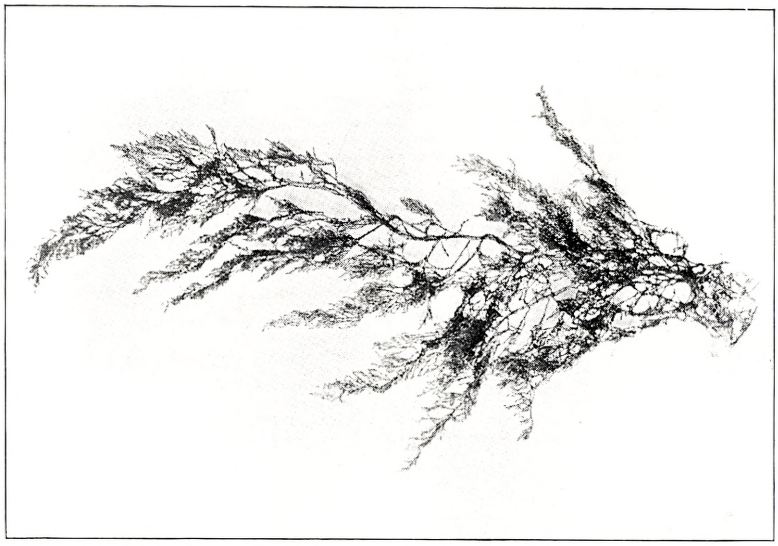
[3] BØRGESEN, F., The marine Algæ of the Danish West Indies. Vol. II, Rhodophyceæ. Copenhagen 1915—20, pp. 491—495.

sea partly by the intervening broad tropical belt from any connection with related floras at present far-off.

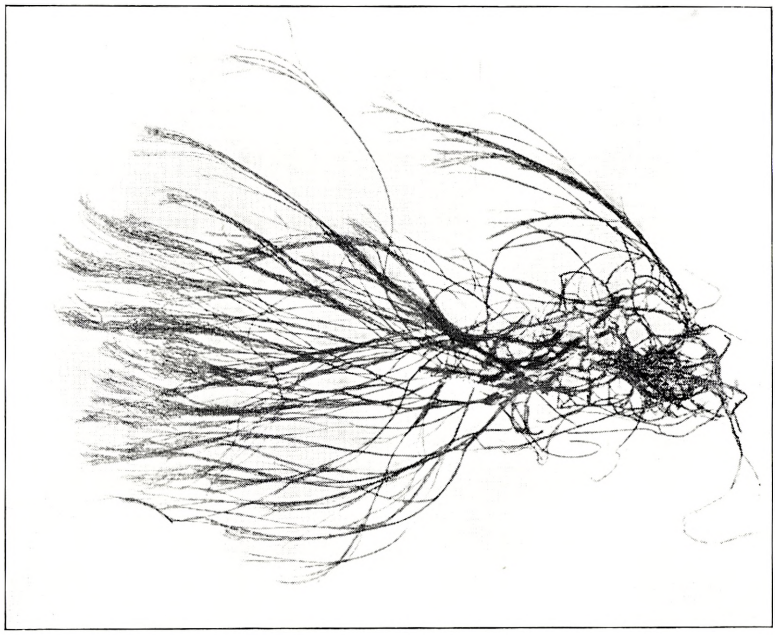
Finally I should like to say that it is to be hoped that more thorough investigations of these localities so very interesting in an algological respect may soon be undertaken. Especially near Karachi it would be of great interest to confirm the presence of the above-mentioned northern species found there in 1883 by James A. Murray according to his collections in the Kew Herbarium.

CONTENTS

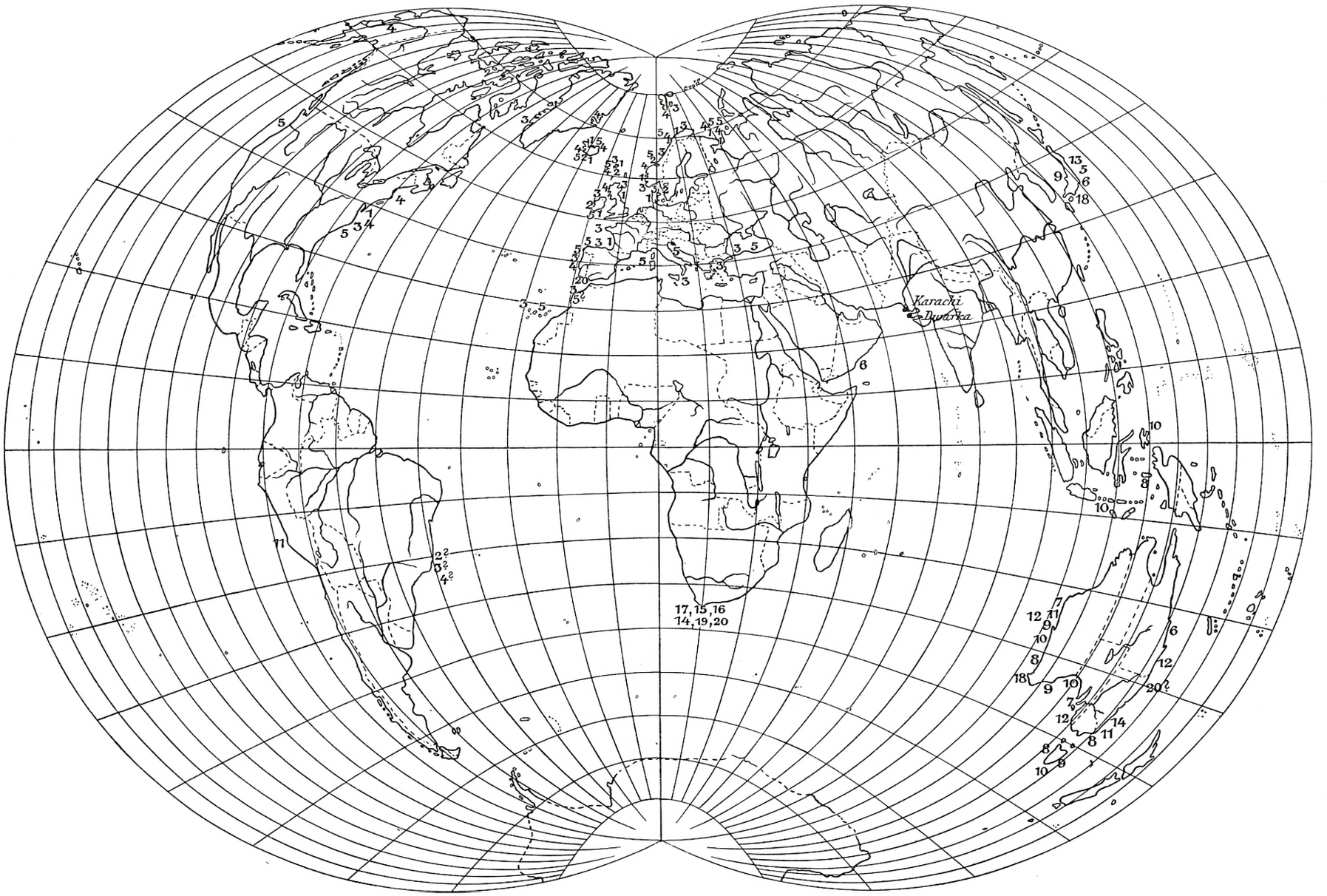
Færdig fra Trykkeriet den 2. Juni 1934.



Dasya flagellifera. (About half natural size).



Griffithsia spec. (Natural size).



1. *Cystoclonium purpureum.*
2. *Ceramium rubrum virgatum.*
3. *Polysiphonia elongata.*
4. *Ahnfeltia plicata.*
5. *Corallina officinalis.*
6. *Botryocladia leptopoda.*
7. *Cryptonemia undulata.*
8. *Claudea elegans.*
9. *Coelarthrum Muelleri.*
10. *Heterosiphonia Muelleri.*
11. *Ceramium miniatum.*
12. *Dictyopteris australis.*
13. *Nemacystus decipiens.*
14. *Myriogloea Sciurus.*
15. *Calliblepharis fimbriata.*
16. *Pterosiphonia cloiophylla.*
17. *Hypnea spicifera.*
18. *Helminthocladia australis.*
19. *Laurencia virgata.*
20. *Platysiphonia miniata.*

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