

The Fucaceæ of Japan.

By

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With 18 plates.

INTRODUCTION.

The family *Fucaceæ* (*Cyclosporeæ*) is in the present paper taken with the same limitations as by KJELLMAN¹⁾ in ENGLER and PRANTL's "Die Natürlichen Pflanzenfamilien," in which he included the *Sargassaceæ* and *Fucaceæ* of other systematists.

In the "Nippon Sōrui Mēi" (Enumeration of the Algæ of Japan) published by Dr. K. OKAMURA²⁾ in 1902, 56 species of Fucaceous algæ are mentioned under 7 genera. The list comprises all known species from Japan reported by various botanists up to that date. Among those mentioned, 39 species belong to the genus *Sargassum*, 8 to *Cystophyllum*, and one or two to each of the remaining genera.

The first knowledge of Japanese *Sargassum* we owe to the elaborate work of TURNER.³⁾ A few species more were added by various European algologists, such as C. AGARDH,⁴⁾ KÜTZING⁵⁾

1) 1 Theil. 2. Abth. p. 268.

2) pp. 137-160.

3) *Historia Fucorum*. 1808-1818.

4) *Species Algarum*. 1821, 1828.

5) Ueber die Eigenthümlichkeit der Vegetation in die chinesischen und japanischen Meeren—*Botanische Zeitung*, 1843. s. 53-57.

and HARVEY.¹⁾ In his classical work "Species Sargassorum Australiæ," J. AGARDH revised all the species of *Sargassum* known from the Australian seas as well as those from the coast of Japan and the Indian Ocean, adding at the same time, a large number of new species described by him. He²⁾ again revised *Sargassum* of Japan in "Analecta Algologica" and added a few other species. Before the last mentioned publication appeared DE TONI included all known species up to that time in his "Sylloge Algarum." The Japanese forms mentioned in that work numbered 39 species and 3 varieties inclusive of the doubtful species described by the early writers. OKAMURA'S enumeration noted above is based entirely upon DE TONI'S work.

Any one who tries to touch upon the *Sargassum* and *Cystophyl-lum* of Japan encounters the utmost difficulty in identifying the specimens with the descriptions. The plants under these genera vary greatly in their morphological characters according to the age of the individual and the conditions of its environment: and not a few species have their upper parts so wholly unlike their lower portions, that it would be quite impossible to imagine the former in cases in which the latter alone were given. Many of the species assigned to the coast of Japan and established by European botanists were based upon fragmentary and sterile specimens of such variable plants as mentioned above found floating on the sea or cast ashore. And moreover the species described by HARVEY and by J. AGARDH have never been illustrated. The present writer could not restrain an exclamation of impatience at a diagnosis of a few lines which was satisfactorily

1) Characters of New Algae chiefly from Japan and adjacent Regions collected by CHARLES WRIGHT in the North Pacific Expedition under Captain RODGERS.—Proceedings of the American Academy of Art and Science. Vol. V. 1859, p. 327-334.

2) De Speciebus Sargassorum Japonicis Scholia. (Anal. Algol. cont. III. p. 49-61).

applicable to several entirely different species. It must be confessed that the most puzzling points in the course of the present study lay in such descriptions and their derivations. As will be found in this paper, among the 39 species of *Sargassum* hitherto annexed to the Japanese algal flora only 18 seem to me to remain as "good" species. The accompanying plates, superfluous as some of them may seem, will give no small advantage to those who may hereafter touch upon the *Fucaceæ* of Japan.

The morphological characters of *Sargassum* have been minutely discussed by J. AGARDH in "Species Sargassorum Australia," and few points need further remark. His observations, however, seem to me, undoubtedly to have been based upon herbarium specimens. Close observation of the plants *in vivo* may reveal interesting and important facts to amplify or to modify his conclusions. Some points which are directly connected with Japanese forms will be noted in the present paper under the species concerned.

Among the members which are grouped in the series *Acanthocarpicæ* J. AG. and *Malacocarpicæ* J. AG. under the subgenus *Eusargassum* J. AG., there are not a few species which cannot be separated from one another without a knowledge of the reproductive organs. GRUNOW¹⁾ seems to have believed that *Sargassum polycystum* is a diœcious plant with smooth male receptacles and prickly female ones. If the presence or absence of the prickly processes on the receptacle be due to the sex, then there is no reason for separating the *Acanthocarpicæ* from the *Malacocarpicæ*. This question, however, is not yet satisfactorily settled. The plant which I have identified as *Sargassum*

1) Forschungsreise der Gazelle. p. 26.

Ilicifolium var. *duplicatum* in the present paper had some of its receptacles quite smooth and some undoubtedly prickly; and a male plant referable, though not without some hesitation, to the same species is provided with prickly receptacles. These facts seem to disprove GRUNOW's remark.

O'KUNTZE revised the *Sargassum* species in 1881¹⁾ and in 1898.²⁾ In so far as it relates to the Japanese species his view is so divergent from that of the systematists of the present day that I can not venture to follow his specific arrangement. He seems to have taken the relative positions of receptacles, vesicles, and leaves in an individual as characters of little importance in defining a species. As a result, some of the members of *Cystophyllum* in our classification are by him referred to *Sargassum*. I have therefore found it advisable not to take his opinions into consideration in the present work except on one or two points.

The present study was first suggested by Dr. K. KISHINOUE of the Imperial Fisheries Bureau of the Department of Agriculture and Commerce. In 1902, circulars were sent to twenty two Marine Experiment Stations along our coasts, requesting the collection of specimens of *Sargassum* and its allies. Numerous specimens of the genus mentioned as well as of *Cystophyllum*, etc., all entire and perfect, were sent to the Bureau. The material was examined carefully together with the dried specimens in the writer's herbarium. For certain reasons the study could not be carried on under the Bureau and all of the material was entrusted to the writer for the execution of the work.

1) Revision von *Sargassum* u. das sogenannte Sargassö Meer. ENGLER'S Bot. Jahrb. Bd. 1, 1881.

2) Revisio Genera Plantarum. III. II.

In the year 1905, the results were published as a preliminary report on the Fucaceous algae of Japan in the Tokyo Botanical Magazine.¹⁾ In that report the present writer asked for the loan of specimens to enable him to secure as complete data as possible in discussing the distribution of the family on our coasts, and several botanists who had specimens in their herbaria kindly forwarded them for the writer's examination. Prof. K. MIYABE who had for twenty years carefully studied the marine flora of Hokkaido placed all his collection, together with that of the Fisheries Department of the Hokkaido Local Government, at the writer's disposal. These extensive collections have thrown much light upon the northern species, as may be seen under the proper headings. The present writer may declare with assurance that few species of the family *Fucaceæ*, if any, are likely to be found in Hokkaido to be added to the present work. Only by the unequalled kindness of Prof. MIYABE was such a result possible. A species found in his collection, undoubtedly new to science, is described in this paper under the name *Sargassum Miyabei* in recognition of his generosity.

Greatly to the regret of the writer it is necessary to say that the coast of Loochoo as well as that of the southern parts of the Kiushiu Islands have not been thoroughly botanized. The specimens from those localities were few in number and often fragmentary. Many of them belonged to the "duplicate-leaved" form, the most questionable members of *Sargassum*. Some of them were sent to Major THEO. REINBOLD for his opinion on them; and he was so kind as to take the trouble to compare them with the authentic specimens and to give invaluable advice

1) Vol. 19. No. 222. pp. 149-161.

to the writer. The whole responsibility, however, with respect to the references and determination, rests with the present author.

The species described by HARVEY as new, in his paper entitled "Characters of New Algæ," i. e., were not described in full, and none of them were illustrated by the author or by any subsequent botanist. These species, indeed, have been the hardest nuts to crack in the study of the *Sargassum* of Japan. Prof. P. E. WRIGHT of Trinity College, Dublin, where the original specimens of HARVEY'S species are kept, generously saved me much time and trouble, by picking out the specimens and taking photographs of each. If HARVEY'S species are in the present paper correctly determined, which the writer may hope to be the case, it is due to the generous help of Professor WRIGHT.

The best thanks of the writer are due to Prof. Dr. J. MATSUMURA under whose care the present work has been carried on; and the writer can not sufficiently express his thankfulness to Dr. K. KISHINOUE, Prof. K. MIYABE, Major THEO. REINBOLD and Prof. P. WRIGHT for their kind help in the ways noted above. To Prof. Dr. M. MIYOSHI, Dr. K. OKAMURA and others he begs to acknowledge his indebtedness for help given him in references or specimens which were indispensable in the course of this study.

TOKYO, NOVEMBER, 1906.

DISTRIBUTION OF FUCACEOUS ALGÆ ON THE COAST OF JAPAN.

The distribution of marine algæ along the coast of Japan was first discussed by Dr. OKAMURA¹⁾ in 1892. The data at that time were by no means ample enough to make the results conclusive; for our knowledge of the marine flora of the Kuriles and of Loochoo was very scanty. Yet the paper is of great value even at present and no fundamental alteration is to be expected in the results. In the year 1901, at the "Minnesota Seaside Station" I gave a brief sketch of the distribution of the marine flora of Japan. It was published in "Postelsia," No. I.,²⁾ the year-book of that station for 1901. In it the whole algal regions of Japan was briefly divided as follows:—

(a) Pacific side.

1. From the Kurile Islands to Kinkwasan Island.
2. From Kinkwasan Island to the southern end of the Kiushiu Islands.
3. From the southern end of the Kiushiu Islands to Formosa.

(b) Japan Sea side.

1. From Iki Island to Ojika peninsula.
2. From Ojika Peninsula to the north.

That the distribution of marine algæ is greatly influenced by prevailing ocean currents is beyond all doubt. To discuss the algal regions of Japan, therefore, it is not unnecessary to explain the prevailing ocean currents along the coast of Japan. This was once done in "Postelsia," l. c. But as the latter publication

1) The Tokyo Botanical Magazine, Vol. VI. No. 60, pp. 56-60, 1892.

2) pp. 179-192. cf. also Bot. Centralbl. Bd. XCI, p. 41, 1903.

has only a limited circulation it will be preferable to repeat the explanation here.

The two prevailing ocean currents along the coast of Japan may be briefly described as a warm and a cold current. The warm current is the main north equatorial stream, which, turning towards the north in the Philippines, runs along the Loochoo Islands. At the Kiushiu Islands, it divides into two streams, the main or eastern being known as the Japan or Black Current. This runs still farther northward and northeastward to Vancouver Island, on the opposite side of the Pacific Ocean. It is this current which washes the east coast of the Main Island (Honshū) of the Japanese Archipelago, running as far north as Kinkwasan Island in the summer, but in winter it is pushed aside by the cold stream from the Behring Sea, so that at that time of the year it cannot be traced farther north than Cape Inuboi.

The lesser of the two branches of the north equatorial stream is known as the Korean or Tsushima Current. It washes the western coast of the Kiushiu Islands and flows into the Japan Sea through Tsushima Strait. Although this branch is a rather weak stream as compared with the eastern current, it travels farther north, washing the west coast of Japan, and passes out through Soya Strait toward the east. Its final end may be traced though faintly on the Ochotsk side of the south Kurile or Etorofu Island.

The main cold currents are likewise two in number. One of them originates at Behring Strait and runs south-westward along the coast of the Kurile Islands and washes the south-eastern coast of Hokkaido (Yezo). Bending southward it disappears in the Pacific near Kinkwasan Island in summer, and at Cape Inuboi in winter. These two points off the coast of

Japan, where the currents meet, are dreaded by mariners on account of the rough water.

The other cold current comes down along the west coast of Saghalin Island, washing the east coasts of Siberia and Korea. Of this current only a small portion touches the west coast of Hokkaido as an undercurrent. Thus the Japan Sea, with the subtropical current on the Japanese side, and the arctic on the Siberian side, shows remarkable climatic differences at places having the same latitude. Otaru, where ice is unknown in the harbour, lies on the same parallel with Vladivostock, ice-blockaded for nearly half the year.

Hakodate, situated on the Tsugaru strait between the Main Island (Honshū) and Hokkaido, has an especially interesting flora. A branch of the eastern cold current escapes to the Japan Sea, washing the Hokkaido side of the strait, and the western warm current enters the same strait along the Honshū shore.¹⁾

The following table is to illustrate the specific distribution of Fucaceæ along the whole coast of Japan. The localities are arranged in order beginning at the southern part of the Japan Sea side and going northwards, including almost all provinces on that side as far as Saghalin, thence turning to the Ochotsk coast of Hokkaido and the Kuriles. In the next, the Pacific coast of the Kuriles comes first and the rocky shores of Hokkaido, the Main Island, Shikoku, and Kiushiu are traced province after province southwards. Two provinces, Oshima in Hokkaido, and Mutsu in the Main Island are mentioned twice, these provinces being separated by the Tsugaru strait through which the two great ocean currents

1) For precise accounts of the currents of the Tsugaru strait, see:—YENDO; Cause of the decrease of seaweeds in the Prefecture of Aomori (*Journ. of the Imp. Fisch. Bureau*) Vol. XII. No. 2. pp. 66-67.

communicate. The coasts of some of the provinces consist in the greater part of sandy beaches, and consequently only a few species have been reported from them; such species are either not considered in the table, or they are attributed to the neighbouring provinces. This will not cause any deception in discussing the distributive features at large.

I should here confess that the material in our hands by no means covers all the existing species on our coast. The southern seas, especially, may supply us with no small number of species as yet unknown, as has been hinted above. However, the data I have been able to procure up to date are ample enough to give sufficient knowledge of the distribution of the family along the coast of Japan. A few remarks on the facts shown in the table will not be superfluous if added here.

1. The species which belong to the genus *Fucus* are strictly limited to the coasts of Hokkaido and the Kurile islands. *Pelvetia* has similar limitations. But the latter does not occur in the northern Kuriles, and one of its formæ extends, though in a less luxuriant state, as far south as Kinkwasan Island. These two genera may stand as representatives of the region extending from the Kurile Islands to Kinkwasan Island. Besides, *Cystophyllum geminatum*, *C. crassipes*, *C. hakodatense*, *Sargassum Kjellmanianum* and *S. Thunbergii f. latifolia* are confined to the same region.

2. *Sargassum* is quantitatively as well as qualitatively poor along the northern coast of Hokkaido. It is especially interesting to note that on the northeast coast of Hokkaido we find only two cold-sea forms of *Sargassum*, *S. Kjellmanianum* and *S. Thunbergii f. latifolia*. *Sargassum Horneri*, *S. Ringgoldianum*, *S. enerve*, *Cystophyllum sisymbrioides*, etc., are the most common

forms of the Pacific and of the Japan Sea side of middle Japan. Late in the spring these species are found in such luxuriance that fishermen experience considerable trouble in running their boats over the dense vegetation. On the northeast coast of Hokkaido none of these species occur even scantily, but instead of them *Cystophyllum crassipes* and *C. geminatum* are found in similar luxuriance. In June, the port of Nemuro is so filled up with *C. crassipes* that a steam launch can hardly navigate the part without the blades of its propeller becoming entangled in the fronds of the weed.

3. The strait of Tsugaru is an outlet of the Tsushima current from the Japan Sea to the Pacific Ocean. This is satisfactorily illustrated in the table. *Coccophora Langsdorffi* has been reported from the provinces of Echigo, Sado, and Noto, all on the coast of the Japan Sea. The present writer found the same species along both sides of the above mentioned strait and could trace it to the Pacific coast of the Province of Mutsu. Again *Sargassum confusum* is found in the Japan Sea in considerable quantities. On the Pacific coast, however, it is confined to the provinces of Mutsu and Rikuchū; both provinces are on or near the outlet of the strait on the Pacific side.

4. The coasts of the Inland Sea which is surrounded by Shikoku, Kiushiu and the western part of the Main Island, were known to us to be poor in algae. A few species of *Sargassum* and *Cystophyllum*, with badly developed fronds, were the only specimens I could get from that sea.

5. *Cystoseira* is confined to the Loochoo archipelago; and *Cystoseira Sonderi* was reported by DICKIE from the southern end of the Province of Kii. The occurrence of this same species there is to be doubted, as nobody else has collected the

species anywhere within our boundaries. There is no reason, however, to deny the occurrence of a *Cystoseira* species on the coast of that province. I actually collected *Marchesettia spongioides* and *Vanvoorstia spectabilis*, which occur in Loochoo and are undoubtedly tropical, some years ago in the southern part of the Province of Kii but at no place further north. There will be no great error in taking *Cystoseira* as a representative, in Japan, of the algæ of the subtropical waters; in other words, of the region from the southern end of the Kiushiu Islands to Formosa. The species of *Sargassum* under the series *Acanthocarpicæ* J. Ag. flourish mainly within this region.

6. The Pacific and the Japan Sea side have many species in common. Both sides, however, differ more or less in having several species peculiar to one or the other of them. Thus:—

Peculiar to the Pacific side.

Sargassum sclaccum.
S. pinnatifidum.
S. toswense.
S. kashiwajimanum.
S. kushimotense.
S. Illicifolium var. *duplicatum*.
S. cristatifolium.
S. graminifolium.
S. sagamianum.
S. nipponicum.

Peculiar to the Japan Sea side.

Sargassum fulvellum.
S. confusum.
S. confusum f. *validum*.
S. Thunbergii f. *nipponica*.
S. Miyabei.
Cystophyllum cæspitosum.
Cocophora Langsdorffii.
C. Imperata.

On both sides the difference of the distributive features is most remarkable in middle Japan, becoming gradually indistinct in the southern seas as well as in Hokkaido.

7. The Ochotsk side of Hokkaido exhibits no peculiarity in specific distribution, but shows to a certain extent the characteristic features of both the Pacific and the Japan Sea sides. It should be remembered that *Sargassum confusum*, which is undoubtedly found in the Tsushima current, also exists on the Ochotsk side of Hokkaido as far north as the southern Kuriles.

8. On the Pacific side, many of the warm-sea forms cease to grow in the region north of the Province of Rikuzen; and the cold-sea forms seldom extend southward beyond the same province. Hence Kinkwasan Island, that lies off the coast of that province, may be taken as the limit of the two. This satisfactorily answers to what has been proved by JORDAN¹⁾ from the ichtheological point of view.

On the Japan Sea side, the Province of Ugo is the northern limit of the warm-sea forms, while the Province of Oshima seems to be the southern limit of the cold-sea forms. It is not certain whether the western shore of the Province of Mutsu is occupied by the northern or by the southern species, as that region has not yet been investigated by botanists. The Ojika peninsula in the Province of Ugo may be at all events not very far from the boundary of the northern and the southern flora of the Japan Sea.

1) JORDAN: the Fish fauna of Japan. (Science, Vol. XIV., No. 354. pp. 545-567. Oct. 1901).

SPECIES.

FUCUS (Tourn.) L.

Fucus evanescens AG.

Plate I. Fig. 1-2.

AG.: Icon. Alg. ined. t. 132.—*Id.*: Spec. 1, p. 92.—J. AG.: Spec. 1, p. 210.—*Id.*: Spetz. Alg. II. p. 40.—FARLOW: Alg. of New Engl. p. 101.—KJELLM.: Om Beringhafv. Alg. p. 34.—*Id.*: Alg. Arct. Sea. p. 202.—KÜTZ.: Tab. Phyc. X. Taf. 42. I. (*non bona*).—DE TONI: Syll. Alg. III. p. 201.—OKAM.: Enumer. Alg. of Jap. p. 137.—SETCH. and GARD.: Alg. N. W. Amer. p. 281.

= *Fucus vesiculosus* var. *evanescens* KÜTZ.: Spec. p. 589.

= *Fucus vesiculosus* POST. et RUPR.: Ill. Alg. t. 30.

The present species abounds in the northern parts of the Pacific as well as of the Atlantic Ocean. More than a dozen formæ have been described by KJELLMAN from both localities, and SETCHELL and GARDNER¹⁾ added two more from the north-west coast of North America. KJELLMAN²⁾ himself, however, observes that the formæ he described "are certainly connected by numerous intermediate forms, but they deserve however to be mentioned specially, because they show the limits and directions of the species and differ somewhat with regard to biology and geographical distribution." I am strongly of the belief that some of his formæ are nothing but extreme cases of one and the same species, due to age and place of growth. The breadth and texture of the segments of the fronds, and especially the caulescence or non-caulescence of the plants, are characters that are never reliable. Generally speaking, young and sterile individuals have the segments mostly winged down to the basal ones, while

1) SETCHELL and GARDNER: *Alge of N. W. America* p. 283.

2) KJELLMAN: *Alge of the Arctic Sea*, p. 203.

the old ones almost always have the basal segments reduced to the ribs, and thus the fronds become caulescent. Any one who has ever tried to make a collection of this species, must have recognized that the young branches which have newly started adventitiously from a part of a caulescent segment are short but broadly winged. The size and the shape of the receptacles, too, undoubtedly tend to vary in some degree according to the locality of the plant.

Along the coast of almost the whole of Hokkaido, the present species may be found in greater or less quantities. The vast horizontal reef in the litoral regions of Kataoka Bay, Shimushu Island, is one of the best localities for this species within our boundaries. When we hunt for different forms in such a place we can easily pick up a good number of modifications in the external appearance of the fronds according to the season and the salinity of the water in which they grow. Some of the formæ will be mentioned below. But, as KJELLMAN has already said, quite a number are applicable partly to one forma and partly to another, and often show an intermediate character. The formæ I mention below are by no means all we can find within our boundaries and hence can not be used in the discussion of the geographical distribution or of the limit of the modification of the species. What I can mention here is the occurrence of *Fucus evanescens* in our northern seas, and the extreme variability of its external forms according to the habitat and the season.

More than half of the specimens in our hands, collected from the various parts of Hokkaido, are referable to *f. pergrandis* KJELLM. or to *f. macrocephala* KJELLM. rather than to any other forma. Some of them, however, have the segments much narrower than any reported of the species and a few are

thin and membranaceous in substance. One of the specimens from Shiranuka, Prov. of Kushiro, has the rib quite obsolete above the middle portions of the frond. The specimens from Shari and Shitsunai have some likeness to both *f. contracta* and *f. angusta*, but more closely resemble the latter. They are characterized by well-defined receptacles and minute but prominent, densely aggregated conceptacles (Pl. I. fig. 1.). One of the specimens from Kushiro stands very near to them but has much larger receptacles which measure 1.5–2.5 cm. in length and 1.–1.2 cm. in breadth, bifurcating with wide angles, thus approaching more closely to *f. macrocephala* KJELLM. The specimen from Osatsube is applicable to *f. cornuta* KJELLM., though fragmentary and sterile; but ours has the receptacles simple or only once forked, and most of them are very well defined at the base. KJELLMAN¹⁾ mentions *f. nana* and *f. bursigera* from Spitzbergen Island at the high water mark or in the river mouth. A specimen which approaches these formæ was found at Esashi in the Province of Kitami and is now in the herbarium of the Department of Fisheries of the Hokkaido Local Government; Pl. I. fig. 2 represents a part of it.

Beside the above mentioned formæ others might be pointed out. It would, however, be unimportant to add to algological literature more formal names, established on what I regard as invalid local forms.

Localities: Zenigamezawa (H. H. F.), Shirikishinai (H. H. F.), Todohokke (H. S. A.), Osatsube (H. H. F.), Oshima Prov.; Mororan (H. S. A.) (!), Urakawa (H. H. F.), Shamani (H. S. A.), Saruru (H. S. A.), Ihuri Prov.; Shitsunai (H. S. A.), Shoya (H. S. A.), Hidaka Prov.; Shiranuka (H. H. F.), Kushiro (!) (H. S. A.), Kushiro Prov.; Nemuro (!)

1) KJELLMAN: Om Spetzbergens Marina Klor. Thallogh. II. p. 4.

(H. H. F.) (H. S. A.) (OKAMURA); Wennai (H. H. F.), Kunashiri Isl.; Bettobu (H. H. F.), Hitokappu Bay (!), Rubetsu (!), Etorofu Isl.; Shiretoko (H. H. F.), Shari (H. H. F.), Moyoro (H. H. F.), Mombetsu (H. S. A.), Rishiri Isl. (!), Kitami Prov.; Uruppu Isl. (H. H. F.) (H. S. A.) (OKAMURA); Rashowa Isl. (!); Onnekotan Isl. (!); Shashikotan Isl. (!); Poromushiri Isl. (!) (H. S. A.); Shimushu Isl. (!); Yavina, Kamtschatka (!).

Fucus inflatus VAHL. *f. edentatus* ROSENV.

Plate I. Fig. 3.

ROSENV.: Grœnl. p. 834.—BÖRGES.: Mar. Alg. Fœres. p. 465.—SETCHEL and GARD.: Alg. N. W. Amer. p. 280.

= *Fucus edentatus* DE LA PYL.: Flor. d. Terr. Neuv. p. 84.

We have a form of *Fucus* on the east coast of Hokkaido, which resembles *Fucus evanescens* in several respects; but it has narrower laminae and the ribs reach to the ultimate points of the terminal segments. If the vanishing of the ribs at the upper portions of the fronds and the broadness of the laminae have been taken as important points characterizing *Fucus evanescens*, the above must be detached from it, and should be referred to *Fucus inflatus* VAHL.

SETCHELL and GARDNER¹⁾ assign the species, with a few formæ, to the northwest coast of North America. Ours probably is equal to theirs although I could not find a form corresponding to *Fucus inflatus f. filiformis* (*F. filiformis* GMEL.) on our coast.

BÖRGESSEN²⁾ discussed minutely the various forms of *Fucus inflatus* and compared them with the descriptions of former writers. I can not enter upon a criticism of his opinion, as most of the forms belong to the north Atlantic. I am therefore

1) SETCHELL and GARDNER: *Algae of N. W. America*. p. 280-281.

2) BÖRGESSEN: *Marine Algae of Fœres*. p. 466 *et seq.*

obliged to follow implicitly his classification in the determination of the various forms of *Fucus inflatus*.

Our form may be referred to *f. edentatus* ROSENV. with satisfaction, and accords especially well with the figure and description of a plant from Thorshaven, illustrated by BÖRGESEN in "Marine Alg. of Färöes" fig. 90.

The specimens collected by myself were growing mixed with *Pelvetia Babingtonii f. japonica*. This fact led me to wonder if the plants that I had considered as the high tide form of the latter were not a form of the plant in question. The high tide form of *Pelvetia Babingtonii f. japonica* has indeed some resemblance to *Fucus inflatus f. disticus* as will be stated hereafter. I have no reason to deny the occurrence of the last mentioned forma within our boundaries: the high tide form, however, which I mention below under *Pelvetia Babingtonii f. Wrightii*, may be conclusively proved not to belong to *Fucus inflatus*.

KJELLMAN¹⁾ mentions a single species, *Fucus evanescens*, in his list of Algæ from Bering Strait. He describes several formæ under it from there, but does not give any account of *Fucus inflatus* or forms resembling it.

There are numerous examples in the specimens at our hand which show a character intermediate between *Fucus evanescens* and *Fucus inflatus*: that is, in some segments of a frond the ribs reach to the apices while in others they disappear at some distance from the ultimate points. Among the specimens which I mentioned under the preceding species many have the ribs in some segments quite to the apices.

It may be easily imagined, taking *Fucus inflatus* as a valid species, that in places where the two species occur together,

1) KJELLMAN: Beringhafvets Algflora, p. 34.

hybrids between them may exist in nature. On one side, however, it is not unreasonable to believe that too much stress has been put on the broad laminæ and the vanishing ribs in separating *Fucus evanescens* from *Fucus inflatus* VAHL. The considerable formæ of and the distinction between *Fucus evanescens* and *Fucus inflatus* have been repeatedly discussed, but I can not find any reliable statement which clearly differentiates the two. A study of the herbarium specimens labelled with either of the two specific names would probably prove the ambiguity of the distinguishing characters. I have stood on the vast field of *Fucus evanescens* at Juan de Fuca Strait, Vancouver Isl., B. C.; and also on that at Kataoka Bay, Shimushu Island in the Kurile group. Although I am not wholly convinced, still the two collections made at those places have strengthened my inclination to agree with Strömpfelt,¹⁾ who included under the single species *Fucus evanescens* everything reported under the names *Fucus inflatus*, *F. edentatus* and *F. furcatus*. I am not, however, inclined at present to give any judgment on the matter as I have not yet visited a *Fucus* reef in the north Atlantic.

Localities: Osatsube, Oshima Prov. (H. S. A.); Mororan, Iburi Prov. (H. S. A.); Urakawa, Hidaka Prov. (H. S. A.); Esashi, Kitami Prov. (H. S. A.); Kushiro (T. KAWAKAMI(!)); Nemuro (!); Rubetsu (!), Hitokappu Bay (!), Etorofu Isl.

Fucus filiformis GMEL. *f. Pylaisii* J. AG.

DE TONI: Phyc. Jap. Nov. p. 48.—OKAM.: Enumer. Alg. of Jap. p. 137.
 = *Fucus leptophyllus* Kütz.: Tab. Phyc. X. p. 6. Taf. 12. fig. IV.—
 DICKIE: Alg. Jap. in Journ. Linn. Soc., Botany. Vol. XV.
 p. 450.

1) STRÖMPFELT: Om Algvegetation vid Islands Kuster, p. 35.

I have not seen any specimen of this species collected in Japan. Its occurrence on our coast has been reported by DICKIE but it is extremely doubtful to me. The upper portion of a sterile specimen of *Halysieris prolifera* OKAM. or of *Carpomitra Cabrerae* KÜTZ.—both occurring within our boundaries—has some apparent likeness to the species in question.

Locality: "Osima Harbour" (DICKIE).

PELVETIA.

Pelvetia Wrightii (HARV.) emend.

Plate I. Fig. 4-5.

HARVEY¹⁾ established two new species of *Fucus* from the specimens collected by CHARLES WRIGHT during the North Pacific Exploring Expedition of the American Navy. They were published with diagnosis only. As the definitions were rather briefly given, there arose some confusion in the attempts of later algologists to identify the species.

One of the species, *Fucus Wrightii*, was unanimously acknowledged by Japanese algologists; but the other, *Fucus Babingtonii* has been regarded as problematical by them. By the kindness of Prof. E. P. WRIGHT of Trinity College, Dublin, I was so fortunate as to get a set of fine photographs of the original specimens of *Fucus Babingtonii*. As a result of a study of the photographs when compared with the rich collection of the specimens in the herbarium of the Sapporo Agricultural College, I was able to satisfactorily identify the species. The two species described by HARVEY, however, are by no means fixed species but rather are different forms of one and the same species. Added to them we

1) HARVEY: Characters of New algae, p. 328-329.

have a third form more or less well defined, which will be remarked upon with the others below.

f. typica form. nov. Plate I. Fig. 4.

Diagnosis. Fronde lato-lineari complanata decomposita dichotoma ramosissima; vesiculis normaliter nullis; receptaculis lanceolatis compresso-turgidis terminalibus.

= *Fucus Wrightii* HARV.: Charact. of New Alg. p. 328.—DE TONI: Syll. Alg. III. p. 209.—*Id.*: Phyc. Jap. Nov. p. 48.

= *Pelvetia Wrightii* OKAM.: Enumer. Alg. of Jap. p. 138.—YENDO: Prelim. List of Jap. Fuc. p. 151.

The original diagnosis of *Fucus Wrightii* was based on a sterile specimen so that a little additional description will not be superfluous.

The frond is tereto-compressed, linear, decomposito-dichotomously branched, with the axils generally acute. The stem is subcylindrical and extremely short, measuring hardly one centimeter in length. It starts from the top of a comparatively small disc-shaped root. Occasionally it bifurcates into two branches before attaining a perceptible length, thus giving the appearance of two fronds starting from the same root. A frond, when fully grown, attains 3 feet in length with copious fastigate branches. The internodal segments are linear varying from 2 cm. to 10 cm. in length, more or less broadened upward, and with no sort of midrib. The sterile terminal segments are linear, truncated or bifurcated at the apices, each pair being parallel. Receptacles are limited to the terminal segments of the branches. They are mostly simple but frequently are bifurcated with wide angles. While yet very young they are flat and lanceolate but gradually swell up, at the same time increasing in general size. The plant is hermaphrodite and antheridia and oogonia are found in the same conceptacle. The conceptacles have bushy hairs which extrude from the mouth.

The typical plant has no true vesicles. But a few blister-like elevations are often met with in an upper branchlet or below a dividing point. In such cases they extend throughout the whole diameter of the segments concerned and are ovate or much elongated. This character is seldom met with in those specimens which were collected in the vicinity and southward of the Tsugaru Strait (Pl. I. fig. 4. a); but in those from colder parts, the ampulation becomes much more frequent, tending to a fixed character, and suggests gradual inclination to the next forma.

f. Babingtonii form. nov.

Diagnosis. Fronde angustiore compresso-plana decomposita dichotoma fastigiata; vesiculis oblongis compressis in ramis superioribus infra axillas immersis; receptaculis linearibus terminalibus complanatis simplicibus vel furcatis.

=*Fucus Babingtonii* HARV.: Charact. of New Alg. p. 329.

=*Pelvetia Babingtonii* DE TOXI: Syll. Alg. III. p. 216.—*Id.*: Phyc. Jap. Nov. p. 48.

The present forma differs from the preceding in having the vesicles constant. The vesicles are oblongo-linear, situated below the bifurcating points, and having diameters slightly larger than the breadth of the segment in which they are found. In the dried specimens they are apt to be over-looked owing to the collapse of the elevated surfaces. The plants which come under this category attain, as far as I can ascertain, hardly two feet in total length. Even the largest of the specimens is much inferior in size to the type specimen.

Fucus Babingtonii has been assigned by HARVEY to the coast of Simoda as well as to that of Hong-kong. It is beyond doubt that there is some mistake concerning the localities. The present forma and its sisters are found exclusively in the colder

seas and never come down so far south as the coast of Simoda washed by the warm Japan current. The plant which Dr. OKAMURA identified with HARVEY'S species and distributed in the "Algæ Japonicæ Exsiccatae" No. 37, is limited to the warm part of Japan. But this is quite a distinct plant, being described in the present paper under the name of *Ishige Okamurai*. The Hongkong specimen, (if any plant of such form as is referable to the forma here described occur there), may probably be the same as *Ishige Okamurai*. But in the herbarium of Trinity College the specimen is lacking and I am unable to enter into any discussion of it.

This forma is more common in the middle part of Hokkaido; and in its characters gradually approaches *f. typica* on one side and *f. japonica* on the other, as we trace it westward and eastwards respectively. Details relating to this circumstance will be given in later paragraphs.

f. japonica form. nov. Plate I. Fig. 5.

Diagnosis. Fronde angustiore compresso-plana decomposite dichotoma fastigiata; vesiculis oblongis vel bilobis in ramis superioribus infra axillas inflatis; receptaculis linearibus truncatis terminalibus complanatis simplicibus vel furcatis.

= *Pelvetia japonica* YENDO.: Prelim. List of Jap. Fuc. p. 151.

The frond of this forma is thinner and narrower than that of *f. typica* and more resembles *f. Babingtonii* in this respect. The vesicles are oblongo-obovate, with a diameter sometimes more than twice as broad as the segment and considerably swollen on both surfaces so that they show a remarkable appearance in the dried specimens. They are, as a rule, found at the terminal portions of the upper segments, the inflation very often running into the upper two segments. Receptacles are linear,

obtuse or truncated at the apices. They are transformed from the terminal segments of the branches. In the majority of cases a small but remarkable vesicle is found at the point of meeting of the two adjacent fertile segments, giving to the receptacles the appearance of having started from the top of the vesicle.

Remark on the affinity and relation to other species. The three formæ above mentioned undoubtedly belong to one species. On the southern end of Hokkaido as well as on the Pacific side of northern Honshū we find *f. typica* only. But as we proceed northward, the chance of meeting *f. Babingtonii* increases; and in the north-eastern parts of Hokkaido *f. japonica* predominates.

The fronds of *f. typica* attain the largest size with proportionally thick segments. In some segments the breadth measures one centimeter, while in the other two it seldom exceeds half a centimeter. The high tide forms of *f. japonica* are indistinguishable from the young shoots of *f. typica* and the forms intermediate between these two formæ exhibit various modifications of *f. Babingtonii*.

The material from which HARVEY described *Fucus Wrightii* was sterile and the exact systematic position of the species has hitherto been in doubt. DE TOXI¹⁾ suspected it to belong to *Ascophyllum*, while he transferred *Fucus Babingtonii* to the genus *Pelvetia*. The vesicles, however, of *Fucus Wrightii*, or *Pelvetia Wrightii f. typica* as it is here called, are never normal and hence the reference of the plant to *Ascophyllum* is not acceptable.

On examining the conceptacles of *f. typica* and *f. japonica* I was able to ascertain that each oogonium contained two oospores, and that the essential characters of the reproductive organs proved

1) Syll. Alg. III. p. 209.

it to be *Pelvetia*. The two oospores, however, different from those observed in the other species of *Pelvetia*, resulted from a longitudinal partition of the mother cell. Very often the two oospores were obliquely situated in an oogonium but those in serial disposition were exceedingly rare. This character would not be important enough to warrant a claim for a new generic position for the species but must be included under the genus *Pelvetia* with the additional note to the generic definition that in certain members the spore-mother-cells are divided by a longitudinal partition.

HARVEY¹⁾ mentions, though with some doubt, a plant under the name *Fucus furcatus*, in the list of plants collected by Dr. LYALL at Esquimalt, Vancouver Island, B.C. He remarks some difficulty in referring his plant to that species and states that it scarcely differs from *Fucus Wrightii* of Japan. In 1901, I visited the "Minnesota Seaside Station" which stands on the west coast of the same island. On the rocks above high water mark, irrigated occasionally by the spray, I found a plant which bears a close resemblance to the dwarfed forms of our *Pelvetia Wrightii*. I had little doubt that it was the plant HARVEY meant in the above cited lines. SETCHELL and GARDNER²⁾ seem to think that HARVEY's plant probably belonged to a form of *Fucus inflatus*.

On comparing the high tide forms of *Pelvetia Wrightii f. typica* with the specimens collected by myself on Vancouver Island I find very little difference between them. Ours, however, are more yellowish when fresh and somewhat thinner than the Canadian plant. It is possible that specific differences between them may be found.

1) HARVEY: List of Plants collected by Dr. LYALL. (Journ. Linn. Soc. VI. p. 163).

2) SETCHELL and GARDNER: Algae of N. W. Amer. p. 280.

In the Minnesota Botanical Studies, Ser. III. Part 1, HOLTZ describes a plant under the name *Pelvetia fastigiata*, collected at the Seaside Station. The illustration of its habit (Pl. VII.) proves it to be of the same species as the plant that I collected there. The photograph of an isolated plant, though differing slightly from the Californian forms, shows the characters of *Pelvetia fastigiata*. It is somewhat broader than the high tide forms of *Pelvetia Wrightii f. typica*. The oogonia studied by HOLTZ prove the plant to belong to *Pelvetia*; and when I examined the receptacles of the fresh material of the Canadian form at the Station I also clearly observed the two parted oogonia. There can be no doubt that the plant described by HOLTZ is of the same species as that which I have compared to a high tide form of our *f. typica*; and that it is a form, if not the type, of *Pelvetia fastigiata*.

On the other hand, there is some similarity between the sterile specimens of *Fucus furcatus f. distichus* and the Canadian form—the reason, probably, why HARVEY thought the plant might be *Fucus furcatus*.

Summing up the above considerations I may conclude that there are close relationships between *Pelvetia Wrightii*, (especially *f. typica*) and *Pelvetia fastigiata*: that these are distinguishable from each other in their low tide forms only: that the sterile specimens of the two species found above the high water marks are scarcely distinguishable: and lastly that *Fucus furcatus f. distichus* has some external resemblance to the dwarfed forms of these two species.

Localities: *f. typica*; Matsushima, Rikuzen Prov. (OKAMURA); Kesenuma, Rikuchū Prov. (OKAMURA); Shimofuro (!), Shiranuka (!), Mutsu Prov.; Hakodate (!) (WRIGHT, HARVEY)

(H. S. A.); Hiura, Zenigamezawa, Oshima Prov. (H. H. F.); Shoya, Abuta, Urakawa, Cape Erimo, Hidaka Prov. (H. H. F.); Rishiri Isl. (!), Sawaki, Esashi, Rebunshiri, Abashiri, Shiretoko, Kitami Prov. (H. H. F.); Otaru (!); Rubetsu (!), Hitokappu Bay (!), Etorofu Isl.; Nemuro (!).

f. Babingtonii; Todohokke (H. S. A.), Osatsube, Hiura, (H. H. F.), Oshima Prov.; Mororan, Tomakomai, Iburu Prov. (H. H. F.) (H. S. A.); Shoya, Shitsukari, Saruru, Shamani, Hidaka Prov. (H. H. F.); Shakubetsu, Kushiro Prov. (H. H. F.) (H. S. A.); Shibetoro, Etorofu Isl. (H. H. F.); Abashiri (H. S. A.), Sawaki, (H. H. F.), Kitami Prov.

f. japonica; Osatsube, Numajiri, Oshima Prov. (H. H. F.); Mororan, Iburu Prov. (H. A. F.); Tomakomai, Hidaka Prov. (H. H. F.); Shari-utoro, Moyoro, Mombetsu, Kitami Prov. (H. H. F.); Nemuro (!) (H. H. F.); Rubetsu (!), Hitokappu Bay (!), Etorofu Isl.

CYSTOSEIRA Ag.

Cystoseira articulata J. Ag.

Spec. I. p. 216.—OKAM.: List of Alg. Coll. in Carol. and Austr. p. 82. (Bot. Mag. Tokyo, No. 209).

=*Hormophysa articulata* Kütz.: Tab. Phyc. X. p. 22. Taf. 61.

A specimen collected by Dr. K. MIYAKE is preserved in the herbarium of the Science College of Tokyo. On examination I found it satisfactorily referable to the species mentioned. For a full account of the generic position of the plant, see OKAMURA's paper, l. c.

Locality: Yonabara, Loochoo (K. MIYAKE, H. SC. COLL.).

Cystoseira triquetra J. Ag.

Spec. I. p. 215.—MARTENS: Preus. Exped. Tange. p. 115.—OKAM.: Enumer. Alg. of Jap. p. 141.

MARTENS reported a fragment of the present species floating on the Pacific Ocean near Japan. OKAMURA mentions this species in his Enumeration of Algæ of Japan, l. c. but without any comment.

Locality: Japan (MARTENS); LOOCHOO (KUROIWA, OKAMURA).

Cystoseira Sonderi PICC.

Nuove Alg. Vettor Pisani, p. 23. No. 60.—DE TONI: Syll. Alg. III. p. 175.

=*Treptacantha Sonderi* Kütz.: Tab. Phyc. X. p. 11. Taf. 28. fig. III.

—DICKIE: Alg. of Jap. in Journ. of Linn. Soc., Bot. Vol. XV. p. 450.

I have not seen any specimen of this species collected within our boundaries. DICKIE may have been in error.

Locality: "Osima Harbour" (MOSELEY, DICKIE).

? *Cystoseira specigera* AG.

Spec. p. 64.—DICKIE: Alg. of Jap. in Journ. of Linn. Soc., Bot. Vol. XV. p. 450.

DICKIE doubtfully mentions the plant without any comment. DE TONI¹⁾ has already questioned the occurrence of the present species in Japan.

CYSTOPHYLLUM J. AG.

Cystophyllum geminatum J. Ag.

Spec. I. p. 232.—DE TONI: Syll. Alg. III. p. 156.—OKAM.: Enumer. Alg. of Jap. p. 139.—SEECH. et GARD.: Alg. of N. W. Amer. p. 285.

=*Cystoseira geminata* AG.: System. p. 286.

=*Sirophysalis geminata* Kütz.: Spec. p. 602.

=*Cystoseira thyrsigera* POST. et RUPP.: Ill. Alg. taf. 38. fig. 1.—RUPP.: Tange des Ochot. Meer. p. 347.

=*Cystophyllum Lepidium* HARV.: List of Plants Vancouver. p. 163.

—DE TONI: Syll. Alg. III. p. 156.—SAUNDERS: Alg. from

1) DE TONI: Phyc. Jap. Nov. p. 47.

Harr. Alaska. Exp. p. 432.—COLLINS, HOLDEN and SETCHEL:
Phyc. Bor. Amer. No. XLVII.—TILDEN: Amer. Alg. Cent.
III. No. 232.

=*Cystoseira Lepidium* RUPR.: Tange des Ochot. Meer. p. 347.—KÜTZ.:
Tab. Phyc. X. Taf. 52. fig. 1.

=*Cystoseira hypocarpa* KÜTZ.: Tab. Phyc. X. Taf. 52. fig. 2.—DE
TONI: Syll. Alg. III. p. 175.

Remark on the synonymy. *Cystophyllum Lepidium* HARV. and *Cystophyllum hypocarpa* KÜTZ. are not well marked with *Cystophyllum geminatum* J. AG. This circumstance has been noted by former writers, who, however, mentioned the three pseudo-species separately. SETCHELL and GARDNER¹⁾ united them into one under the single species *Cystophyllum geminatum* J. AG. which is highly preferable.

RUPRECHT²⁾ says that *Cystophyllum Lepidium* does not occur in the north Pacific, and that the specimen in MERTEN'S herbarium bearing that name and labelled "Insul. Kurile" seems to have been collected at Saghalin Island. The specimens, however, in our hands are from the southern Kuriles. In Etorofu Island, where I collected the plant, it is especially common along the northern side, often covering an extensive area of rocks in the sublitoral region and not infrequently occurring mixed with *Fucus evanescens* in the litoral region.

Localities: Rubetsu(!), Shana (H. H. F.), Etorofu Isl. (OKAMURA). Uruppu Isl. (H. H. F.).

Cystophyllum crassipes J. AG.

Plate II. Fig. 9-12.

Spec. I. p. 232.—DE TONI: Syll. Alg. III. p. 155.—*Id.*: Phyc. Jap. Nov. p. 46.

1) SETCHELL and GARDNER: l. c. p. 286.

2) RUPRECHT: Tange. p. 347.

- = *Fucus crassipes* MERT.: in TURN. Hist. Fuc. Vol. II. p. 154. Tab. 131.
 = *Cystoscira crassipes* AG.: Spec. p. 69.—*Id.*: System. p. 286.
 = *Sirophysalis crassipes* KÜTZ.: Spec. p. 602.—*Id.*: Tab. Phyc. X. Taf. 56. fig. 1.—MARTENS: Preus. Exped. Tange. p. 128.
 = *Sirophysalis kakiloides* KÜTZ.: Tab. Phyc. X. Taf. 56. fig. 2.
 ? = *Fucus kakiloides* MERT. mscr? (*sec.* DE TONI: Syll. Alg. l. c.).

I have seen no authentic specimen of the present species. But judging from the illustrations delineated by TURNER in Hist. Fuc., l. c. and by KÜTZING in Tab. Phyc., l. c., I venture to refer the specimens from eastern Hokkaido to this species.

Description of the species. In a fully grown individual, the frond attains 3–6 feet in total height, solitarily attached to the substratum by a hemispherical or subconical disc-shaped root. The stem is simple, stout and cylindrical, measuring about half a centimeter in diameter. It gradually diminishes in thickness upwards and sends out several branches in all directions, which further divide into fastigate branchlets. The principal branches at the lower parts of the axial stem are similar in appearance to the latter, but are somewhat more slender with more abundant scars of old branchlets.

In a young or average plant the axial stem barely reaches a few inches in height but has several branches already of considerable length at its upper portion. These branches have their basal regions incrassated into fusiform stems. I shall call these branches “fusiform branches” for convenience sake. While the plants are yet very young, the incrassation of the stems is very conspicuous and the future indefinite branches and branchlets appear as several short, cylindrical but recurved processes at the upper ends, as well as on the swollen sides, of the fusiform bodies. Cf. Pl. II. fig. 13. Each apical process of these fusiform bodies elongates further into an axial member and the processes

at the upper portion mostly elongate into lateral branches; while those on the swollen side develop into subordinate fusiform stems of similar appearance.

The stems of the fusiform branches are smooth, cylindrical or subterete, and measure about 2 mm. in diameter above the incrassated portion. Lateral branches are given out in all directions, apparently pinnately ramose in the pressed specimens. Some of them in the upper portions are geminate but by no means of specific importance.

The lower lateral branchlets of the fusiform branches are generally entirely wanting in vesicles. They often attain 13–16 cm. in length, the diameter of the stems being 1.5 mm. or less. The leaves at the basal portions of these branchlets are narrowly linear, 2–3 cm. in length and 1.5–3.0 mm. in breadth, pointed above, and tapering below into flat stipes. They are ribless and entire. The upper leaves become narrower by degrees and divide decomponently pinnately or apparently sympodially. The terminal ones are hair-like and less ramose.

The lateral branchlets found in the middle portions of the fusiform branches are decomponently pinnate and are vesiculiferous at their basal parts with or without the receptacles on the terminal regions. The uppermost branchlets are generally destitute of vesicles and each ultimate segment ends in a receptacle.

Vesicles are spherico-ellipsoidal with a long, flat stalk at the base, and are mucronated or awned at the top. Some of them are found with one or more minor vesicles in succession on the top. Each two successive vesicles are sharply and distinctly separated one from another by a short and delicate link. This character is especially important in distinguishing

a sterile form of the present species from the one next mentioned.

Receptacles are simple lanceoid-cylindrical, solitarily situated at the terminal points of the sympodially divided ramulets.

Localities: Sawara, Oshima Prov. (H. H. F.); Mororan, (H. S. A.), Abuta, (H. H. F.), Iburi Prov.; Onnebetsu, Kitami Prov. (H. H. F.); Nemuro (!).

Cystophyllum hakodatense sp. nov.

Plate II. Fig. 13-15.

= *Cystophyllum*? *hakodatense* YENDO.: Prelim. List of Fucac. of Japan. p. 152.

= *Cystophyllum crassipes* OKAM.: (nec J. AG.). Enumer. of Alg. of Japan. p. 139. *excl. syn.*

Diagnosis. Radice scutelata, hemisphaerico-elevata; caule gracili, cylindraceo, undique ramis egredientibus; ramis a basi incrassatis, fusiformi-elongatis, sursum complanatis, filiformibus, inermibus, quoquoersum ramulis egredientibus; foliis inferioribus anguste lineari-lanceolatis, superioribus filiformibus pinnatim divaricatis; vesiculis ellipsoideis solitariis vel concatenatis, longe stipitatis, apice obtusis vel in ramulis fructiferis abeuntibus; receptaculis cylindraceis verrucosis longe pedicelatis.

Description of the species. A well grown plant of the present species measures 5-6 feet in length, attached to the substratum by a circular disc which is slightly elevated at the top. Pl. II. fig. 5 shows a young shoot just starting out. In this sort of plant the stem at the basal region is smooth and cylindrical, not exceeding a few inches in length. The primary stem is subclavate, with a number of fusiform, approximate branches near the top as well as around the swollen portion. The morphological characters of these fusiform branches are identical with those described under the preceding species.

The lateral branchlets which start from the lower portions of the fusiform branches are more or less thick and robust,

hardly exceeding 10 cm. in length. They are decompoundly alternately divided, with the lower laciniaë terete filiform; the upper ones may develop into ordinary leaves. As a rule, they are sterile and not provided with vesicles. Occasionally, however, the apex of a leaf is inflated into an ovate mucronate vesicle. The branchlets from the middle and the upper portions develop further and constitute the principal parts of the frond. They are decompoundly subpinnately ramose with leaves or sterile ramules at the base; the ultimate segments become vesiculiferous and, when mature, are fertile. The leaves are linear-lanceolate, acuminate above, and taper downwards into a short, flat stipe: they are ribless, entire, and destitute of cryptostomata.

Vesicles are ellipsoidal or ovate, occasionally fusiform. They are sometimes solitary but 2-5 or more of them are found in a moniliform series at the terminal portion of a vegetative segment. The constrictions between two successive vesicles are loose and seldom stalk-like. The inferior end of the lowermost vesicle of a series tapers downwards into a long filiform stipe, and from the upper end of the uppermost vesicle, a racemose receptacular ramulet rises. Each receptacle is lanceoid-cylindrical, verruculose, acuminate above and with a filiform stipe below.

Remark on the affinity to other species. There are six species hitherto reported from the north Pacific Ocean, which have some relation to the present species, viz:—*Cystophyllum crassipes* J. AG., *Cystophyllum geminatum* J. AG., *Cystophyllum Lepidium* HARV., *Cystophyllum filifolium* J. AG., *Cystoseira spieigera* AG., and *Cystoseira hypocarpa* KÜTZ. Among these six species, *Cystoseira hypocarpa* KÜTZ. is probably synonymous with *Cystophyllum Lepidium* HARV. as DE TONI¹⁾ has already pointed out; and *Cystoseira*

1) DE TONI: Syll. Alg. III. p. 175.

spicigera AG. is a doubtful plant being described from an undoubtedly incomplete specimen: and lastly, *Cystophyllum Lepidium* HARV. has no well marked character to separate it from *Cystophyllum geminatum* J. AG. The remaining species *Cystophyllum crassipes* J. AG. and *Cystophyllum filifolium* J. AG. have been assigned to Japan and are more closely related to the plant here described than to any of the others.

Cystophyllum crassipes apparently stands close to the present species especially when we compare the sterile specimens of both. But the relative positions of the vesicles and receptacles readily distinguish the two species. *Cystophyllum filifolium* J. AG. was formerly reckoned under the genus *Cystoseira* by C. AGARDH. This circumstance at first led me to identify our plant with that species. But the characters of the vesicles and receptacles in the diagnosis of *Cystophyllum filifolium* J. AG. are rather nearer to *Cystophyllum crassipes* J. AG. than to the present species.

So far as our present researches extend we can not find any other species than *Cystophyllum crassipes* and the present one, that approaches the description of *Cystophyllum filifolium* J. AG. It may be permissible to say that the last mentioned species may be identical with either of the two species mentioned. At present, however, I must leave J. AGARDH'S species in doubt, with the hope that some one who has an opportunity of examining the original specimen, will carefully compare it with the two species described in this paper.

Remark on the generic position of the present species. So long as the definition of the genus *Cystoseira* remains as it is now, the plant here described ought to be counted under that genus. In the preliminary list of the *Fucaceæ* of Japan, I¹⁾

1) YENDO: l. c. p. 152.

hesitatingly referred this species to *Cystophyllum*. No one will doubt that there is a very close relationship between the present species and *Cystophyllum crassipes* and that it may be found that these two do not belong to different genera.

In such species as *Cystoseira ericoides* AG., *Cystoseira Myrica* J. AG., *Cystoseira fibrosa* AG., etc., the vesicles are not limited to the final division of the ramulets, and certain portions of vegetative organs are generally found above a vesicle. But in *Cystoseira Osmundacea* AG., *Cystoseira fœniculacea* GREV., *Cystoseira squarrosa* KÜTZ., etc., the case, as in the present species, is different: the vesicles are always on the terminal division of the vegetative organs, and only the receptacles or the receptacular branchlets may be found above a vesicle. In *Cystophyllum geminatum* the relative positions of receptacles and vesicles are somewhat indeterminate: in most cases the receptacles are above the vesicles but not infrequently a vesicle may be found at the apex of a receptacle. Cf. also KÜTZING'S Tab. Phyc. X. Taf. 52 fig. 2. under *Cystoseira hypocarpa*.

I propose the following key to distinguish *Cystoseira* from *Cystophyllum*:—

Cystoseira: vesicles not restricted to the final divisions of the vegetative organ.

Cystophyllum: vesicles restricted to the final divisions of the vegetative organ; only the receptacles or receptacular ramulets may be above the vesicles.

In accordance therewith *Cystophyllum hakodatense* may without impropriety be assigned to the genus *Cystophyllum* and other species such as *Cystoseira Osmundacea* AG., *Cystoseira fœniculacea* AG., *Cystoseira squarrosa* DE NOT. etc., should be transferred to that genus.

Localities : Iwaki Prov. (OKAMURA); Rikuchū Prov. (OKAMURA); Shimofuro, Mutsu Prov. (!); Hakodate (!) Esashi, Oshima Prov. (H. H. F.); Cape Raiden (H. H. F.), Yoichi (H. H. F.), Takashima (H. S. A.), Sukuzushi (H. S. A.), Zenibako (H. S. A.), Shiribeshi Prov.; Atsuta (H. S. A.), Mashike (H. H. F.), Ishikari Prov.; Rumoi (H. H. F.), Chikubetsu (H. H. F.), Onishika (H. S. A.), Teshio Prov.; Rishiri Island (!), Abashiri (H. H. F.) (H. S. A.), Kitami Prov.; Nemuro Harbour (!), Tomoshiri (H. H. F.), Nemuro Prov.; Kushiro (T. KAWAKAMI) (!) (H. S. A.); Shoya (H. H. F.) (H. S. A.), Horoizumi (H. H. F.), Urakawa (H. H. F.), Hidaka Prov.; Tomakomai (H. S. A.), Mororan (H. H. F.), Iburi Prov.

Cystophyllum sisymbrioides J. AG.

Plate III. Fig. 1-6.

- Spec. I. p. 234. *excl. syn.*—DE TONI: Syll. Alg. III. p. 158. *excl. syn.*
 —*Id.*: Phyc. Jap. Nov. p. 47.—OKAM.: Enumer. Alg. of Jap. p. 140.
 = *Fucus Myagroides* TURN.: Hist. Fuc. Vol. II. p. 28. Tab. 83.
 = *Fucus sisymbrioides* TURN.: Hist. Fuc. Vol. II. p. 150. Tab. 179.
 = *Spongocarpus sisymbrioides* KÜTZ.: Phyc. Gen. p. 365.—*Id.*: Spec. Alg. p. 632.—*Id.*: Tab. Phyc. X. Taf. 91. fig. 1.—SURING.: Alg. Jap. p. 26.—MARTENS: Preus. Exped. Tange. p. 116.
 = *Sargassum Myagroides* AG.: Spec. p. 25.—O'KUNTZE: Revisio Gen. Plant. III. 2. p. 427.
 = *Sargassum sisymbrioides* AG.: System. p. 307.—O'KUNTZE: Revisio Gen. Plant. III. 2. 427 *excl. syn.*
 = *Sargassum filicinum sisymbrioides* O'KUNTZE: Revisio Sarg. p. 215.
 = *Spongocarpus siliculosus* SOND.: in KÜTZ. Tab. Phyc. X. Taf. 91. fig. 2.
 = *Myagropsis Camelina* KÜTZ.: Ueber d. Eigent. (Bot. Zeitg. 1843) p. 57.—*Id.*: Spec. Alg. p. 634.—*Id.*: Tab. Phyc. X. Taf. 92. fig. 1.—*Id.*: Phyc. Gen. p. 368.—MARTENS: Preus. Exped. Tange. p. 130.

This is one of the most common algæ along nearly the whole of our coast. As the frond is apt to vary in form the exact

character of the species was not satisfactorily advertised. The following remarks may add something to the present knowledge of the plant.

Description of the species. Roots are disc-shaped, occasionally attaining 7 cm. in diameter, flat on the lower surface and subhemispherical on the upper, from which a stout cylindrical, rugose stem arises. At the lower portion of the stem a number of decom- poundly pinnated branches are given off patently. The upper terminal point of the stem is truncated and complanated, with short "anlage" of the branchlets on both sides. (Cf. Pl. III. fig. 7 b. under *Cystophyllum Turneri*). The lateral branches are distichously pinnately disposed on the principal branches and are exceedingly approximate. The principal branches are, in a manner, a sort of "Kurztrieb." The pinnation of an order is always in a plane at right angles to the plane in which the pinnation of the next order lies.

The lower parts of the stems of the lateral branches are smooth and subcompressed, elliptical in cross section. Near the insertion points they are much thickened, forming subfusiform or not infrequently angulate bases. When a well grown plant is uprooted and beaten upon the shore for many days, the lateral branches wear away from the point just above the swollen region. The result is a robust twig with coarse dentation along both sides of each branch (fig. 8.).

The lateral branches are transformed either into the definite branchlets (leaves) or into the filiform stems of the indefinite branchlets. The leaves are linear 1.5–2 mm. wide and 10–20 mm. long, occasionally measuring 30–35 mm. Well developed ones are pinnately sected or, more strictly speaking, sympodially divided. A slightly elevated midrib traverses the whole length of each leaf

with the lateral veins running into the segments. The basal part of each leaf is more or less constricted to form a short cylindrical petiole. The leaves are either directly inserted in the "Kurztrieb" disposed in the manner explained above, or they are alternately pinnately arranged along the margins of subterete, filiform indefinite branchlets. One or more of the lateral segments of a leaf are often transformed into vesicles.

Well grown lateral branches often measure 6.5 feet in length. The stems are terete, compressed with round edges. Each gives off minor ramules from its edges in a distichous, alternate and pinnate manner. These ramules are simple or decomposed and have vesicles at the lower part and receptacles at the upper; in a younger ramule, the vesicles only. Both vesicles and receptacles are alternately pinnately arranged.

Vesicles vary in their form according to their position in a frond. Those which are transformed from the lateral segments of a leaf, and usually found at the basal regions of a frond, are ellipsoidal, 6–8 mm. in major axis and 4–5 mm. in minor axis, slightly narrowed downwards, each having a short stalk, and coronated with a narrow, linear, costated leaflet at the apex. As we trace them upwards, they become much elongated, diminishing in diameter and finally becoming spindle-shape. Such vesicles have stalks often as long as their length and the corona frequently long and setaceous.

Receptacles are racemosely arranged at the upper part of a ramulet, the terminal one being the largest. They are elongated conical or cylindrical, attenuated above and abruptly ending at the base in a comparatively long filiform stalk. The receptacles of both sexes have the same appearance, except that the female receptacles mostly have a darker colour.

Remark on the synonymy. The present species is readily recognized by its general habit. The colour, the texture and the external appearance of the upper portions of the sterile fronds remind us of *Desmarestia aculeata* as has been noted by former algologists.¹⁾ Without seeing the fertile branches one is led to place the species under the *Phyllotricha* J. AG. not however without difficulty. C. AGARDH²⁾ once actually referred the plant to *Sargassum*.

O'KUNTZE³⁾ has dwelt on the opinion that the species in question should be classified under the genus *Sargassum*. The generic conception of *Sargassum* given by him in his papers differs widely from that of recent authors. As far as the Japanese species of *Sargassum* and *Cystophyllum* are concerned, I can not fully concur in the specific disposition of KUNTZE. There is no doubt that he is trying to disarrange the system of *Sargassum* after a study of fragmental herbarium specimens.

Myagropsis Camelina KÜTZ. was first described in "Botanische Zeitung," 1843, p. 57., from a specimen collected by TILESUS in Japan. J. AGARDH⁴⁾ referred both it and *Myagropsis Turneri* KÜTZ. to his *Sargassum sisymbrioides* remarking that the former two have been described from the upper portions of the latter. KÜTZING⁵⁾ insisted upon his opinion and illustrated the so called inferior part of *Myagropsis Camelina*, at the same time, criticising sharply J. AGARDH's reference.

I took particular care in trying to settle the problem. There is no doubt that *Spongocarpus siliculosus* SOND. is identical with

1) Cf. DE TONI: Syll. Alg. III. p. 158.

2) C. AGARDH: System. p. 307.

3) O'KUNTZE: Revisio Gen. Plant. III, 2. p. 427; *Id.*: Revisio von Sargassum. p. 215.

4) J. AGARDH: Spec. I. p. 234.

5) KÜTZING: Tab. Phyc. X. p. 32. Taf. 92. fig. 1.

Cystophyllum sisymbrioides. I have found, however, a plant which is much more applicable to *Cystophyllum* (*Myagropsis*) *Turneri* than to *Cystophyllum sisymbrioides*. The detail will be given under the next species. As for *Myagropsis Camelina* I have little doubt, judging from the descriptions and figures given by KÜTZING, l. c., that it belongs to the present species.

In defining *Myagropsis Camelina*, KÜTZING¹⁾ says that the stem is “zusammengedrückt, dreikantig” and that the branchlet “flach dreikantig.” He further observes that the stem is “hie und da mit spitzigen und hakenförmigen Dornen besetzt,” and the branchlets “an den Kanten mit zweispalten, entfernt stehenden, sehr kleinen Dörnchen besetzt.” These statements are evidently induced from the scars of the dropped lateral branchlets, leaves, or vesicles. The size of the vesicles cannot be a specific character in this case. I have many specimens of *Cystophyllum sisymbrioides* which have in their basal portions more roundish vesicles than KÜTZING has figured under *Myagropsis Camelina*.

Localities: Nagato Prov. (!); Izumo Prov. (OKAMURA); Tango Prov. (!); Wakasa Prov. (R. TSUGE) (!); Noto Prov. (OKAMURA); Echigo Prov. (!); Sado Prov. (!); Rikuzen Prov. (!); Hitachi Prov. (!); Boshū Prov. (!); Misaki (!), Enoshima (!), Sagami Prov.; Izu Prov. (!); Shima Prov. (!); Awa Prov. (!); Bungo Prov. (!); Nagasaki (HORNER, TURNER).

Cystophyllum Turneri nov. nom.

Plate III. Fig. 7–11.

= *Myagropsis Turneri* Kütz.: Ueber d. Eigent. (Bot. Zeitg. 1843) p. 57. *excl. syn.*—*Id.*: Spec. Alg. p. 634.—*Id.*: Phyc. Gen. p. 368.—*Id.*: Tab. Phyc. X. p. 32. Taf. 92. fig. 2.—MARTENS: Preus. Exped. Tange. p. 130.

1) KÜTZING: Ueber die Eigentümlichkeit. (Bot. Zeitg. 1843 s. 57).

Description of the species. I have not yet seen an authentic specimen of *Myagropsis Turneri* KÜTZ. But the plant here treated answers to the descriptions and illustration of KÜTZING'S species in many points.

KÜTZING referred TURNER'S *Fucus Myagroides* to his genus *Myagropsis*, calling it *Myagropsis Turneri*. After a careful examination of the material at hand, I found that TURNER'S species should be amalgamated with *Cystophyllum sisymbrioides* as had been done by J. AGARDH¹⁾; and that KÜTZING'S species accorded fairly well with another plant found in several parts of Japan. This plant has several well marked characters and deserves a specific rank. Hence the name *Cystophyllum Turneri* (Kütz.)

The relative dispositions of the branches and branchlets in the present species are identical with the preceding. But the branchlets are generally less approximate in this species, and the thickening of the basal parts of the stems is less conspicuous and even quite negligible. The stems of the branchlets are filiform, more slender and compressed than in the preceding species, but occasionally angulate at the thickened portions.

The leaves are very narrow, hardly attaining 1.5 mm. in breadth but frequently measuring 12 cm. in length. They are alternately pinnately divided, with the segments patent and distant, and with a breadth nearly equal to that in the axial part. The midrib is distinct, and traverses the whole length of the leaf, running into the segments up to their apices.

The vesicles on the lower portions of the branchlets are subspherical, 3.5 mm. in length and 3 mm. in diameter, with a stalk slightly shorter than the length of the vesicles, and coro-

1) J. AGARDH, Spec. Alg. I. p. 234.

nated with simple or often bifurcated, long, linear-spathulate, subcostated leaflets. Those in the lower portions of the minor ramulets are mostly spherical 1.5–2 mm. in diameter with long stalks and simple setaceous crown leaflets. Very young vesicles, usually found at the upper parts of the minor ramulets are slightly ovate or pyriform. Two or more spherical vesicles are often disposed in a series with filiform links, and coronated on the terminal one (fig. 10).

Receptacles are cylindrical, acuminate above, racemously arranged at the upper part of a ramulet. In the majority of cases only the terminal one develops, the rest being abortive. Hence the receptacles are apparently solitary and terminal on the ramulets.

The largest specimen I have seen measured 3 feet in total length.

In other respects it is similar to *Cystophyllum sisymbrioides*.

Localities: Boshū Prov. (H.S.A.); Misaki, Sagami Prov. (!); Sanuki Prov. (!); Chikuzen Prov. (M. YANO) (!).

Cystophyllum cæspitosum sp. nov.

Plate III. Fig. 12–13.

Diagnosis. Radice hemisphærico-scutelata, caule simplici, teretiusculo, ramis undique egredientibus; ramis filiformibus, compressis, inermibus, decomposite pinnatim ramulosis, pinnis e margine distichis; vesiculis in petiolo ipsis nunc æquale nunc brevioribus ellipsoideis, folio simplici vel furcato coronatis; receptaculis apice ramulorum racemosis cylindraceis; caulibus folisque minute glandulosis.

Description of the species. The present species is easily recognized by the general appearance and the extreme delicacy of every part of the frond. The indefinite branches at the lower portions of a frond attain greater length than those at the upper, so that the entire plant is densely cæspitose and fastigiata.

The lateral branchlets on the lower indefinite branches measure generally 20–30 cm. in length when fully grown. Their stems are delicate and filiform, about $\frac{3}{8}$ mm. wide, issuing subordinate ramulets in an alternately pinnate manner. The ramulets are further divided in a similar manner, and their basal segments may be transformed into vesicles and the upper segments into receptacles. The vesicles are small, ovate, with a short stipe at the base and a simple or bifurcated leaflet at the apex. No ribs are found on the leaves, as the latter seem too narrow to admit them. All parts of the frond except the old and basal portions are provided with small but obvious cryptostomata.

The mode of ramification, the disposition of the receptacles and other essential characters of the present species, except the points remarked above, are similar to the preceding two species. What has been stated about them may in general be applied to the species here described.

Localities: Echigo Prov. (!); Ugo Prov. (!).

TURBINARA LAMX.

Turbinaria ornata J. AG.

Spec. I. p. 266.—OKAM.: Enumer. Alg. of Jap. p. 141.

I have not seen a specimen of this species.

Localities: Ishigaki-jima, Loochoo (OKAMURA); Bonin Isl. (OKAMURA).

Turbinaria trialata KÜTZ.

Tab. Phyc. X. p. 24. Taf. 67.—BARTON: Syst. Struct. Acc. of *Turbinaria* p. 218.—DE TONI: Syll. Alg. III. p. 127.

=*Turbinaria vulgaris* var. *trialata* J. AG.: Spec. I. p. 268.

=*Turbinaria heterophylla* KÜTZ.: Tab. Phyc. X. Taf. 69. fig. 1.

A single but fertile specimen, collected by Dr. K. MIYAKE in Loochoo, is kept in the herbarium of the Science College of the Tokyo Imperial University. It accords very well with the descriptions of the above mentioned species and especially with the illustrations of *Turbinaria trialata* var. *capensis* KÜTZ. in Tab. Phyc. 1. c.

Locality: Tomari, Loochoo (MIYAKE, H. SC. COLL.).

Turbinaria (?) *fusiformis* YENDO.

Plate IV. Fig. I-7.

Prelim. List of Fuc. Jap. p. 153.

=*Cystophyllum fusiforme* HARV.: Charact. of New Alg. p. 328.—DE TONI: Syll. Alg. III. p. 159.—*Id.*: Phyc. Jap. Nov. p. 47.—OKAM.: Alg. Exsic. Jap. No. 36.—*Id.*: Enumer. Alg. of Japan. p. 141.

f. clavigera YENDO. 1. c. Plate IV. Fig. 7.

=*Cystophyllum fusiforme* β *clavigerum* HARV.: 1. c.

Remark on the species and the forma: The present species was described by HARVEY under the genus *Cystophyllum* from the material collected by CHARLES WRIGHT at Shimoda and Hakodate. Since that time no one has given any further information respecting the plant except that DE TONI repeated the original diagnosis in his works above cited. HARVEY'S specimen was sterile: and as the species was established on incomplete dried specimens there are some points misrepresented in the original diagnosis. The following remarks may not be unnecessary for a full knowledge of the species.

The root is a small holdfast, with the rhizines robust and cylindrical, ca. 1 mm. in diameter. Frequently some of the rhizine elongate horizontally like a stolon, giving off several minute processes from the under sides.

The stem is erect, cylindrical, usually branching at a short distance from the holdfast. A few radical leaves are found below or near the diverging point of the stem. These leaves are borne by very young individuals only, and seem to drop off at an early stage. They are flat but thick and succulent, yellowish brown, and slightly elevated along the median line; some are very small, ovate or clavate, hardly measuring 1 cm. in length; some, however, grow to be as large as 4 cm. by 1 cm., and are linear-spathulate, more or less tapering upwards, ending in a round apex, with a short cylindrical petiole. I have seen them frequently with undulating or even coarsely dentated margins (fig. 2 and 3a, b).

The rami, as they are called, on the young and short branches vary in shape according, it seems to me, to the locality. In the plants found in the northern seas, they are short and clavate with the apical portion inflated into a pyriform "vesicle." In those of the southern seas the "vesicles" are mostly mucronated or slightly tapering upward and seldom become fusiform. The plants commonly found along the coast of middle and southern Japan, and as far as Korea, have all the "rami" several inches long, solid, cylindrical with equal diameter throughout nearly the whole length; and frequently some of the "rami" are elongated, clavate, complanated above and sparingly dentated. In such forms the ramuli on the lateral branches are fusiform and inflated.

Generally speaking, the plants from cold seas are rich in the clavate "rami"; while in those from warmer regions the "rami" on the principal members are mostly filiform, the fusiform rami being limited to the lateral branches. The former coincide with the definition of *β. clavigerum* HARV. But it is

an invalid form and a number of intermediate forms between both extremes may be met with.

Branchlets are axillary. They are for the most part stunted and are beset with several ramuli in a spiral arrangement. The result is the presence of subfasciculate bunches at the axils. The ramuli are always an inflated fusiform however the fulcrant "rami" may vary in their shape. Hence those plants which have the filiform and cylindrical "rami" assume a very widely spread and slender appearance (fig. 2), while those in which the pyriform "rami" predominate, have a dense and robust appearance (fig. 2.).

Receptacles are smooth, cylindrical clavate, round at the apex, and have very short stalks. As a rule, 3-5 or more of them are found forming a cluster on an inconspicuous stem, directly on the axil of a "ramus" or of a ramulus of the fertile branches.

Remark on the systematic position of the species. *Cystophyllum fusiforme* was established by HARVEY, as above noted, from sterile specimens. So far as I have been able to ascertain no one has ever described its receptacles. In spite of the abundance of the sterile individuals, the receptaculiferous plants are rather rare. The plants attain their utmost luxuriance at the end of April and most of them are driven away from the substratum before they produce the reproductive organs. Some of the plants, which have passed a summer, and dropped most of the "rami" from the lower and middle portions of the fronds continue their development late into the autumn; and those in quiet coves frequently reach 6-8 feet in total height at the end of the following March. The receptacles are found in June and July. They are sometimes met with on individuals a few inches in height which had evidently germinated the previous autumn, or sometimes on the two-year old fronds.

A close observation of the receptacles suggests the impropriety of assigning the species to the genus *Cystophyllum* as has been acknowledged. The receptacles are unquestionably axillary, however much the fulcrant leaves may vary in their shape.

As may be understood from the above remarks the fulcrant leaves or the "rami" may vary in shape to a considerable degree. If these cylindrical "rami" have been considered as a modification of the ordinary leaves of *Sargassum*, we shall find a remarkable relationship of this species to that genus. On the other hand, if the vesiculation of the clavate "rami" has been taken as an important character of the species, the plant must be counted as a member of, or at least standing very close to, the genus *Turbinaria*. The only difficulty in so disposing of it is that the species hitherto placed under *Turbinaria* have winged and trumpet-shaped "vesicles," while in our species they are smooth and ovate or fusiform. The foliaceous leaves at the base of the young plants of this species seem at first to justify assigning it to *Sargassum*. But according to J. AGARDH,¹⁾ KUTZING,²⁾ *et al.*, the leaves at the basal portions of the *Turbinaria* species are also often filiform or dichotomously divided. Most species of *Sargassum* have disc-shaped roots, and all of *Turbinaria*, like the plant under consideration have ramose holdfasts. The two genera, *Sargassum* and *Turbinaria*, stand very close to each other in regard to the relative positions of the vegetative and reproductive organs. The only radical distinction between them is that the latter genus has nearly all the "rami" transformed into vesicles, characteristic of the genus; while in the former the differentiation of the "rami" into leaves and vesicles is

1) Species I. p. 265.

2) Tab. Phyc. X. Taf. 67-68.

highly developed. Our species shows the character of both genera at once, if indeed it is not an intermediate form.

To propose a new generic position for such a plant as this, which stands between two genera so closely allied as *Turbinaria* and *Sargassum* would be unacceptable. I provisionally mention the problematic species under *Turbinaria*, expecting that a closer study of the phylogeny of the two genera will probably settle the legitimacy or illegitimacy of assigning it as I have done.

Localities: Nagasaki (H. SC. COLL.); Mogi (H. SC. COLL.); Higo Prov. (!); Tsushima Prov. (Y. YABE); Fusan, Korea (H. YABE); Tango Prov. (OKAMURA); Rikuchū (?) (OKAMURA); Hakodate (?) (OKAMURA); Kazusa Prov. (!); Boshū (!); Sagami Prov. (!); Izu Prov. (!) (WRIGHT, HARVEY); Numazu, Izu Prov. (H. S. A.); Ise Prov. (OKAMURA); Shima Prov. (!); Kii Prov. (!); Awa Prov. (!); Tosa Prov. (H. S. A.); Kagoshima (OKAMURA).

f. clavigera: Tsugaru Str. (WRIGHT, HARVEY); Toppu, Zeni-gamezawa, Fukuyama, Hakodate (!) (H. S. A.), Oshima Prov.; Rikuchū Prov. (!) (H. S. A.); Rikuzen Prov. (!); Eno-ura, (H. SC. COLL.), Shimoda (!), Izu Prov.

COCCOPHORA GREV.

Coccophora Langsdorffii GREV.

Plate V.

Alg. Brit. p. XXXIV.—KÜTZ.: Spec. Alg. p. 635.—*Id.*: Tab. Phyc. XI. Taf. 45. fig. 2.—J. AG.: Spec. I. p. 250.—SMITH: in MURR'S. Phyc. Mem. II. p. 30. t. IX.—DE TONI: Syll. Alg. III. p. 184.—*Id.*: Phyc. Jap. Nov. p. 48.—MARTENS: Preus. Exped. Tange. p. 130.—YENDO: On *Cocc. Langs.* p. 137.

=*Fucus Langsdorffii* TURN.: Hist. Fuc. Vol. III. p. 76. Tab. 165.

=*Fucus Tilesii* AG.: Dec. No. 1.

=*Cystoscira Tilesii* AG.: Spec. p. 78.—*Id.*: System. p. 291.

- = *Coccophora phyllamphora* J. AG.: Spec. I. p. 250.—MARTENS: Preus. Exped. Tange, p. 130.—KÜTZING: Tab. Phyc. XI. Taf. 48. fig. 1.—*Id.*: Spec. Alg. p. 636.—DE TOXI: Syll. Alg. III. p. 185.—*Id.*: Phyc. Jap. Nov. p. 48.
- = *Cystoseira phyllamphora* AG.: Spec. p. 79.—*Id.*: System. p. 291.—*Id.*: Icon. Alg. Ined. Tab. IV.

Description of the species. Judging from the references hitherto accessible to me, no complete frond of the present plant seems to have reached the algologists. They have unanimously remarked that the conceptacles are found in the walls of the vesicles. The present writer was so fortunate as to get many complete specimens at Hakodate and actually to observe the habit in the same locality.

A well grown individual measures 40–50 cm. in total length arising at the base from a knotty stump, which is firmly attached to the substratum. From the surface of the stump there start out several shoots which soon branch into several stems. The bases of the shoots are mostly swollen into rugose knots which give a rough aspect to the primary stump. In an old plant the shoots often fall off, leaving the basal knots on the surface of the primary stump; the latter thus becoming much more knotty. These shoots correspond morphologically to the indefinite branches of *Sargassum*.

There are two distinct forms of shoots. One of these satisfactorily answers to the descriptions and figures of *Coccophora phyllamphora* J. AG., and the other to those of *Coccophora Langsdorfi* GREV. I shall call the former the *Phyllamphora* form for convenience sake. This is nothing but a young part of the frond and is always found un-branched and sterile. The latter, called for convenience, LANGSDORF'S form, as has been well figured by TURNER and by SMITH, is simple and straight,

and gives out numerous receptaculiferous branches in all directions. Frequently one or more branches of the *Phyllamphora* form are found in the places usually occupied by the receptaculiferous branches.

The apical portions of the axial stems of LANGSDORF'S form are generally rubbed off. As a rule, the scale-like leaves are entirely wanting on the axial stems throughout the whole length. For a few inches from the basal point the stems are naked, but with subprominent scars of the fallen leaves.

Of the receptaculiferous lateral branches, SMITH¹⁾ gave a full description and beautiful illustration. He seems to have doubted the existence of the small bulb at the base of each lateral branch as described by TURNER. I also was not able to verify any such character as TURNER described and illustrated.

The stems of the lateral receptaculiferous branches are more slender than the axial member and are covered with scale-like leaves spirally arranged with a divergence of $\frac{2}{3}$. These leaves are approximate below and gradually separate toward the apex of the stems. The lower leaves are very small, hardly exceeding 1.5 mm. in length and 0.5 mm. in the broadest part, sessile, entire and tapering upward; the upper ones become gently elongated often attaining 10 mm., equally sessile and tapering with but one or two obtuse teeth on the lower margins. In the apical portions of the stems, the leaves are replaced by berry-like hollow receptacles, each borne on a short stalk. The uppermost receptacle on each branch, as a rule, is the largest.

The stems of the *Phyllamphora* form are as thick as the axial stem of LANGSDORF'S form, and are similarly covered with scale-like leaves in similar arrangement. The leaves are, however,

1) SMITH; in MURRAY'S *Phyc. Mem.* Part II. Pl. IX.

much further apart. Those on the middle portions of the stems measure 2-3 cm. in length, and 1.-1.5 mm. in breadth, gradually tapering upwards. The dentation is limited to the basal portion which is now broadened into stipule-like appendages; and finally divides into distichously alternately pinnate leaves, each segment equaling the main part in breadth.

Near the middle portions of the simple or parted leaves, the vesicles are found. They are elliptical or subspindle shaped, generally only one to a leaf, but often two or more in the same leaf. When found in the parted leaf they are usually situated near the parting point. If they are found just at the point, the part above the vesicle has the appearance of a furcated corona.

In some fully matured specimens of the *Phyllamphora* form an embryonal stage of the lateral branch was found at each axil of the leaves. It can be demonstrated that these leaves fall off before the lateral branches come to maturity. No specimen was found with a leaf remaining undetached at the base of a receptaculiferous branch.

Remarks on the synonymy and the systematic position of the plant. *Coccophora phyllamphora* J. AG., as has been stated above, is a pseudo-species described from a sterile branch of *Coccophora Langsdorffii* GREV. As far as I could judge from the habit of the plant the sterile simple branches begin to give rise to the lateral fertile branches early in the summer or late in the spring. The latter attain their maturity in the spring of the next year, the new phyllamphora forms appearing until then. Thus the basal stump is evidently perennial.

It is curious that no one has ever detected the relation between the two forms. Sterile and fertile branches have stood

as separate species for nearly a half century. OKAMURA is the only one, as far as my references extend, who has touched on this problem. He¹⁾ noted that *Coccophora phyllamphora* might possibly be a special modification of its fellow species. But ceased to pursue the subject further.

AS LANGSDORF'S form was taken as the complete or nearly complete frond, the hollow receptacles were thought to serve at the same time as vesicles. This consideration resulted in an awkward misrepresentation in the systematic disposition.

The fact that the lateral branches are axillary, and that the vesicles and receptacles are developed into special organs places the present plant near *Sargassum*; but both in general appearance and in minute points, there is hardly any correspondence with any species of *Sargassum*. The decaying away of the vegetative portions, which bear the vesicles, and the succeeding growth of the reproductive branches are especially characteristic. We find some species of *Sargassum* whose vegetative branches in greater part disappear before the maturity of the receptacles. As regards the lateral branch, arising from an axil of a leaf, with receptacles at the apical portions, and some with vegetative leaves on the lower portions, we can find some similarity in *Sargassum* only.

The essential morphological difference between *Sargassum* and *Coccophora* lies in the fact that the vesicles and the receptacles may occur in the same definite branch in the former, while they are in separate ones in the latter.

The amputation of the receptacles seem to be the result of physiological necessity, for the vesicles are already absent when the reproductive organs have reached maturity. In this respect

1) OKAMURA: Enumer. of Alg. Jap. p. 138.

the character may be considered under a conception similar to that of the receptacles of the *Hormophysa*.

Localities: Hakodate (!); Mutsu Prov. (!); Noto Prov. (OKAMURA); Echigo Prov. (OKAMURA).

Coccophora (?) *Imperata* YENDO.

Plate IV. Fig. 8-12.

Prelim. List of Jap. Fuc. p. 154.

Diagnosis. Radice primordiale ignota, plantæ adultiores nodoso-prostrata, caulibus communibus confluenti, ramis erectis sursum exeuntibus; ramis cylindraceis inermibus ad basim mox intumescens, spiraliter ramulis egredientibus; ramulis brevissimis spiraliter foliis gerentibus; foliis basalibus sessilibus, stipulatis, filiformibus, dichotome divaricatis, minute glandulosis, ramulorum sessilibus imbricatis; vesiculis receptaculisque ignotis.

Description of the species. The fronds are apparently multicapital, arising from a rugose knotty prostrate stump. Morphologically speaking, the stump, as in *Coccophora Langsdorffi*, is a dwarfed stem, and the erect stems upon it correspond to the principal branches of *Cystophyllum* and *Sargassum*. The stems are cylindrical, 20-30 cm. high, more or less abruptly thickened at the very base, with short stunted ramules subregularly spirally disposed above: angle of divergence ca. $\frac{1}{3}$.

Ramules are beset with filiform elongated leaves at the base and with subulate scale-like leaves above, in the same disposition as the ramules on a stem. The filiform leaves divide dichotomously once or twice with wide axils, with a few elevated cryptostomata on the surface; the base of a leaf is generally abruptly expanded and often stipule-like. The scale-like ones are obcuneate, broadened downward, concave inside, and longitudinally ridged outside (fig. 12).

Receptacle and vesicle unknown.

Remark on affinity. A good number of the specimens of the present plant were sent from the Marine Experiment Station of Akita Prefecture. But none of them was either fertile or vesiculiferous. The exact systematic position can not be ascertained at present. The scale-like leaves, their disposition on the ramules and the general characters of the root, suggest a close affinity to *Coccophora Langsdorffii*, from which, however, it may at once be separated by the dotted filiform leaves.

If referable to *Coccophora*, which is highly probable, the specimens at hand are a vegetative form of the plant, being parallel to the Phyllamphora stage of *Coccophora Langsdorffii*. The lateral ramules with the scale-like leaflets may grow to be the receptaculiferous branches. Further discussion is reserved until we shall have been able to examine a fertile specimen.

The densely foliferous ramules at the upper portions of the stem remind us of the paniculate inflorescence of *Imperata*. Hence the specific name.

Locality: Ugo Prov. (!).

SARGASSUM Ag.

PHYLLOTRICHA J. Ag.

Sargassum pituliferum Ag.

Plate VI. Fig. 1-7.

Spec. p. 27.—J. Ag.: Spec. I. p. 289.—HARIOT: Alg. d. Yokosk. p. 218.—SURINGAR: Alg. Jap. p. 25.—MARTENS: Preus. Exped. Tangé. p. 116.—DE TONI: Syll. Alg. III. p. 17.—^s*Id.*: Phyc. Jap. Nov. p. 43.—OKAM: Enumer. of Alg. of Jap. p. 143.

=*Fucus pilulifer* TURN.: Hist. Fuc. Vol. I. Tab. 65.

=*Fucus microceratius* TURN.: Hist. Fuc. Vol. II. p. 153. Tab. 130.

=*Sargassum microceratium* AG.: Dec. No. 33.—J. AG.: Anal. Alg. Cont. III. p. 59.

=*Myagropsis microceratia* KÜTZ.: Tab. Phyc. X. Taf. 94.

Description of the species. Frond attains 2–4.5 feet in height with a knotty, rugose, disc-shape root at the base. Generally several shoots start from the surface of the same root, giving the appearance of a multicipital frond. A primary shoot is nothing but a simple lanceolate or linear leaf attached to the surface of a circular disc by a very short petiole. It gradually elongates and divides decomponently pinnately, with the margin entire; an immersed midrib traverses the whole length of the lamina and a series of cryptostomata is found on each side of the latter. The pinnæ are 1.5–2.0mm. wide and the entire length of a leaf measures 5–6 cm.

The axial part of a primary shoot develops to form the main stem of a frond, thickening simultaneously into a compressed or ancipitous rachis. The lower portion of the stem has several leaves arising alternately from the ancipitous edges. These leaves are essentially similar to the primary shoots in every respect. In an old stem, these lower leaves are generally worn off, leaving conical scars at the points of insertion. The stem in the upper portions is subterete, with rounded margin, measuring 1.5–2.0mm. in breadth. The fulcrant leaves in the upper portions are fili-form, subterete, pinnately divided or apparently dichotomous, or sometimes simple, with the apices of the segments sharply pointed. No distinct midrib is found in the upper leaves which have cryptostomata on the margins.

Vesicles are spherical, without cryptostomata, ending abruptly in a slender stipe as long or even twice as long as the diameter

of the vesicles. The apices of the vesicles are absolutely round and smooth. A vesicle is evidently transformed from the apical portion of a segment of a leaf, and is often found at a terminal end of the bifurcated leaflets.

Receptacles are ramose, spirally arranged on the ultimate ramulets. They are cylindrical, more or less tapering upwards, with verruculose surface in the matured specimens. They are 2–3 mm. long with slender stalks of about half their length. A fulcrant leaflet is found at the base of a fertile ramulet but no branchlet exists at the insertion point of a receptacle.

var. pinnatifolium var. nov. Plate VI. fig. 8–11.

= *Sargassum pinnatifolium* AG.: System. p. 303.—Kütz.: Tab. Phyc. XI. Taf. 33.—DICKIE: Alg. Jap. in Journ. Linn. Soc. Bot. Vol. XV. p. 449.—MARTENS: Preus. Exped. Tange. p. 116.—YENDO: Prelim. List of Jap. Fuc. p. 154.

= *Fucus pinnatifolius* AG.: Alg. Dec. No. 3.—*Id.*: in Act. Holm. 1815. Tab. 5.

= *Sargassum Henslowianum* var. *pinnatifolium* J. AG.: Spec. Sarg. p. 121.—DE TONI: Syll. Alg. III. p. 109.—*Id.*: Phyc. Jap. Nov. p. 45.—OKAM.: Enumer. Alg. of Jap. p. 159.

Description of the variety. The essential characters of the fronds of the present variety are similar to those of the type, except in a few points. I am not acquainted with the primary stage of the frond. Judging, however, from the youngest plants at hand, it is easily seen that both the type and the variety have similar aspects in the primary stage. The basal leaves of the well grown individuals are robust in texture and darker in colour: hence the cryptostomata are usually undetectable in the basal leaves. The leaves and stems are generally much narrower in the type than in the variety.

Vesicles are comparatively small, measuring 2.5–3 mm. in diameter, pyriform, not coronated, attenuated below into a stipe

of equal or double the length of the vesicle. They are found at the lower portions of the fertile ramules, often assuming the position of branchlets. The shape of the vesicles is an important point in distinguishing practically the variety from the type. It must be kept in mind, however, that an intermediate form is sometimes met with.

Receptacles are cylindrical, simple or often divided, verruculose on the surface, and with a short stipe. They are racemously disposed on a fertile ramule. A linear-lanceolate subulate leaflet is found at the base of a lower receptacle, but is usually wanting in the upper ones.

Remark on the affinity and the synonymy. The type and the variety are so closed related that it is often hard to distinguish them by mere description. In general aspect, however, they are always quite different from each other and one never fails to separate them at a glance although he will often meet with plants of an intermediate character.

A plant bearing the name *Sargassum piluliferum* AG. is distributed in COLLINS, HOLDEN and SETCHELL'S Phyc. Bor.-Amer. No. 537, and also in FARLOW, ANDERSON and EATON'S Alg. Exsic. Amer. Bor. No. 102. On comparing it with our specimens I do not hesitate to say that the American plant and our own belong to different species, or at least different varieties. The diagnosis of *Sargassum piluliferum* given by J. AGARDH in his former works accords very well with our plants: but the description of the same species in his Spec. Sarg. Austr. relates much more closely to the American plant than to ours.

The present species was first reported from Japan as collected by TILESIIUS and described by TURNER in 1808. The specimen seems to have been incomplete and the specific definition was

rather inadequate and ambiguous. Afterwards an allied plant was found on the Californian coast and was referred by FARLOW to the same species. As far as I could judge, the American plant differs from ours in having terete verrucose stems, while ours has compressed and smooth ones: the leaves are generally smaller and more delicate, the receptacles much shorter and more approximate in the American plant than in the Japanese. J. AGARDH omits to mention the present species in Anal. Alg. Cont. III. It is rather remarkable that the species which was originally established on Japanese material should be referred to an American plant and its occurrence in the mother country neglected.

The definitions of *Sargassum pinnatifolium* by AGARDH¹⁾ and by KÜTZING²⁾ are at once applicable to *Sargassum piluliferum*. The figures, however, delineated by the latter in his Tab. Phyc., l. c., suggest the plant that I mention here in varietal rank. If the determination by the present writer has been correctly done, the plant is by no means a valid species but merely a variety of *Sargassum piluliferum* AG.

J. AGARDH³⁾ refers *Sargassum pinnatifolium* to a variety of *Sargassum Henslowianum*. Had all the fulcrant leaves in the illustration of the latter species been removed, it might have assumed a shape nearly similar to that of our variety, the young fertile ramulets of *Sargassum Henslowianum* corresponding, in the illustration, to the much divided upper leaves of this variety. I am compelled to suspect that J. AGARDH compared the two plants, by their illustrations, in some such way as has been

1) AGARDH: System. l. c.

2) KÜTZING: Spec. Alg. p. 616.

3) J. AGARDH: Spec. Sarg. p. 121.

suggested: otherwise, we can hardly imagine any affinity between the two. He,¹⁾ however, remarked that if a complete specimen of *Sargassum Henslowianum* var. *pinnatifolium* J. AG. had been examined, his variety might be found to belong to the *Dimorphæ*: and he²⁾ entirely disregarded that variety in his later work.

SURINGAR mentions *Sargassum piluliferum* f. *capillaris* SUR. in *Algæ Japonicæ* p. 25. as being distinguished from the type by having "foliis superioribus capillaribus enerviis." But as above stated, the upper leaves in the adults of the present and of the next species, generally lack the midrib and this character is never formal.

Fucus microceratius TURN. it would seem had better be amalgamated with the present species. The only difficulty in doing so is that the figure illustrated in *Hist. Fuc.*, l. c., has the vesicles mucronated or apiculated. But TURNER in describing the species says that the vesicles are spherical and externally smooth. In *Tab. Phyc.*, l. c., KÜTZING delineates all the vesicles with round apices. These facts strengthen my belief that TURNER'S species and its derivatives should be placed in a position synonymous with the present species.

It is to be noted here that a sterile, non-vesiculiferous form of *Cystophyllum Turneri* is often difficult to distinguish from a similar form of this species.

Localities: Nagasaki (H. SC. COLL.); Chikuzen Prov. (M. YANO (!); Tsushima Prov. (H. S. A.); Nagato Prov. (!); Osumi Prov. (H. S. A.); Tosa Prov. (H. YAMAMOTO (!); Sanuki Prov. (!); Kii Prov. (H. S. A.); Shima Prov. (!); Mikawa Prov. (!); Sagami Prov. (!);

1) *Spec. Alg.* I. p. 290; *Sarg. Austr.* p. 122.

2) *Anal. Alg.*, Cont. III. p. 49 *et seq.*

Boshū Prov. (!); Kazusa Prov. (!); “Elsewhere on the coast of the Japan Sea and the Pacific Ocean” (OKAMURA).

var. pinnatifolium: Oshima, Kii Prov. (MOSELEY, DICKIE); Akashi Channel (MOSELEY, DICKIE); Japan (TILESIIUS); Mikawa Prov. (!); Noto Prov. (!); Tango Prov. (!).

Sargassum setaceum YENDO.

Plate VII. Fig. 5-7.

Prelim. List of Jap. Fuc. p. 154.

Diagnosis. Radice scutelata complanata, caule communi breve cylindraco, mox fastigiato ramoso, ramis teretibus sursum compressis, subtortilis, pinnato-ramulosis, ramulis sæpe geminatis; foliis inferioribus anguste linearibus decomposite pinnatis, laciniis lineari-lanceolatis, evanescente costatis, superioribus filiformibus decomposite dichotomis, laciniis longissimis setaceis ecostatis, sparsim glandulosis, terminalibus simplicibus setaceis; vesiculis inferioribus sphaerico-obovatis, muticis, in petiolo ipsas æquante, superioribus mediisque glandulosis, in inferiore ramulorum parte solitariis; receptaculis cylindracois breve stipitatis, apice ramulorum racemosis.

Description of the species. A well grown plant attains a height of 3-4 feet with copious lateral branches. The root is disc-shaped, flat and comparatively small, hardly 1.5 cm. in diameter. Often two or more shoots are found starting from a common disc. The stem is short and cylindrical, 1-2 cm. in length, and a few mm. in diameter. It soon gives rise to several fastigiato branches which are practically the principal members of the frond. The stems of these branches are cylindrical or terete, gradually compressed above and loosely twisted, pinnately ramose. The basal leaves on the old branches are complanated, thin and coreaceous, decompositely alternately divided. Each segment is linear-lanceolate, entire, with an obscure rib running nearly the whole length, and without cryptostomata. The upper

leaves are in like manner decomponently pinnately divided, but the segments are thick, filiform and ribless, cartilaginous in substance and frosted with conspicuous cryptostomata on the surface. The young branches are morphologically similar to the basal leaves and may further develop into long branches by the thickening and elongating of the axial segment.

One or two lateral branches start out from each axil of the middle and the upper leaves. The lower lateral branches measure 20 cm. or more, the lowest being the longest. The leaves on the branches are essentially like the fulcrant leaves but the number of segments gradually decreases. The leaflets on the terminal portions of the ramulets are mostly simple and setaceous.

Vesicles are sphaerico-obovate, round at the apices, and have stipes as long as the vesicles. Those in the lower portions of the fronds lack the cryptostomata but those in the upper are evidently spotted with conspicuous ones. They are mostly found solitary near the insertion points of the branches or branchlets.

Fertile ramulets are found at the axil of the simple setaceous leaflets in the terminal portions of the lateral branchlets. The receptacles are cylindrical, somewhat pointed above, verruculose on the surface, and with a short stipe.

Remark on the affinity. The present plant exhibits close similarity to *Sargassum piluliferum* and its variety. On the other hand, it has no less resemblance to the plant reported from the Californian coast under the name *Sargassum piluliferum*. This species, however, is, in the well grown individuals, easily distinguished from the others by its having ribless, filiform leaves.

Locality: Kashiwajima, Tosa Prov. (!).

SCHIZOPHYCUS J. AG.

Sargassum pinnatifidum HARV. mut. str.

Plate VII. Fig. 1-3.

Charact. of New Alg. p. 327.—? J. AG.: Anal. Alg. Cont. III. p. 50.
Diagnosis (emend.). Caule tereti sursum compressa, distiche pinnatim ramosis, ramis e margine egredientibus; foliis inferioribus approximatis, anguste linearibus, laciniis linearibus simplicibus vel pinnatifido-dichotomis, integris, costatis, superioribus linearibus, laciniis lineari-lanceolatis, argute serratis subsingula utrinque serie glandulosis; vesiculis ellipsoideis folio saepe bipartito serrato coronatis; receptaculis.....

Description of the species. There are three specimens of the present species which were collected by Dr. K. MIYAKE and are kept in the herbarium of the Science College of the Tokyo Imperial University. None of them have the basal part of the frond and they are all sterile. In the spring of 1904, I found several specimens at Misaki; and in the next year, I received a specimen of the same species for determination from the Hiroshima Higher Normal School. Unfortunately these were equally sterile and lacked the basal portions.

As far as the material shows, the axial stem is complanated with rounded edges and has short lateral branches from its margins. In some specimens a short spinous process was found at the edge of each internode in the lower portions. The lateral branches are disposed distichously pinnately with the internodal distance rarely exceeding one centimeter. The lower ones have the leaves on them very approximate and when they drop off, the scars give the stem a very rugose and prickly appearance. The leaves on these branches are narrow and linear, measuring 1-2 mm. in breadth and are subdichotomously furcated, or often simple. An immersed midrib traverses almost the entire length of the

lamina, running into each segment. The margin of the leaves usually has a few sharp dentations but often is quite entire. In one specimen collected at Misaki, all of the leaves were entire; while in another, the leaves on the basal portions were entire but those on the upper had become dentated. The total length of a leaf measures 3-5 cm. No cryptostoma were found on the leaves.

The leaves on the upper branches are thin and membranaceous. They are essentially similar to the lower ones in shape but attain a much larger size, often measuring 8 cm. in length, and 4 cm. in maximum breadth. They are occasionally decom-
poundly pinnately sected and the margin is mostly dentated. In the specimen from the Hiroshima Higher Normal School the apices of the segments are obtuse but in the Loochoo specimens they are generally acute. The cryptostomata are small but evident, and are arranged in an irregular series on each side of the lamina.

Vesicles are usually found solitary at the base of the lateral branches or on the petiole of the fulcrant leaf of the upper portions of a frond. They are oblong or sometimes spherical, coronated with simple or bifurcated leaflets and with stipes shorter than their diameter, which varies from 3 to 5 mm.

Receptacles unknown.

Remark on Relation to other species. Judging from the photographs, the original specimens of *Sargassum pinnatifidum* HARV. were two different plants catalogued under the same name. One of them is evidently equal to *Sargassum patens* var. *Schizophylla*; and the other, an upper portion of the present species. HARVEY did not distinguish them as separate species, and the original diagnosis of *Sargassum pinnatifolium* seems to

relate more to *Sargassum patens* var. *Schizophylla* than to the present species. J. AGARDH mentions *Sargassum pinnatifidum* in Anal. Alg. l. c. I have not seen his specimen; but as far as I can judge from the description his plant is probably different from ours here described.

This species has some apparent resemblance to *Sargassum piluliferum* AG. This is especially the case with the lower portions of a sterile specimen. But the latter species has the vesicles always round at the apices, while in the present species they are coronated with a simple or furcated leaflet, or at least they are mucronated. It has still more likeness to *Sargassum patens* var. *Schizophylla*, so much so that some fragmentary specimens of both species, especially when dried, can hardly be distinguished from one another. The present species, indeed, shows characters to some extent intermediate between the two species above mentioned. The short lateral branches with approximate leaves, however, may in many cases serve to distinguish the sterile specimens.

I am equally in doubt as to the propriety of mentioning this species under the subgenus *Schizophycus* J. AG. although it undoubtedly stands nearer to *Sargassum patens* var. *Schizophylla* than to any others. The present arrangement is a provisional one until we shall have the good fortune of examining the embryonal stages of the frond.

Localities: Loochoo (WRIGHT, HARVEY); (K. MIYAKE) (!); Misaki (H. S. A.) (!); Shima Prov. (H. HIROSHIMA HIGH. NORM. SCH.) (!).

Sargassum patens AG.

Plate VIII.

AG.: Sp. p. 47.—*Id.*: System. p. 303.—J. AG.: Spec. I. p. 288.—*Id.*: Spec. Sarg. p. 56.—*Id.*: Anal. Alg. Cont. III. p. 50.—DE TONI:

Syll. Alg. III. p. 19.—*Id.*: Phyc. Jap. Nov. p. 43.—HARLOT: Alg. de Yokosk. p. 218.

=*Sargassum Rodgersianum* HARV.: Charact. of New Alg. p. 327.

=*Fucus patens* AG.: in Act. Holm. 1815. p. 244.

=*Fucus pilulifer* β *major* TURN.: Hist. Fuc. Vol. I. p. 146.

=*Halochloa patens* KÜTZ.: Spec. Alg. p. 632.—*Id.*: Tab. Phyc. XI.

Taf. I. fig. 1.—MARTENS: Preus. Exped. Tange. p. 116.

=*Anthophycus japonicus* MART.: Preus. Exped. Tange. p. 115.

=*Carpophyllum?* *japonicum* DE TONI: Phyc. Jap. Nov. p. 46.

Description of the species. The youngest plants of this species have a few basal leaves growing almost radically from the top of a disc-shaped root. The primary basal leaves are usually simple, elliptical or obovate, with a short flat petiole: but the successive upper ones become much longer, alternately lobed, with the lobes narrowed at the points of divergence and mostly elliptical in outline.

The younger basal leaves elongate further by apical growth adding a few lobes, as it were, successively above the older ones. When they have grown several inches in height, the upper lobes eventually become narrower and pinnately sected. Leaves in this stage are no longer leaves but branches, and the lobes are evidently the definite branches, i. e. the leaves. This manner of development is characteristic of *Phyllotricha* J. AG. and *Schizophycus* J. AG.

The leaves on the lower portions of the branches are sometimes simple and sometimes divided. The simple ones are linear-spathulate more or less narrowed upwards with the margins subentire or sparingly dentated: the base is very often oblique, terminating in a short petiole. The divided leaves usually diminish in breadth: the margins are mostly subentire but often roughly toothed.

The upper leaves on the stems become gradually narrower

and finally filiform; at first patent, but soon bent upward. They usually divide into a few segments, and those at the apical regions are mostly simple. Very often we find a simple leaf attaining 20 cm. in length.

The basal leaves—the young branches—as well as the leaves on the elongated stems are always flat on the same plane in which the flattened stem lies. This character distinguishes the plant readily from the other members of the *Bactrophyceus* or *Eusargassum*. An elevated rib runs along the median of the leaf, sending out lateral costæ into the lobes if any. In the upper filiform leaves these costæ are not evident, especially in the dried material; but the cross section of leaves of this sort from a fresh specimen is elliptical, with the middle portion slightly elevated on both surfaces. Cryptostomata are always present along the edges of the upper leaves and stems. In the lower leaves, however, they are, as a rule, obscure.

Ramules are axillary. In the beginning they appear as short subcompressed processes starting from the upper margin of the petiole. Each process develops into a vesicle and a ramule starts from the basal point of the vesicular stalk. (Plate VIII. fig. 3, 5).

Vesicles are obovate or subspherical, with a complanated stalk nearly as long as the vesicle, and each crowned with a simple or pinnately divided filiform leaflet. In the upper vesicles several cryptostomata are found as elevated brown spots.

Receptacles are linear, simple or often divided, round at the apices, attenuated below, disposed on a short ramule in a distichously pinnate manner. Cryptostomata are also found on the receptacles.

var. Schizophylla YENDO. Plate IX. Fig. 1-3.

Prelim. List of Jap. Fuc. p. 155.

= *Halochloa Schizophylla* Kütz.: Ueber d. Eigent. (Bot. Zeitung 1843.)
s. 56.—*Id.*: Spec. Alg. p. 632.—*Id.*: Phyc. Gen. p. 367.—*Id.*:
Tab. Phyc. XI. Taf. I. fig. 2.

= *Sargassum pinnatifidum* HARV. p.p.: Charact. of New Alg. p. 327.—DE
TONI: Syll. Alg. III. p. 20.—J. AG.: Anal. Alg. Cont. III. p. 50.

Description of the variety. *Sargassum patens* AG. varies greatly according to the condition of the environment and the season; still, there is a distinct form found in the southern part of Japan. This form accords with the description and the illustration of *Halochloa Schizophylla* Kütz. It is, however, by no means a species, as we sometimes encounter a specimen which shows intermediate characters, especially when sterile.

The radical leaves of the variety are simple or pinnately lobed as in the type. They are, however, thin and membranaceous, beset with several irregular rows of inconspicuous cryptostomata; the margins of the simple leaves or the segments of the divided leaves are minutely dentated, and the axial laminae of the divided leaves are usually armed with a few sharp spinous processes on the margins. The lower fulcrant leaves are lobed into several lateral segments, each segment, as well as the axial lamina being irregularly but sharply serrated. Very frequently two vesicles are found serially connected, the upper one being crowned with a divided leaflet at the top. Occasionally one or two simple leaflets were found on a vesicle at some distance from the corona. (Pl. VIII. fig. 8).

The leaves on the upper portions are as in the type. In some dwarfed forms, however, they are often short and profusely ramose, apparently approaching certain leaves of *Sargassum pinnatifidum*. Some extreme forms show a resemblance to the lower

portions of *Sargassum piluliferum*. A specimen from Tsushima Island, preserved in the herbarium of the Sapporo Agricultural College, has the upper leaves almost capillaceous. KUNTZE¹⁾ notes that *Halochloa Schizophylla* is an abnormal young form of *Sargassum piluliferum*. This is probably derived from such partial similarity.

J. AGARDH, MARTENS and others agree in the opinion that *Halochloa Schizophylla* KÜTZ. is hardly separable from *Sargassum patens* AG. MARTENS²⁾ observes that the former is nothing but a young individual or a lower part of the latter species. As has been stated above, the difference between the type and the variety is already perceptible in the young shoots.

Remark on the synonymy. As has been stated in the preceding chapter, the original definition of *Sargassum pinnatifidum* given by HARVEY is satisfactorily applicable to *var. Schizophylla*. J. AGARDH³⁾ recognized the close affinity between HARVEY'S species and *Sargassum patens* AG. He mentioned, however, *Sargassum pinnatifidum* HARV. as an independent species as it differed to some extent from the type form of *Sargassum patens* AG. It is much to be regretted that the eminent algologist did not happen to compare it with the variety.

Sargassum Rodgersianum is also a species established by HARVEY. The original diagnosis is so very brief that we can hardly grasp the exact character of his plant. J. AGARDH mentions the species in Anal. Alg. cont. III. p. 54. But judging from the remark made by him in that paper, and from the fact that he mentioned it under the subgenus *Bactrophyceus* it is

1) KUNTZE: Revisio von Sarg. p. 227.

2) MARTENS: Prens. Exped. Tange. p. 116.

3) Anal. Alg. Cont. III. p. 54.

beyond doubt that his plants were quite different from HARVEY'S. By the kindness of Prof. WRIGHT of Trinity College I was able to get the photograph of the original specimen of *Sargassum Rodgersianum*. The plant is nothing but a part of *S. patens* AG. GRUNOW had recognized this when he revised HARVEY'S specimen, according to a letter from Prof. WRIGHT, and the label bearing the name *Sargassum Rodgersianum* HARV. is correctly amended.

Anthophycus japonicus is proposed by MARTENS in Preus. Exped. Tange. p. 115. The diagnosis is not clear enough being in some respects applicable to *Sargassum Ringgoldianum* HARV. DE TONI¹⁾ referred it doubtingly to the genus *Carpophyllum*. GOEBEL illustrates a plant in Biologische Schildringen p. 8. fig. 2. bearing the name of *Anthophycus japonicus* MART. The figure reveals nothing but an upper portion of a sterile frond of the typical form of the present species.

Localities: Nagasaki (KJELLMAN, J. AGARDH), Goto (KJELLMAN, J. AGARDH), Hizen Prov. (!); Tsushima Prov. (H.S.A.); Shimonoseki (KJELLMAN, J. AGARDH), Nagato Prov. (J. NIKAI) (!); Izumo Prov. (!); Iwami Prov. (!); Tango Prov. (!); Shimōsa Prov. (!); Boshū Prov. (!); Sagami Prov. (H.S.A.) (!); Shima Prov. (!); Kii Prov. (!); Awa Prov. (!); Tosa Prov. (H.S.A.); Sanuki Prov. (!); Aki Prov. (!); Bingo Prov. (!).

var. Schizophyllum: Misaki (H.S.A.) (!); Kii Prov. (!); Awa Prov. (!); Higo Prov. (!); Hizen Prov. (!); Loochoo (OKAMURA), (WRIGHT, HARVEY); Tsushima (H.S.A.).

Sargassum tosense YENDO.

Plate IX. Fig. 1-4.

Prelim. List of Jap. Fuc. p. 158.

Diagnosis. Radice scutelata compressa; caule communi brevissimo mox

1) Phyc. Jap. Nov. p. 46.

racemoso; ramis complanatis ancipitibus sursum teretibus, pinnatim ramulosis, pinnis e margine egredientibus; ramulis teretibus vel cylindraceis pinnatis; foliis verticalibus, lineari-lanceolatis basi constrictis, simplicibus vel pinnato-dichotomis costatis integerrimis vel crispato-dentatis, utrinque pluri-serie glandulosis; vesiculis sphaerico-ovatis, folio simplici vel furcato coronatis, glandulosis, in inferiore ramulorum parte solitariis; receptaculis subcylindraceis verruculosis in ramulo paniculatis.

Description of the species. The plant attains 3–5 feet in total length. The root is disc-shape of irregular outline, comparatively small in size. From the upper surface of the root several shoots often start off, each of which may ramify at a short distance from the base almost multicipitally. The primary shoot is complanated, linear-elongated, attenuated below into a short, terete stem, and alternately pinnately divided above. An immersed rib traverses the whole length of the axial segment and diverges into the lateral segments quite to the apices. Thus the primary shoot is very similar to that of *Sargassum patens*. But in the present species the axial segment is from the very beginning of its growth more stem-like. As the shoot grows further the axial segment becomes a stem with enormously prolonged internodes, but remaining flat, immersedly ribbed, and with ancipitous margins crispato-dentated. The lateral segments develop into simple, basal leaves which are narrowly lanceolate, attenuated upward, slightly ribbed, cryptostomated, and crisped or undulated in the margins. In some cases basal leaves measured 20 cm. in length and 1 cm. at the widest part (Pl. IX. fig. 4).

The stem in the upper portions as well as in the lateral branches is no longer ancipitous but terete, with the fulcrant leaves at its compressed margins. Most of the fulcrant leaves are simple, linear-lanceolate, but often pinnately divided with narrow segments. Branches and branchlets start patently from the upper edge of the

petiole of the fulcrant leaves, as in the case of *Sargassum patens*. The leaflets, on the petioles of which the receptacles are borne, are narrowly linear, almost filiform, tapering gradually upward. They have no rib but have conspicuous cryptostomata along both edges.

Vesicles are always solitary at the base of the lateral branches, and not seldom the lowermost division of a receptacular ramulet is modified into a vesicle. They are ovate, apiculated while young, crowned with a long simple or furcated leaflet when fully grown, spotted with cryptostomata, and provided with a flattened stalk sometimes twice as long as the vesicle.

Receptacles are subcylindrical, granulose, each with a short cylindrical stem below. They are paniculately disposed on the lateral branches.

Relation to other species. The primary shoot and its manner of development suggest the subgenus *Schizophycus* J. AG.; and the species evidently stands near the preceding species. The fertile ramules of both the present species and *Sargassum patens* are very much alike but the latter species has more receptacles to a ramulet; while the former has, as far as I have been able to ascertain, less than four of them. The two species, however, may be readily distinguished by their leaves.

Locality. Tosa Prov. (!).

Sargassum kashiwajimanum YENDO.

Plate VII. Fig. 4.

Diagnosis. Caule....., ramis complanatis ramulos a margine pinnatim emittentibus; ramulis teretibus pinnatis; foliis fulcrantibus brevissime stipitatis, palmatim pinnato-dichotomiis, laciniis linearibus, subdentatis, costatis; vesiculis maximis, in petiolo ipsas æquale, sphericis, foliis pinnatis vel simplicibus coronatis; receptaculis.....

Description of the species. The lower portions of the frond are not known. The stem is compressed with rounded edges, alternately pinnately ramose. The leaves on the principal branches grow patently from the edges of the complanated stem, with a very short petiole: they are decompoundly pinnately or subdichotomously divided with the segments linear and the margins shallowly and irregularly dentated. An immersed rib traverses the whole length of the leaf running into the segments almost to the tip of each.

Vesicles are spherical, with complanated stipe nearly as long as the diameter, coronated with one or two or often three pinnately divided leaflets. They are axillary and solitary. A lateral branch starts from the axil formed by a vesicle and the principal stem.

Receptacles unknown.

Relation to other species. The specimen is fragmentary and the appearance of the entire plant is not known. But the characters shewn in the specimen at hand are quite unique and not referable to any described species. Unfortunately the specimen is sterile so that the exact systematic position can not be ascertained. The plant, however, should probably be grouped under *Schizophycus* J. AG. and placed near *Sargassum patens*. From the latter it may be easily distinguished by the forms of the vesicles and the leaves.

Locality. Kashiwa-jima, Tosa Prov. (T. MAKINO) (!).

ARTHROPHYCUS J. Ag.

Sargassum kushimotense YENDO.

Plate XVI. Fig. 20.

Prelim. List of Fuc. Jap. p. 157.

Diagnosis. Radice scutelata, caule compresso, lævi, distiche pinnato; foliis verticalibus papyraceis in specimini exsiccato glaucis, lanceolatis, breve stipitatis, immerse costatis, argute crispato-dentatis, irregulariter utrin-

que glandulosis; vesiculis in petiolo complanato elliptico-sphericis, folio majore longe stipitato coronatis; receptaculis.....

Description of the species. In the preliminary list of *Fucaceæ* of Japan, l. c., I mentioned the present species established from a fragmentary sterile specimen that I collected at Kushimoto, Kii Prov. Among the specimens preserved in the herbarium of the Sapporo Agricultural College, I also found a complete though sterile specimen of the same species, collected at Shibushi, Hiuga Prov. I do not hesitate to mention them under the new specific name on account of the unique characters revealed in the specimens.

The root is scutellate with a primary stem on it. The stems of the principal branches are smooth, subcompressed with rounded edges, from which the lateral branches are sent off distichously and alternately. The leaves on the principal branches are thin and papyraceous, turning a dirty whitish colour on drying due to a powder-like substance on the surface of the lamina. They are simple, linear-spathulate, narrowed above, measuring 5–10 cm. in length and 1.5–2 cm. in width at the broadest part. The petiole is complanated and short, and expands abruptly into the lamina. An immersed rib runs from the petiole quite to the apex of the leaf. Minute, dark cryptostomata are found on both sides of the rib, disposed with no apparent regularity. They are invisible except by translucent light, owing to the grayish hue of the leaves. The margin is coarsely dentated with sharp and spinulose teeth.

Vesicles are ovate or spherical with a long complanated stalk below and a large crown leaflet above. The latter is often as large as an ordinary leaf which it resembles, except that the basal portion gradually attenuates into a long compressed stalk. In the Kii specimen we have a bifurcated leaflet upon a vesicle, as shown in Pl. XVI. fig. 20. But this may be an abnormal case.

Systematic position of the species. Our specimens unfortunately lack the reproductive organ, and the exact relationship between the present species and the others is therefore uncertain. But the vesicles, in this species, are evidently transformed from the basal portions of simple leaves; and the branches do not result from the elongation of leaf-segments. This suggests to us to group the species under either *Bactrophyucus* or *Arthrophyucus*. It probably belongs to the latter subgenus standing near *Sargassum grande* or *Sargassum undulatum*. From these species ours may be easily distinguished by the peculiar corona and the smooth compressed stem. The present disposition is, however, a provisional one until we have a full knowledge of the reproductive organ.

Localities: Kushimoto, Kii Prov. (!); Shibushi, Hiuga Prov. (H. S. A.).

BACTROPHYCUS J. Ag.

Sargassum Horneri Ag.

Plate X.

Spec. p. 38.—*Id.*: System. p. 307.—J. AG.: Spec. Alg. I. p. 290.—*Id.*: Spec. Sarg. Austr. p. 57.—*Id.*: Anal. Alg. Cont. III. p. 50 (*nomen*).—HARIOT: Alg. de Yokosk. p. 218.—DE TONI: Syll. Alg. III. p. 20.—*Id.*: Phyc. Jap. Nov. p. 43.—O. KUNTZE: Revis. von Sarg. p. 218 (*excl. syn.*) Pl. I. fig. 26.—*Id.*: Revis. Gen. Plant. III. 2. p. 429.—OKAM.: Enumer. Alg. of Jap. p. 144.

= *Fucus Horneri* TURN.: Hist. Fuc. Vol. I. p. 34. Tab. 17.

= *Spongocarpus Horneri* KÜTZ.: Ueber d. Eigent. s. 54.—*Id.*: Tab. Phyc. X. Taf. 89.—*Id.*: Phyc. Gen. p. 365.—SURING.: Alg. Jap. p. 26.—MARTENS: Preus. Exped. Tange. p. 116.

= *Sargassum spathulatum* J. AG.: Spec. Sarg. Austr. p. 58. *adnot.*—*Id.*: Anal. Alg. Cont. III. p. 50.

= *Sargassum Horneri* var. *spathulatum* OKAM.: Enumer. Alg. of Jap. p. 144.

= *Sargassum Fengeri* J. AG.: Spec. Sarg. Austr. p. 58.—*Id.*: Anal. Alg. Cont. III. p. 50 (*nomen*).—DE TONI: Syll. Alg. III. p. 21.—

Il.: Phyc. Jap. Nov. p. 43. (*excl. syn.*).—OKAM.: Enumer. Alg. of Jap. p. 144.

=*Sargassum polyodontum* J. AG.: Anal. Alg. Cont. III. p. 51.—OKAM.: Enumer. Alg. of Jap. p. 145.

Description of the species. The frond is 2–5 feet in height, frequently attaining 16 feet in total length. The root is scutellate, irregularly lobed on the margin. From the top of the root rises a single erect stem which, in full grown forms, sends upwards lateral branches. The stem of a young frond of about half a foot in height is subcylindrical with small, sharp, spinous processes over the surface. In more fully grown individuals these spinous processes usually disappear at the basal region and the stem becomes 4–5 sided with the scars of the basal leaves spirally disposed (Pl. X. fig. 2, 3). The lower portions, however, of the stem as well as the branches retain the processes for a considerable time. In the middle and upper portions the stems are cylindrical, smooth and cartilagineous, usually with shallow longitudinal furrows running downward from the insertion points of the leaves. They are loosely twisted. The interfolial distance varies according to the habit of the plants, ranging from a few centimeters to 20 cm.

The basal leaves of young sterile plants are characteristic (Pl. X. fig. 1). They are linear-spathulate, alternately pinnately sected, the sinu being round and deep quite up to the midrib in the basal part of a leaf, but gradually becoming shallower and narrower towards the apex. The apex of a leaf is obtuse, or often roundish-truncate: segments truncate, directed slightly upward, and dentated at the apices. The size of segments in a leaf gently diminishes downwards until finally they are reduced to small but sharp spinous processes on the filiform petiole. The midrib is slightly elevated but sharply defined, and vanishes near the apex. On the upper surface of the rib there are frequently several spinous processes

in a row; but they are usually confined to the lower half of the leaf.

The leaves on the lower portions of the sterile lateral branches are similar to those above described in every respect, but usually much smaller. On the terminal portions of a frond they are much narrower and extremely delicate and membranaceous (Pl. X. fig. 7): often deeply alternately pinnatisected with the sini deep and the segments ascending, sometimes shallowly dentated or even undulated; and sometimes with the apices of the leaves acuminate or spatulate. These variations are often met with in one and the same individual.

Vesicles are cylindrical, 10–14 mm. in length and 2–2.5 mm. in diameter. The apex of a vesicle ends abruptly in a simple, serrated crown leaflet with a long petiole, and the base in a short stalk. Many vesicles are usually found disposed in a raceme or cyme on the lower portion of a ramule.

Receptacles are cylindrical and terminal on a ramulet. The male and female receptacles are found on different individuals and differ in their external shape as has been described by KÜTZING¹⁾ though somewhat inadequately. The male receptacles are long and homogeneously cylindrical, mucronate above, and ending abruptly in a short stipe below (Pl. X. fig. 6). The female ones are much thicker and shorter, more or less attenuated upwards, and equally mucronate at the top (Pl. X. fig. 5). The conceptacles of both sexes begin to ripen first at the upper portion of a receptacle and then gradually lower down. Those that are discharging their contents are much swollen resulting in a much larger diameter in that part of the receptacle. KÜTZING's figures²⁾ illustrate the stage

1) Phyc. Gen. p. 365.

2) Tab. Phyc. Bd. X. Taf. 89. fig. c.

just referred to. The author¹⁾, undoubtedly through some misunderstanding, remarks that the spores are contained in the swollen upper half and the antheridia in the lower. Finally the whole of the receptacle becomes much swollen, and, at the same-time, extremely gelatinous and easily corruptible.

Remark on the synonymy. The vesicles and the basal leaves are characteristic of the present species. The young and sterile forms which are destitute of even a vesicle can be determined without the least doubt by the unrivalled character of the basal leaves; in a fragmentary specimen a vesicle enables us to surely tell the species. A study of a large stock of specimens from various parts of our coast convinces me of the unreliability of all other characters.

J. AGARDH²⁾ found in collections from Korea, Saghalin and Japan, some fragmentary specimens which had some characters varying from the ordinary form of *Sargassum Horneri*. They were more robust in texture, different in shape of leaves, and were more densely ramiferous. He was, however, in some doubt as to its specific value and noted it provisionally under the name *Sargassum spathulatum*. In his later work³⁾ he claimed a specific position for it. The essential character separating it from *Sargassum Horneri* was the obtuse apex of the leaves.

We have specimens from Sado Prov., Otaru Harbour, and Rikuchu Prov., which accord with the description of *Sargassum spathulatum* with remarkable accuracy. The main stem is always more robust, and the branches and branchlets, usually comparatively short, start out approximately: the leaves are spathulate,

1) Tab. Phyc. Bd. X. p. 31.

2) Spec. Sarg. Austr. p. 58.

3) Anal. Alg. Cont. III. p. 50.

shallowly cleft with ribs evanescent in the upper portions. Some of the forms exhibit more divergent characters in the vesicles, being often subfusiform and not homogeneously cylindrical. There are, however, numerous forms which stand between these and the typical forms of *Sargassum Horneri*. The spathulate leaves are never constant in these specimens but may frequently be found on the typical ones. The branches are approximate or non-approximate, and the texture varies from robust to soft, according to the condition of the place where the plant grows. In general, in those which grow in the warmer and more sheltered seas the stems are slender, the interfolial distances longer, and the leaves broader and more deeply cleft.

In Spec. Sarg. Austr. p. 58, J. AGARDH described another species, viz. *Sargassum Fengeri*. Judging from the description I am not able to find any legitimate ground for separating it from *Sargassum Horneri*.

In Anal. Alg. Cont. III. p. 50, AGARDH described still another species from a lower portion of a sterile specimen, which had been collected by KJELLMAN in Japan. The author remarked that the species, i. e. *Sargassum polyodontum*, might be distinguished from *Sargassum Horneri* by its having a furrowed cylindrical stem instead of a triquetrous one. But as I have above stated, the cylindrical but furrowed stem is an important character of *Sargassum Horneri*, especially when yet young. The angulate stem is to be found at the lower portion of the older fronds, and is a result of the falling off of the basal leaves. I can not find any reason for mentioning *Sargassum polyodontum* as a distinct species or even as a variety.

It must be admitted that J. AGARDH's three species have been described from fragmentary or sterile specimens, which as

the author confesses, had none of their parts in a complete state. *Sargassum spathulatum* was first noted from an upper portion of a frond. He afterward found a lower portion of a frond that he believed to belong to the same species, which, in my judgment, was a local form of *Sargassum Horneri* apparently different from the sterile but normal specimen he ever possessed. The confusion has probably arisen from his ignorance of the complete form of the present species.

f. furcatodentatum O'KUNTZE. Plate X. Fig. 8.

Revisio von Sarg. p. 224. Pl. II. fig. 25.

Remark on the forma. I have mentioned above that when found in a warmer and more sheltered sea the plants assume a changed appearance. The essential and only difference between such plants and the typical form lies in the basal leaves of the young stems as well as in those of the sterile branches. They are much smaller in size and membranaceous in texture; deeply, alternately pinnately sected clear to the midrib throughout their whole length; the pinnæ, except those of the lowermost leaves, are narrowly linear, once or twice dichotomously or digitately divided, with each apex pointed and curved inward, the spinous processes along the upper surface of the rib being very conspicuous and almost always present. These characters are also manifested in some degree in the fulcrant leaves and the crown leaflets. The vesicles are usually proportionally small. This form, although it gradually approaches the ordinary forms through several intermediate stages, is by no means negligible. It is worth mentioning in a formal rank. Forma *furcatodentatum* O'KUNTZE, l. c., suggests the present form, and the photographic print accompanying the original paper illustrates an upper portion of it.

A specimen sent from the province of Satsuma has every part much elongated and delicate. The stem is almost filamentous, the vesicles elongated, crowned with a narrow undulated leaflet, and the receptacles unusually pronounced. Undoubtedly an extremity of the present forma.

Localities: Goto, Hizen Prov. (KJELLMAN, J. AGARDH); Korea (OKAMURA); Iwami Prov. (!); Izumo Prov. (!); Tango Prov. (!); Noto Prov. (!); Ugo Prov. (!); Fukuyama (H.S.A.), Hakodate (!), Esashi (H.S.A.), Usujiri (H.H.F.), Oshima Prov.; Otaru, Shiribeshi Prov. (H.S.A.); Ishikari Prov. (H.S.A.); Saghalin (FENGER, J. AGARDH); Mouth of Amur (FENGER, J. AGARDH); Shoya, Hidaka Prov. (H.S.A.); Rikuchū Prov. (!); Rikuzen Prov. (!); Shimōsa Prov. (!); Boshū Prov. (!); Sagami Prov. (!); Izu Prov. (!); Shima Prov. (!); Kii Prov. (!); Bungo Prov. (!); "Everywhere along the Pacific and Japan Sea side" (OKAMURA).

f. furcatodentatum: Mikawa Prov. (!); Kii Prov. (H. SC. COLL.); Iyo Prov. (H. YAMAMOTO) (!); Chikuzen Prov. (M. YANO) (!); Hizen Prov. (K. OSHIMA) (!).

Sargassum filicinum HARV.

Plate XI. Fig. 8.

Charact. of New Alg. p. 327.—J. AG.: Spec. Sarg. Austr. p. 58.—*Id.*: Anal. Alg. III. p. 50.—DE TONI: Syll. Alg. III. p. 21.—*Id.*: Phyc. Jap. Nov. p. 44.

Remark on the affinity. I have identified a few specimens, which, though fragmentary, exactly accord with the diagnosis and the photograph of the original specimen of the above named species. The plant has a strong resemblance to *Sargassum Horneri* as well as to *Sargassum kiushianum*. But the spherical vesicles of the present species readily separate it from the former and the

cylindrical, fusiform receptacles from the latter. It has also some apparent similarity to a certain form of *Sargassum micracanthum*, from which, however, it may be distinguished by the thin papyraceous texture of the leaves and the great elongation of the lateral branches, and by the truncated or bidentated segments of the pinnated leaves; and more easily, when fertile, by the shape of the receptacles. It is an unmistakable species but seems to be comparatively rare.

Localities: East coast of Japan (WRIGHT, HARVEY); Misaki(!).

Sargassum serratifolium AG.

Plate XI. Fig. 1-7.

- System. p. 299.—J. AG.: Spec. Alg. I. p. 291.—*Id.*: Spec. Sarg. Austr. p. 59.—*Id.*: Anal. Alg. Cont. III. p. 53.—DE TONI: Syll. Alg. III. p. 22.—*Id.*: Phyc. Jap. Nov. p. 44.—OKAM.: Enumer. Alg. of Jap. p. 148.
 = *Fucus serratifolius* AG.: Dec. No. 31.
 = *Fucus longifolius* var. *tenuifolia* TURN.: Hist. Fuc. Vol. II. Tab. 88.
 = *Halochloa longifolia* Kütz.: Tab. Phyc. X. Taf. 100.—*Id.*: Phyc. Gen. p. 367.
 = *Halochloa serratifolia* Kütz.: Tab. Phyc. X. Taf. 99.—*Id.*: Ueber d. Eigent. (Bot. Zeitg. 1843) s. 56.
 = *Halochloa serratifolium* β *longifolia* KÜTZ.: Spec. p. 633.
 = *Fucus longifolius* TURN.: Hist. Fuc. Vol. II. p. 88. Tab. 104.
 = *Sargassum corynecarpum* HARV. (*nec* J. AG.): Charact. of New Alg. p. 328.—DE TONI: Syll. Alg. III. p. 25.—*Id.*: Phyc. Jap. Nov. p. 45.—OKAM.: Enumer. Alg. of Jap. p. 151.

Description of the species. At an early stage of development, the root is disc-shaped with a primary shoot upon it. The stem of the shoot usually ramifies at or near the very base. The stem of the primary shoot as well as the branches develop further, rapidly increasing in thickness and elongating by apical growth. The root eventually becomes a stout conical elevation often exceeding 4 cm. in diameter at the base. In a well

developed plant, as a consequence, the primary stem generally becomes confluent with the upper portion of the root, with the basal branches apparently starting multicipitally from the surface of the conical elevation. It is these basal branches which appear as the principal members of a frond. When old, their lower portions are cylindrical but irregularly verrucose from the scars left by the dropped basal leaves, and are mostly trunk-like. These stout stems, when only a few centimeters in length, ramify profusely.

The stem of a branch which is sent forth from the basal stem, is compressedly ancipitous with a longitudinal costal elevation on one surface, and provided with several spinous processes along the ancipitated margins.

While the plants are yet very young, measuring not more than 2 feet in height, the basal leaves are usually still to be found. In such specimens the leaves are strongly retrofractive, linear-spathulate, and irregularly dentated with a midrib running from the base nearly to the apex. The base of such a leaf is cuneate, round or often cordate, and is continuous to a short complanated petiole. The margins of the complanated stipule frequently expand into thin membranaceous wing-like appendages confluent above with the ancipitous margins of the stem. The substance of the leaves is mostly thick and coreaceous without cryptostomata, but often very thin and membranaceous with inconspicuous cryptostomata or else entirely destitute of them. The leaves in the upper portion of a frond are linear-spathulate, duplicato-serrated, with the segments pointing obliquely upwards.

In these young forms vesicles are found solitary on the upper surface of the flat petioles. They are large and spherical, often measuring 1 cm. in diameter, coronated with a lanceolate or spathulate leaflet at the top, and with a stalk usually shorter

than the diameter. From the middle portion of the stalk a young lateral branch is given off. In some cases the base of the crown leaflet passes downwards along the longitudinal lines with small wings here and there.

The young plants of the above described forms attain their maximum size in April, and seem to develop no further during the summer. During that season the larger number of the basal leaves drop off, leaving the petioles together with the short lateral ramulets upon them. In the autumn of the same year these short ramulets begin to develop further. They continue to grow until the next spring, ramifying decompositely and alternately pinnately, attaining frequently several feet in length.

The stems of the ramulets, as well as of the ultimate portions of the principal branches, are tereto-triquetrous, and much more slender than the middle and upper portions of the stems of the latter. They are more or less twisted.

The duplicato-serrated leaves, characteristic of the present species, are found in large numbers in those plants which are collected late in winter or early in spring. These leaves mostly appear as the fulcrant leaves of the lateral branches. The leaves in the last mentioned parts, which support the minor ramulets, are much narrower and longer, attenuated in both directions, and mostly shallowly alternately pinnately dentated, with elevated midrib running nearly the entire length of the lamina. The leaves on the ultimate portions of the ramules as well as on the minor ramulets gradually become narrower, with obscure serrature and midrib.

The vesicles on these plants are elliptical, much smaller than those found in the young forms, measuring 6-8 mm. in length and 4-5 mm. in diameter. Some are coronated with a

narrowly linear, costated and serrated leaflet, while others are simply mucronated at the apex.

Receptacles are complanated, clavated or spatulated, often attenuated above, ending at the base in a short slender stalk. They are disposed in a panicle or raceme on the final ramulets of the upper branches. Receptacles of both sexes have a similar external appearance.

Remark on the synonymy. The present species is prone to a considerable variation in its vegetative organs, according to the condition of the environment and the season. The characteristic duplicato-serrated leaves are often obliterated even in the spring forms. In younger individuals, as above described, they are often entirely wanting. Hence the morphological value of the leaves in specific determination is sometimes very slight. The matured plants without the characteristic fulcrant leaves are, indeed, often liable to be confounded with *Sargassum tortile*. The distinction between these two species will be discussed in the next chapter.

On consulting the original diagnosis of *Sargassum corynecarpum* HARV., I was led to strongly suspect that it had been based on a specimen of *Sargassum serratifolium* which had lost its fulcrant leaves by age. The photograph of the original specimen of the former species showed that HARVEY'S plant was undoubtedly an old specimen of the present species, with some basal leaves still undetached but having lost the fulcrant leaves on all branches. J. AGARDH¹⁾ referred a plant to *Sargassum corynecarpum* HARV., but his plant belongs to a quite different species, as may be easily seen by comparing the descrip-

1) Anal. Alg. Cont. III. p. 57.

tion with HARVEY'S diagnosis. Cf. also the remarks under the heading of *Sargassum Kjellmanianum* in the present work.

Sargassum serratifolium AG. has been doubtfully referred to *Sargassum tortile* by J. AGARDH. He also added that *Halochloa macrantha* KÜTZ. might be referred to the latter species. These three plants, in my judgment, can scarcely be separated unless one is supplied with a complete set of specimens of each.

I shall not say anything about the opinion of O'KUNTZE¹⁾ who declares that the present plant belongs to *Sargassum vulgare* and *Sargassum medium*.

Localities: Loochoo (OKAMURA); Shimabara, Hizen Prov. (MARTENS); Tsushima (H. S. A.)(!); Izumo Prov. (!); Tango Prov. (!); Sado Prov. (!); Rikuzen Prov. (!); Shimōsa Prov. (!); Boshū Prov. (!); Sagami Prov. (!); Shimoda, Izu Prov. (WRIGHT, HARVEY under *Sargassum corynecarpum*); Shima Prov. (!); Awa Prov. (!); Tosa Prov. (H. YAMAMOTO) (!); Bungo Prov. (!).

Sargassum tortile AG.

Plate XII. Fig. 1-8.

Dec. No. 2.—*Id.*: System. p. 299.—*Id.*: Spec. p. 15.—J. AG.: Spec. Alg. I. p. 291.—*Id.*: Spec. Sarg. Austr. p. 60.—*Id.*: Anal. Alg. Cont. III. p. 53 (*excl. syn.*).—DE TONI: Phyc. Jap. Nov. p. 44.—*Id.*: Syll. Alg. III. p. 23 (*excl. syn.*).—OKAM.: Enumer. Alg. of Jap. p. 147.

?=*Fucus longifolius* var. *angustifolius* TURN.: Hist. Fue. Vol. II. p. 88. Tab. 104. fig. b.

=*Halochloa tortilis* KÜTZ.: Tab. Phyc. X. Taf. 99.—*Id.*: Ueber d. Eigent. (Bot. Zeitg. 1843) s. 56.

=*Fucus scoparius* TURN.: Hist. Fue. Vol. II. p. 156. Tab. 132.

=*Sargassum scoparium* AG.: Spec. p. 26.—J. AG.: Spec. Alg. I. p. 292.—*Id.*: Spec. Sarg. Austr. p. 60.—DE TONI: Syll. Alg. III. p. 23.

1) Revisio von Sarg. p. 216.

- =*Halochloa scoparia* KÜTZ.: Spec. p. 634.—*Id.*: Tab. Phyc. X. Taf. 95.
- =*Halochloa pachycarpa* KÜTZ.: Ueber d. Eigent. (Bot. Zeitg. 1843) s. 55.—*Id.*: Spec. p. 34.—*Id.*: Tab. Phyc. X. Taf. 96.
- =*Halochloa siliquastra* KÜTZ.: Spec. p. 634.—*Id.*: Tab. Phyc. X. Taf. 97. fig. 1.
- =*Fucus siliquastrus* TURN.: Hist. Fuc. Vol. III. p. 26. Tab. 82.
- ?=*Sargassum siliquastrum* J. AG.: Spec. Alg. I. p. 292.—*Id.*: Spec. Sarg. Austr. p. 60.
- ?=*Cystoseira siliquastra* AG.: System. p. 288. pp.
- ?=*Sargassum siliquastrum?* var. *pyriferum* HARV.: Charact. of New Alg. p. 328.
- ?=*Carpacanthus trichophyllus* KÜTZ.: Spec. p. 622.—*Id.*: Tab. Phyc. XI. Taf. 37. fig. 2.—*Id.*: Phyc. Gen. p. 368.—*Id.*: Ueber d. Eigent. (Bot. Zeitg. 1843) s. 57.
- ?=*Halochloa tenuis* KÜTZ.: Ueber d. Eigent. (Bot. Zeitg. 1843) s. 57.—*Id.*: Phyc. Gen. p. 367.—*Id.*: Spec. p. 623.—ОКАМ.: Enumer. Alg. of Jap. p. 160.—J. AG.: Spec. I. p. 292.

Description of the species. In a well grown individual the stem is a stout cylindrical trunk arising from the top of a hemispherical or compressed conical root, which measures 2–3 cm. in diameter. The average length of a frond measures 3.5–4 feet but frequently as much as 8 feet. The stem, in most cases, sends out numerous branches at a distance of a few centimeters from the base. These branches divide repeatedly, resulting finally in a number of subordinate branches.

The stems of the youngest principal branches are cylindrical and smooth on the lower portions but above become gradually compressed. Coarse spinous processes are usually present on the margins of the complanated portions of the stems. The leaves on these stems are thick, coreaceous, dark-brown, oblongo-ovate or spatulate, slightly elevated at the costal region, and irregularly and roughly serrated on the margins.^e As in the preceding species, the subordinate branch grows out from the upper surface

of the petiole of the basal leaf, which sooner or later drops off as the branches develop further.

The lateral branches on the principal members play the important part of a frond. When just starting, their stems are compressed and ancipitous sending out strongly retrofractive leaves alternately from the surfaces of the stems. As the interfolial distances measure but a few centimeters, such stems bend in a zigzag manner with a leaf at each angulate point. The leaves on the basal regions of these sterile branchlets are spatulate or lanceolate, frosted in some individuals with cryptostomata which may however be wanting in others: they are thick and coreaceous in texture, dark brown in colour, mostly irregularly serrated, and with an immersed midrib. The upper leaves, however, are narrow, linear-lanceolate, brownish in colour, immersedly costated, with or without cryptostomata, and sharply and subregularly alternately pinnately dentated. The laciniae are obliquely triangular, directed upwards, and ending in a sharp point. Every one of these leaves on the lateral branches may, after further development, become a fulcrant leaf supporting a lateral branch upon the petiole.

The leaves on the lesser indefinite branches are very narrow, sharply serrated as in the upper fulcrant leaves. They become narrower by degrees, as we trace them upwards, till the lamina is finally reduced to a wing-like appendage along the rib, or often becomes quite filiform. The laciniae of the serrature become likewise narrower and claw-like, obliquely reflexed above, and regularly alternately pinnately disposed. Very often the indefinite branches just above the basal leaves are stunted with approximate retrofractive leaves, which are usually setaceous with a few prickle-like dentations.

The stems of the minor branches, as above remarked, are

ancipitous, often with a few spines along the margins. In the upper portions of the more developed branches, however, they become triquetrous and are often very strongly twisted. The stems of the fertile branchlets are slender, filiform and triquetrous or terete.

Vesicles are mostly found solitary near the base of the terminal ramulets. They are pear-shaped, often subspherical, mucronated at the apex or with a setaceous crown leaflet, and with a short, slender, cylindrical stalk. In a specimen kindly given me by Mr. R. TSUGE, who collected it in the province of Wakasa, the setaceous crown leaflets are so very pronounced as to give a piluliferous appearance to the upper portions of the frond. Frequently the apex is crowned with an alternately pinnately serrated, filiform leaflet. The size of a vesicle varies according to its position in the frond, but the largest ones measured 1 cm. in length and 0.8–0.6 cm. in diameter.

Vesicles are in most cases not met with in the young branches but are found abundantly on the upper portions of the full grown but sterile fronds: in April, when the plants become fertile, the fronds are very poor in vesicles as they are mostly given off in this season.

Receptacles are linear-spathulate, clavate or elongato-elliptical, compressed with round margins, more or less attenuated below ending in a short cylindrical stalk. They are disposed in a raceme on a final ramulet with a filiform, simple setaceous bractlet at the base of each. The bractlets easily drop off and often no trace of them is to be found on the frond, except their insignificant scars. The result shows an apparent similarity to the receptacular ramulets of the members of the section *Siliquosae* under the *Eusargassum* J. AG.

f. macrocarpa YENDO. Plate XII, Fig. 8.

Prelim. List of Jap. Fuc. p. 156.

=*Sargassum macrocarpum* AG.: System. p. 307.—*Id.*: Spec. p. 36.—
 J. AG.: Spec. Alg. I. p. 293.—*Id.*: Spec. Sarg. Austr. p. 60.—
Id.: Anal. Alg. Cont. III. p. 53.—OKAM.: Enumer. Alg. of
 Jap. p. 146.—DE TONI: Syll. Alg. III. p. 24 *p.p.*—*Id.*: Phyc.
 Jap. Nov. p. 44.

=*Halochloa polyacantha* KÜTZ.: Tab. Phyc. X. Taf. 98.—*Id.*: Ueber
 d. Eigent. (Bot. Zeitg. 1843.) s. 56.

=*Halochloa macracantha* KÜTZ.: Tab. Phyc. X. Taf. 97. fig. 2.

Remark on the forma. I identify one plant as *Sargassum macrocarpum* AG. As the original diagnosis is so very simple that it may be applied to other allied species, my identification is mostly based on the descriptions given by J. AGARDII. If the determination by the present writer has been correctly done, the plant is by no means a valid species but may be connected with the typical form of the present species by various gradations. Still it often exhibits some remarkable characters and is worthy of mention in a formal rank.

The essential characters of the frond are similar to the type. The total length of a well grown plant often measures 7–8 feet with the lateral branches as long as 1–1.5 feet. The vesicles at the basal portions of the lower branches are remarkably large attaining sometimes 2cm. in length, with a short sub-ancipitous stalk, crowned with a narrow, dentated, ribbed, and glandulated leaf. Those on the terminal branchlets are nearly equal to those of the type. The leaves sometimes become as long as 15–18cm. and are generally very stiff and coreaceous, with the ribs distinctly elevated almost to the tips. The margin is coarsely but deeply dentated with the sinu round and the laciniae deltoid and curved upwards. The cryptostomata are conspicuous in some individuals but entirely wanting in others. The spinous processes

on the margin of the lower ancipitous stems are prominent and abundant but, gradually diminish in number on the upper stems.

Remark on the synonymy. The present species is the most perplexing one in the study of the *Sargassum* of Japan. Extraordinary confusions have occurred in the specific conception of the European herbarists, particularly on account of the divergent opinions of J. AGARDH and KÜTZING.

J. AGARDH discounted the specific value of *Halochloa scoparia* KÜTZ. and referred it once to *Sargassum macrocarpum* J. AG.¹⁾ and afterward to *Sargassum tortile* AG.²⁾ He³⁾ declared that KÜTZING'S plant was different from *Fucus scoparius* TURN. which he mentions as a distinct species: and he referred *Halochloa pachycarpa* KÜTZ., though sometimes⁴⁾ with doubt, to TURNER'S species. Judging from the figures of *Halochloa scoparia* KÜTZ. in Tab. Phyc., l. c., I have no doubt that it is identical with *Sargassum tortile* AG., and the descriptions and figures of *Sargassum scoparium* AG. or *Fucus scoparius* TURN. prove no reasonable mark to distinguish the latter from KÜTZING'S. In a similar manner, J. AGARDH⁵⁾ combined *Halochloa siliquastra* KÜTZ. with *Sargassum tortile* AG., while he⁶⁾ mentioned *Fucus siliquastrus* TURN. as an independent species under the name of *Sargassum siliquastrum*. But the distinction between KÜTZING'S and TURNER'S plants, as made out from references, is entirely worthless in practice.

DE TONI⁷⁾ combined *Sargassum siliquastrum?* var. *pyriferum* HARV. with *Sargassum macrocarpum* J. AG. The reason for his

1) Spec. Sarg. Austr. p. 60.

2) Anal. Alg. Cont. III. p. 53.

3) Spec. Sarg. Austr. p. 60.

4) Anal. Alg. Cont. III. p. 53.

5) Spec. Sarg. Austr. p. 60.

6) Anal. Alg. Cont. III. p. 55.

7) Syll. Alg. III. p. 24.

having done so is not clear to me. Judging from the original diagnosis, HARVEY'S plant seems to be a form referable either to *Sargassum serratifolium* or to *Sarg. tortile*, with the fulcrant leaves off. Prof. WRIGHT wrote me when I asked for a photograph of HARVEY'S original specimen, that he could not find any bearing that name in the herbarium of Trinity College.

Carpacanthus trichophyllum KÜTZ. seems extremely doubtful to me. DE TONI¹⁾ has placed it under the questionable species. It has exactly the same characters as *Sargassum tortile* except that the receptacles are "ad angulos spinoso dentata." So far as my researches on the Japanese forms of *Sargassum* extend, I can not believe such a species occurs on our coast. The plant which KÜTZING had illustrated was probably a specimen of the present species with shrunken receptacles apparently angulate.

Fucus heterophyllus is assigned to Japan by TURNER²⁾ J. AGARDH^{3) 4)} seems to doubt its occurrence in Japan, which is reasonable, and mentions it under *Sargassum siliquastrum*. The figures delineated by TURNER are incomplete; they are referable to *Sargassum serratifolium* or rather to *Sarg. tortile*. He remarks, however, of the receptacles: "some solitary, others growing two or three together,"—which is not a character of the present species.

J. AGARDH⁵⁾ referred *Fucus longifolius* *r* *angustifolius* TURN. to the present species. But TURNER'S original description and illustration may at once be applied to both *Sargassum serratifolium* and this species. It may not be possible to solve the problem before seeing TURNER'S original specimen.

1) Syll. Alg. III. p. 118.

2) Hist. Fuc. Vol. II. p. 62.

3) Spec. Alg. I. p. 293.

4) Spec. Sarg. Austr. p. 60.

5) Spec. Alg. I. p. 291.

Halochloa pachycarpa KÜTZ. has been established undoubtedly on a basal portion of a local form of *Sargassum tortile*. The plant is characterized by the enormous dilatation at the residual portions of the fallen basal leaves. I illustrate a plant which agrees very well with KÜTZING'S figure, from a sheltered cove at Hamajima in the Province of Shima. The upper portions of this aberrant form, however, satisfactorily prove it to belong to the present species. (Pl. XI. fig. 4).

Halochloa polyacantha I refer to *f. macrocarpa*, though I do so with hesitation. The much divided laciniae of the pinnatisected leaves, as delineated by KÜTZING, l. c., were not verified in our collections.

Localities: Nagasaki (TILSIUS, AGARDH), (HORNER, TURNER), Hizen Prov. (!); Chikuzen Prov. (M. YANO) (!); Tsushima Prov. (H. S. A.); Fusan, Korea (H. SC. COLL.); Nagato Prov. (H. SC. COLL.); Izumo Prov. (!); Tango Prov. (!); Hakodate (H. H. F.), Esashi (H. H. F.), Oshima Prov. (!); Ugo Prov. (!); Shimōsa Prov. (!); Sagami Prov. (!); Shima Prov. (!); Kii Prov. (H. SC. COLL.); Awa Prov. (H. S. A.); Sanuki Prov. (!); Aki Prov. (!); Satsuma Prov. (H. S. A.).

f. macrocarpa: Sagami Prov. (H. S. A.); Kii Prov. (H. S. A.); Tsushima Prov. (H. S. A.); Tango Prov. (!); Noto Prov. (!); Sado Prov. (!).

Sargassum fulvellum Ag.

Plate XIII. Fig. 18–20.

Spec. p. 34.—*Id.*: System. p. 306.—J. AG.: Spec. Alg. I. p. 293 (*excl. syn.*).—*Id.*: Spec. Sarg. Austr. p. 61.—*Id.*: Anal. Alg. Cont. III. p. 55.—DE TONI: Syll. Alg. III. p. 25.

= *Fucus fulvellus* TURN.: Hist. Fuc. Vol. I. p. 148. Tab. 66.

= *Spongocarpus fulvellus* KÜTZ.: Spec. p. 633.—*Id.*: Tab. Phyc. X. Taf. 90.

Description of the species. Fronds of a matured plant measure 2–2.5 feet in total length. The root is complanated, disc-shaped and has a subcylindrical stem on its top. The scars of the fallen basal leaves, as in many other members of the *Bactrophyceus*, give to the lower portion of the stem a knotty appearance. Several fastigiate branches are sent forth in all directions from the stem at a few centimeters above the root. The stems of the branches are triquetrous, slightly twisted with a few dentations on the ridges, but gradually become terete and smooth upwards.

The leaves on the sterile branches as well as on the lower portions of the fronds are retrofractive, elongato-elliptical with round apex and short complanated and often winged petiole. In the fresh specimens they are dark brown in colour and thick and cartilaginous in texture. Small but well defined cryptostomata are discernible in translucent light. The margin is generally entire but in some leaves on young sterile branches it is often coarsely serrated. As a rule, these serrated leaves are variable in their shape ranging from ovate to lanceolate according to individuals and the locality of the plant. An elevated midrib runs through the meridional line and disappears before reaching the apex.

The leaves on the fertile branches are highly variable in their shape according to their position in the frond. On the lower portions they are mostly lanceolate or spathulate, very often obliquely cuneate, with comparatively short stipe and sparingly serrated or entire margin. Those on the upper portions are narrow, cuneate or spathulate, tapering towards the base into a long stipe; mostly entire at the margin but frequently sparingly dentated. The midrib becomes gradually obsolete as the

leaves ascend, the number of the cryptostomata at the same time diminishing.

The leaves on the minor branchlets are narrow and filiform, mostly with neither rib nor cryptostoma.

Vesicles are pyriform, with very short stipe at the base and quite round at the apex. In some cases a few mucronated vesicles are found among the muticous ones; and often an individual with all the vesicles mucronated is met with. A specimen from the Province of Izumo belonged to the latter category but had exactly the same characters as the others in the remaining points. As a rule two or three vesicles are found in a dwarfed raceme at the base of the ramulet. No cryptostomata on the vesicles.

Receptacles are elongato-conical, 3–5 mm. in length, obtuse at the apices and with a very short pedicel at the base. They are found, in matured plants, in dense racemose branchlets. Excepting the few terminal ones, each of them is accompanied by a small filiform, subulate and spotted bractlet.

Remark on the identification. The descriptions and illustrations of *Sargassum fulvellum* AG. are largely applicable to our plant, except in a few points. The pallidity of the frond, which characterized the species, has not been proved in our specimens. The material on which the original description was based had probably been bleached as J. AGARDH¹⁾ has already noted. In defining the species C. AGARDH²⁾ and TURNER³⁾ used the expression “foliis.....enervibus.” Our plant, however, has the leaves mostly evanescently costated except those on the terminal parts

1) Spec. Sarg. Austr. p. 61.

2) System. p. 306.

3) TURN.: Hist. Fuc. Vol. I. p. 147.

of the subordinate branchlets. It must be remembered that the next species has leaves absolutely destitute of midrib, and that its fronds are very liable to lose colour when cast ashore. The figure, indeed, of *Fucus fulvellus* illustrated by TURNER is applicable to both this and the following species. The greater part of the description by TURNER also applies to both plants. But he notes that the plant does not adhere in the least to the paper. *Sargassum enerve* is remarkable for adhering closely to the paper on drying, while the plant here treated never does so.

J. AGARDH¹⁾ remarks that the vesicles of the present species are mucronated; and DE TONI²⁾ notes that the mucronation measures 2.2mm. In our plant, however, as has been shown above, most of the vesicles are entire at the top, and mucronated ones are rather uncommon. They say also, "folia vix uncialia, paullo ultra 3mm." This remark applies to the upper portions only of the frond of this plant.

It is to be remembered that the present writer has never seen an authentic specimen of either TURNER'S or J. AGARDH'S. There is, therefore, no little danger in disputing the former descriptions; but it may be said with safety that in Japan we find no other plants than the one now described and the next one which presents a close agreement with the descriptions of *Sargassum fulvellum* AG.

Localities: Nagasaki (MARTENS), Iizen Prov. (!); Iwami Prov. (!); Izumo Prov. (!); Tango Prov. (!); Sado Prov. (!).

1) Spec. Alg. I. p. 293-294.

2) Syll. Alg. III. p. 25.

Sargassum enerve AG.

Plate XIII. Fig. 1-6.

Spec. p. 17.—*Id.*: System. p. 279.—J. AG.: Spec. Alg. I. p. 294 (*excl. syn.*).—*Id.*: Spec. Sarg. Austr. p. 61.—*Id.*: Anal. Alg. III. p. 55.—KÜTZ.: Tab. Phyc. XI. Tab. 13.—HARIOT: Alg. de Yokosk. p. 218.—MARTENS: Preus. Exped. Tange. p. 116.—DE TONI: Syll. Alg. III. p. 25.—*Id.*: Phyc. Jap. Nov. p. 45.—OKAM.: Enumer. Alg. of Jap. p. 149.
 = *Sargassum fulvellum* OKAM.: Enumer. of Alg. of Jap. p. 149.
 = *Spongocarpus enervis* KÜTZ.: Ueber d. Eigent. (Bot. Zeitg. 1843.) s. 55.—*Id.*: Tab. Phyc. X. Taf. 89. II.—*Id.*: Phyc. Gen. p. 365.—O'KUNTZE: Revisio von Sarg. p. 220.

Description of the species. The root is a depressed cone with a simple erect stem on its top. In a shoot just starting the leaves are sent off spirally upwards from very near the base. The leaves are strongly retrofractive, linear-spathulate or cuneate, irregularly dentated, attenuated below into a more or less elongated petiole. From the petiole a costal elevation passes into the lamina but disappears within a very short distance. The substance of the leaves is thick but soft, dark brown in colour, and without cryptostoma. Short lateral branches, not exceeding an inch in length, with several large vesicles at each base, are seen on the upper portions of these young plants.

The plants with the above features generally attain full development early in the spring, reaching 2-3 feet in height. Then the basal leaves begin to drop off. Late in the autumn, the majority of the basal leaves disappear, and the axial stem elongates considerably, often attaining 15 feet in total length, the lateral branches developing proportionally at the same time. In the vicinity of the Biological Laboratory at Misaki, the receptacles are discharging their contents early in January. The stems of the matured plants are in the middle and the upper

portions triquetrous or quadrangulate with prominent ridges, and unexclusively twisted. The stems of the lateral branchlets are cylindrical but in the lower portions slightly angulate. The leaves on the lower portions of the lateral branches are spatulate, sub-obtuse at the apex, attenuated below into a petiole; coarsely serrated on the margin, ribless, with many minute dark spots. Those on the upper portions, especially on the fertile branchlets, are much smaller, linear-clavate or often obliquely cuneate and slightly dentated on the margin, and are extremely soft in texture. It is owing to the latter character that the present is the principal species of *Sargassum* used as food by the fishermen in certain parts of Japan.

The vesicles at the base of a lateral branch in young and sterile shoots are ellipsoidal or obovate, measuring 12–13mm. in length and 8–9mm. in diameter. They are usually slightly compressed with an inconspicuous longitudinal ridge over the apex. The apices of the vesicles are generally round, but often mucronate or even crowned with a small leaflet. The vesicles on the matured fronds are obovate, sometimes pyriform, with a very short stipe, usually round at the apex, but occasionally fusiform and apiculated. They rarely exceed 5mm. in length.

Receptacles are elongato-conical, shortly pedicelled, each borne on a small, subulate and complanated bractlet, except the terminal one. They are disposed in a raceme on the terminal branchlets.

Remark on the synonymy. KÜTZING¹⁾ declared that *Sargassum enerve* AG. and *Spongocarpus enervis* Kütz. are different plants. But they belong to one and the same species, as J. AGARDH²⁾ had

1) Phyc. Gen. p. 365.

2) Spec. Sarg. Austr. p. 61.

suspected. The character of the vesicles which the former writer pointed out in distinguishing both are demonstratively unreliable.

J. AGARDH¹⁾ and DE TONI²⁾ remarked that the present species has a close affinity to *Sargassum fulvellum* AG. and the former writer once united *Sponcarpus enervis* KÜTZ. with it. Both are, indeed, nearly related, but may be easily distinguished by various points as already mentioned under the preceding species.

J. AGARDH³⁾ relates that the plant which he received from MARTENS with the name of *Fucus pallidus* is equal to *Sargassum enerve* AG., while the plant described and figured by TURNER in Hist. Fuc. Vol. I. t. 67 bearing the former name is quite different from the latter. The figures of *Fucus pallidus* illustrated by TURNER, l. c., and of *Halochloa pallida* by KÜTZING in Tab. Phyc. X. 94. II. do not coincide with the present species in several important characters. These figures, incomplete as they are, are rather referable to *Sargassum piluliferum* AG. or a variety of it.

O'KUNTZE⁴⁾ remarks that *Sargassum enerve* is a hybrid between *Sargassum vulgare* and *Sargassum Horneri*. On what ground his opinion is based is beyond our imagination.

Localities: Chikuzen Prov. (M. YANO (!); Korea (TILESUS); Hagi, Iwami Prov. (J. NIKAI); Izumo Prov. (!); Tango Prov. (!); Noto Prov. (!); Rikuzen Prov. (!); Shimōsa Prov. (!); Boshū Prov. (!); Sagami Prov. (!); Izu Prov. (!); Shima Prov. (!); Kii Prov. (!); Awa Prov. (!); Sanuki Prov. (!); Bungo Prov. (!); "Everywhere along the coast of the Pacific Ocean and the Japan Sea" (OKAMURA).

1) Spec. Sarg. Austr. p. 61;—Spec. Alg. I. p. 294.

2) Phyc. Jap. Nov. p. 45.

3) Spec. Alg. I. p. 294.

4) Revisio von Sarg. p. 222.

Sargassum hemiphyllum Ag.

Plate XIII. Fig. 7-17.

- Spec. p. 39.—*Id.*: System. p. 307.—J. AG.: Spec. I. p. 331.—*Id.*: Spec. Sarg. Austr. p. 61.—*Id.*: Anal. Alg. Cont. III. p. 56.—DE TONI: Syll. Alg. III. p. 26.—*Id.*: Phyc. Jap. Nov. p. 45.—DICKIE: Alg. Jap. in Journ. Linn. Soc., Bot. Vol. XV. p. 45.—OKAM.: Enumer. Alg. of Jap. p. 150.
 = *Fucus hemiphyllus* TURN.: Hist. Fuc. Vol. III. p. 86. Tab. 169.
 = *Spongocarpus hemiphyllus* KÜTZ.: Spec. p. 633.—*Id.*: Tab. Phyc. X. Taf. 90.
 = *Sargassum hemiphyllodes* KÜTZ.: Spec. p. 608.—*Id.*: Tab. Phyc. XI. Taf. 7.
 = *Sargassum hemiphyllum* var. *sinense* J. AG.: Spec. Sarg. Austr. p. 61.—DE TONI: Syll. Alg. III. p. 26.
 = *Sargassum hemiphyllum* var. *micromerum* J. AG.: Spec. Sarg. Austr. p. 62.—DE TONI: Syll. Alg. III. p. 27.
 = *Sargassum micromerum* J. AG.: Anal. Alg. Cont. III. p. 57.
 = *Sargassum chinense* J. AG.: Anal. Alg. Cont. III. p. 56.

Description of the species. The roots are ramose, irregularly dividing as they extend, with the ramuli spreading radially and horizontally. Some of the ramuli more elongate than the rest, having the appearance of a stolon. I am not certain whether a new shoot may start out from the stolon-like ramuli or not. But none of the numerous specimens in our hands proves a vegetative multiplication by budding from the ramuli.

The stem of a young frond usually branches at a point a few millimeters above the root. The branches become nearly as long as the primary frond and have similar characters in all respects. The stems of the branches hardly exceed 1.5 mm. in diameter. They are spirally beset with the characteristic asymmetrical leaves, the interfolial distances ranging from 3 to 8 mm. or more.

The leaves on the lower portions of the stems are cuneate, obovate or oblongo-elliptical, more or less attenuated below and

minutely serrated at the upper margin, or often entire. They are usually destitute of cryptostomata, and are frequently symmetrical. Those on the upper portions of the principal stems, as well as those on the lateral branches, are without exception asymmetrical and situated perpendicularly. They are obliquely cuneate in general outline, attenuated below and ending in a filiform petiole. The upper margin is entire and recurved upward, the lower is minutely or coarsely dentated, not infrequently subentire. The total length of the leaves varies to a considerable degree even in the same individual, ranging from $\frac{1}{2}$ cm. to 3 or more cm. When the plant has attained maturity the fulcrant leaves on the principal members have mostly dropped off, and the lateral branches play the important part of the frond. The leaves on the terminal ramulets are usually narrowly cuneate, entire, or shallowly bi-trifid at the apices.

The lateral branches are axillary. As the fulcrant leaves are perpendicularly situated, the branches grow apparently from the base of the smooth upper margin. This character in a fair degree distinguishes the plant, together with a few others, from the rest of the *Bactrophycus*.

The stems of the lateral branches are more slender than those of the principal members. The leaves on them are proportionately smaller, and very approximately disposed. These leaves have in most cases the lesser ramulets arising from their axils which sooner or later become provided with the receptacles. The ramulets usually measure 2–4 cm. in length, but frequently do not exceed one centimeter.

Vesicles are found on the lower portions of the ramulets. They are liable to a considerable variation in shape according to the individual and to their position in the frond. As a rule

those on the lower portions of a frond are obovate or pyriform, often with round apices, while on the upper they are elliptical or oblongo-obovate and mucronated at the apices. Frequently, they appear like an inflated leaf with a wing-like appendage at the margin. These variations occur sometimes in the same, sometimes in different individuals.

Receptacles are cylindrical, about 1 mm. in diameter, 3-6 mm. in length, more or less attenuated above, and abruptly ending below in a short stipe. They are racemosely disposed at the upper portion of the terminal branchlet. When the latter has been much depressed they appear in a small cluster with a few vesicles at the base. A small, subulate bractlet accompanies each receptacle except the terminal one.

Remark on the synonymy. J. AGARDH distinguished two varieties of *Sargassum hemiphyllum* AG., calling them *var. chinense* and *var. micromerum* in Spec. Sarg. Austr. l. c. In his later work, Anal. Alg., l. c., he raised them both to specific rank. A close examination, however, of rich collections of the plant from various localities made at various seasons proves that the characters pointed out by J. AGARDH to distinguish the three species are not diagnostic, and that it would be better to unite them into one species. The size of the leaves is, first of all, wholly unreliable for specific or varietal distinction. It varies according to the parts of the frond and also according to individuals. In an aberrant form collected by myself at Cape Shiomizaki, in the Province of Kii, I found the leaves on the lateral branches nearly as large as the fulcrant leaves on the main stems. The roundness or sharpness of the apices of the leaves is a much more unfixed character. Frequently plants are found with leaves decidedly entire at the margin and round at the apices.

Sargassum hemiphylloides KÜTZ. was suspected by J. AGARDH to be nearly related to *Sargassum chinense*. He, however, left it in doubt, as KÜTZING's figure had a regular dentation on the outer margins of the leaves. This character as well as the round-headed vesicles shown in the figure presents no objection to a union of KÜTZING's plant with the present species.

Localities: Nagasaki (!); Hagi, Iwami Prov. (H. SC. COLL.); Hakodate (H. SC. COLL.); Boshū Prov. (!); Sagami Prov. (!); Izu Prov. (!); Suruga Prov. (!); Shima Prov. (!); Awa Prov. (!); Tosa Prov. (!); Ise Prov. (K. TANI) (!); Osumi Prov. (H.S.A.); Hiuga Prov. (H.S.A.).

Sargassum Kjellmanianum YENDO.

Plate XV. Fig. 1-5.

Prelim. List of Jap. Fuc. p. 158.

?=*Sargassum corynecarpum* J. AG.: (*nec* HARV.) Anal. Alg. Cont. III. p. 57.

Diagnosis. Radice scutellata subconica; caule tereto sursum longitudine striato, subtortili, quoquoversum ramoso; ramis lateralibus filiformibus ramossissimis; foliis fulcrantibus oblongo-obovatis apice obtusis, stipitis brevissimis, subdentatis, ecostatis, minute glandulosis, superioribus ramulorumque minoribus, subspathulatis vel lanceolatis rarius oblique cuneatis, parce dentatis, medio singula serie cryptostomatibus glandulosis; vesiculis in petiolo ipsis brevioribus subsphaericis vel pyriformibus, mucronatis, parce glandulosis; receptaculis cylindraceis, brevissime stipitatis, in ramulo ultimo racemosis.

Description of the species. A well grown plant measures 75-120 cm. in height, and is attached to the substratum by a small, depressed, conical root. The primary stem is subterete and hardly exceeds 1 inch in length, sending out several branches fasciculately from the top. At an early stage of development these branches are bud-like with numerous, thick, scale-like leaves

disposed spirally around the abbreviated stem. The diameter of the stem measures ca. 1.5mm. and seems to gain a little even in a fully grown form. As the branches elongate upwards the scale-like leaves gradually increase in size. The leaves on the portion several centimeters above the root are generally oblongo-ovate, 1.5-2.5cm. long and 3-4mm. wide, with obtuse apex, sparingly serrated, ribless and with or without spots. The substance of the leaves is thin but coreaceous. They almost all fall off before the frond attains its maturity.

The lateral branches at the lower portions of the principal members are short, hardly one inch long; but they become gradually longer on the upper portions and eventually ramify decomponently. Stems of the branches are cylindrical, filiform and smooth. The leaves on these branches and branchlets are very small, about 5mm. in length, and 1.5mm. in width, with a few dentations on the margins; subspathulate or lanceolate in shape. Often some of the leaves are bifid cuneate and sometimes apparently hemiphyllous. Most of them have a few cryptostomata in a series along the median line, as in the leaves of *Sargassum confusum*.

Vesicles are subspherical or pyriform, less than 3mm. in length, with a stalk about half as long as the vesicles, sparingly dotted with minute cryptostomata. The apices of the vesicles are generally mucronate but some of the upper young ones are fusiform. Two or three vesicles are generally found in the lower portion of an ultimate ramulet. Very frequently the bractlet below a receptacle is swollen at the apex into a small roundish vesicle; or occasionally a small vesicle with a long stalk is given off from the lateral side of a receptacle.

Receptacles are cylindrical, attenuated upwards, with a short stalk below, growing solitary at the base of a subulate, filiform

or narrowly lanceolate bractlet. They are disposed in a raceme on the terminal portion of the ultimate ramulet.

f. muticus form. nov.

Diagnosis. Foliis inferioribus majoribus, lanceolatis, ecostatis, minute dentatis, superioribus ramulorumque cuneatis sæpe obliquis bi-tridentatis, medio irregulari unica serie cryptostomatibus glandulosis; vesiculis obovatis muticis rarius mucronatis.

Remark on the forma. What has been said above on the type may in large part be applied to the present forma. The essential points separating it from the type are the leaves of young sterile branches and the shape of the vesicles. The leaves on the basal portion of a young frond are lanceolate, ribless, and minutely serrated or coarsely dentated. They often attain 2 cm. in length and 5 mm. in width. The leaves on the upper ramules are bi-tridentated, cuneated and frequently subhemiphyllous, with minute cryptostomata irregularly disposed along the median line. Vesicles are mostly obovate, muticous, but in rare cases some in an individual are aristated or mucronated, and frequently spotted with a few cryptostomata.

This forma is limited, as far as our collection extends, to the warmer parts of the Pacific side of the Main Island. The typical form seems to exist in the colder seas only.

Remark on the affinity to other species. The plant has apparently a close resemblance to *Sargassum hemiphyllum* in its general aspect and texture, but it may be readily distinguished from the latter species by its simple scutate root and by the greater elongation of the ultimate ramulets.

J. AGARDH describes a plant from Hakodate, collected by KJELLMAN, under the name of *Sargassum corynecarpum* HARV. I am in considerable doubt about his plant. He says¹⁾

1) Anal. Alg., Cont. III. p. 57.

that it bears a close resemblance to *Sargassum hemiphyllum*. *Sargassum coryneacarpum*, as already stated (p. 84), was established by HARVEY on a withered specimen of *Sargassum serratifolium*. Although J. AGARDH had never seen an authentic specimen of HARVEY'S species, it is rather surprising that he should refer a plant which had some likeness to *Sargassum hemiphyllum* to the diagnosis of such a widely differing species as *Sargassum coryneacarpum* HARV. Judging from the description given in Anal. Alg. Cont. III. l. c., his plant seems to come near the present species, though it is said to have immersedly costated leaves and apparently fibrous roots. In our plant the root is small and scutate. But when the basal stem is greatly diminished in length, the adventitious buds from the lower portions of the main branches give the appearance of a fibrous root. The basal leaves in our plant, again, are frequently evanescently elevated on the meridional line, but the upper ones are decidedly ribless. It is with some hesitation that I refer the present species to the plant that J. AGARDH mentioned under the name of *Sargassum coryneacarpum*; it may, however, be safely stated that his plant is remote from HARVEY'S, but is closely related to the species here described, if not identical with it.

Sargassum Thunbergii f. *latifolia* is closely allied to the present species. The young shoots of both, indeed, are almost indistinguishable the one from the other. When fully grown, however, both exhibit several characters which enable us to separate them quite easily. In the present species the leaves on the upper ramules are cuneate, bifid cuneate or often linear-lanceolate, but rarely filiform; the vesicles have longer and more delicate stipes; and the vesiculiferous ramulets are not abbreviated as in *Sargassum Thunbergii*. The young and sterile specimens

of the latter species show an external resemblance to *Rhodomela Larix* or *Chordaria abietina*, while those of the present species exhibit no such appearance. In the aged fronds of *Sargassum Thunbergii* the primary stem is quite hard to recognize, while in the present species the short subterete stem remains unchanged.

Localities: Fukushima, (H. H. F.), Hakodate (H. S. A.), Yesashi (H. S. A.), Toppu (H. S. A.), in Oshima Prov.; Takashima (H. S. A.), Yoichi (H. H. F.), Shiribeshi Prov.; Yangeshiri Isl., Teshio Prov. (H. H. F.); Rishiri Isl. (H. S. A.), Notoro (H. S. A.), Soya (H. H. F.), Kitami Prov.; Akkeshi, Kushiro Prov. (H. S. A.); Nishiura, Kunashiri Isl. (H. H. F.); Shana, Etorofu Isl. (H. H. F.); Rikuzen Prov. (!).

f. muticus: Rikuzen Prov. (R. TSUGE) (!); Boshū Prov. (!); Sagami Prov. (!); Shima Prov. (!); Kii Prov. (!); Chikuzen Prov. (!).

Sargassum confusum AG.

Plate XIV. Fig. 1-12.

System. p. 301.—J. AG.: Spec. I. p. 294.—*Id.*: Spec. Sarg. Austr. p. 127.—*Id.*: Anal. Alg. Cont. III. p. 60.—KÜTZ.: Spec. p. 610.—DE TONI: Syll. Alg. III. p. 115.—*Id.*: Phyc. Jap. Nov. p. 46.—OKAM.: Enumer. Alg. of Jap. 158.

= *Sargassum acinaria* MARTENS: Preus. Exped. Tange. p. 128.

= *Sargassum acinaria* KÜTZ.: Tab. Phyc. XI. Taf. 17. fig. II.

= *Fucus heterophyllus* AG.: Dec. No. 52.

? = *Sargassum fuliginosum* KÜTZ.: Spec. Alg. p. 612.—*Id.*: Tab. Phyc.

XI. Taf. 19.—J. AG.: Anal. Alg. Cont. III. p. 60.—DE TONI:

Syll. Alg. III. p. 117.—OKAM.: Enumer. Alg. of Jap. p. 158.

—? MARTENS: Preus. Exped. Tange. p. 116.

? = *Fucus pallidus* TURN.: Hist. Fuc. Vol. I. p. 150. Tab. 67.

Description of the species. The root is a complanated disc with a single stem rising from its top. The primary stem seems never to exceed a few inches in height even in the mature plant. The important function of the frond is played by the copious

branches which are sent off more or less alternate-pinnately from the principal stem. In a well grown individual the total length of the frond measures 2-5 feet. While the primary and also the principal branches are yet very young they are cylindrical but densely beset with small, sharp, spinous processes. The leaves on them are linear-spathulate or obovate, often attaining 7 cm. in length. They are thick and coreaceous in substance, evanescently costated, with sparingly dentated or entire margin, and frosted with many cryptostomata.

As the plant further develops the basal leaves on the lower portion of the primary stem fall off, leaving prominent angulate elevations on its surface. The principal branches elongate upward, the leaves gradually decreasing in size, and send out eventually a lateral branch from the axil of each new leaf. The fulcrant leaves seem to drop off soon after the lateral branches have appeared, but the large basal leaves often remain solitarily for a considerable time. The lateral branches and the upper portions of the principal branches are mostly smooth and cylindrical but frequently are subangulate.

The leaves on the lateral branches vary considerably in size and shape. It is owing to this character and to the length of the ultimate branchlets that the fronds of the present species are frequently quite dissimilar. The average leaves on a sterile branch are linear-lanceolate, 3-4 cm. long and 3-4 mm. or less wide, acute at the apices and tapering downwards into filiform petioles; the margin is entire, the substance thin and papyraceous, and several prominent cryptostomata are found in a series along the median of each lamina. We occasionally meet with a specimen in which the cryptostomata are hardly detectable. The leaves on the fertile ramulets are mostly filiform or narrowly linear-clavate.

Vesicles are generally found on the basal portions of the ultimate branchlets. Those fully grown are spherical or sub-spherical, round at the apices, with a stalk at the base nearly as long as the diameter of the vesicle. The young ones are often obovate and apiculated. They are provided with few but well defined cryptostomata.

Receptacles are cylindrical, more or less narrowed above, each, excepting the apical ones, borne on the foot of a filiform, subulate bractlet. They are racemosely disposed at the terminal portion of the ultimate branchlets.

f. valida YENDO. Plate XIV. Fig. 8-12.

Prelim. List of Fuc. Jap. p. 160.

?=*Sargassum validum* J. AG.: Anal. Alg. Cont. III. p. 59.

=*Sargassum expansum* J. AG.: l. c. p. 60.

Remark on the forma. J. AGARDH in his paper Anal. Alg. Cont. III. described two new species calling them *Sargassum validum* and *S. expansum*. These two species are distinguished essentially from each other as well as from *Sargassum confusum* by the characters of the rib and the arrangements of the cryptostomata on the upper leaves, and the dentations of the basal leaves. After careful study of the material in our hands I have decided to unite the two species into one and mention it as a forma of the present species. It must be remembered, however, that I have not seen any of the authentic specimens of AGARDH'S plants and the present disposition is therefore a provisional one. But as far as I could judge from our specimens, provided that I have referred them to J. AGARDH'S species correctly, the specific characters pointed out by that author are by no means constant, and often are reversed. The cryptostomata on the leaves of the lateral branches are, as above noted, occasionally wanting. The

patentness of the lateral branches, the number of the spinous processes on the stems, etc., are also quite unreliable characters.

The present forma may be separated from the type to some extent by having the basal leaves mostly lanceolate, with the rib extending nearly to the apex of each, and irregularly serrated at the margin. In some of the specimens from the vicinity of the Otaru Bay, the serrature on the leaves is remarkably regular; yet plenty of specimens from other localities serve to link them with those having entire spatulate leaves. Linear-spatulate, ribbed leaves are not uncommon in the upper portions of the present forma. When the basal leaves have fallen off this and the typical forma are often hardly distinguishable.

Remark on the synonymy. The original diagnosis of *Sargassum validum* is at once applicable to both *Sargassum confusum* and *Sargassum fulvellum* in the specific conception taken in the present paper. J. AGARDH described *Sargassum validum* from the material collected by KJELLMAN at Hakodate. *Sargassum fulvellum* seems to be limited to the warmer parts of Japan, and its occurrence in the vicinity of Hakodate seems to me very doubtful; while *Sargassum confusum* is commonly found along the coast of Hokkaido (Yesso). Hence I choose to refer the questionable species, *Sargassum validum*, rather to the northern species.

Fucus pallidus TURN. is a problematic species. J. AGARDH¹⁾ once referred it, though with doubt, to *Sargassum enerve*, but he neglected it in his later works. Referring to TURNER'S Hist. Fuc. l. c., I believe that it may be identical with the present species. The figure of *Halochloa pallida* in Tab. Phyc. X. Taf.

1) Spec. Alg. I. p. 294.

94, is rather referable to *Sargassum piluliferum*. If *Fucus pallidus* be nothing but the present species, the name *Sargassum pallidum* must stand instead of *Sargassum confusum* according to the rule of priority.

J. AGARDH¹⁾ mentions a plant which he thought probably a young form of *Sargassum validum*. I can not but suspect, judging from his note, that his plant may have been a basal portion of *Sargassum patens* var. *Schizophylla*. None of the young and sterile specimens of the present species in our collection verifies his remark.

Sargassum fuliginosum KÜTZ. seems to me an extremely doubtful form. It is assigned by KÜTZING to the coast of Kamtschatka. We have reason to believe that, in Japan, *Sargassum* has its northern limit at the southern end of the Kurile Islands. J. AGARDH refers, though with doubt, a plant from Jeto (Jeso?) to this species. It is not clear whether the plants of both writers belong to exactly the same species or not; but, as far as the references extend, KÜTZING's plant seems to come near the present species if not to be a form of it.

J. AGARDH considered as doubtful *Sargassum acinaria* KÜTZ. reported from Korea. The lower portions of the plant are not figured, and the leaves at the base of the lateral branches have the ribs almost quite to the tip. The general appearance of the plant, judging from the illustrations in Tab. Phyc. l. c., suggests a part of the present species.

Remark on the affinity to other species. J. AGARDH added a new section *Angulate* to the subgenus *Eusargassum*, and *Sargassum validum*, *S. expansum*, etc., were included in it. He

1) Anal. Alg. Cont. III. p. 59.

notes that the receptacles of these species have an arrangement similar to that of the members of the *Bactrophyceus* while the characters of the vesicles have a greater resemblance to those of the *Eusargassum*. The present writer can not hold with the opinion that the roundness or apiculation of the vesicles in a frond is a sufficiently important point to serve for subgeneric distinction. As has been repeatedly stated in the preceding chapters, the vesicles are in some species generally muticous in the lower parts of the fronds, while in the upper and younger portions they are often apiculated or mucronated. In *Sargassum enerve* which is undoubtedly a member of the *Bactrophyceus*, some of the vesicles are round-headed in the young sterile fronds; and in *Sargassum fulvellum* some of the vesicles are muticous while others in the same individual are apiculated. In *Sargassum Kjellmanianum* we noticed that the southern and the northern forms differed essentially in the shape of the vesicles. In *Sargassum Ringgoldianum* which has been counted as a member of the *Bactrophyceus*, the vesicles are coronated with an enormously prolonged spathulate leaflet, while the receptacular ramulets claim a position for the species somewhere outside that subgenus.

Sargassum Miyabei has a close resemblance to the present species. They are so alike that in sterile specimens the species may not be discriminated with safety. When fertile, however, the former can be readily separated from the latter by the absence of the bractlets at the bases of the receptacles. Other points will be discussed later on.

Localities: Cape Nomo, Hizen Prov. (KJELLMAN, J. AGARDH); Fusan, Korea (N. YABE, HERB. SC. COLL.); Hagi, Iwami Prov. (J. NIKAI, HERB. SC. COLL.); Wakasa Prov. (R. TSUGE)(!); Noto Prov. (K. OKAMURA); Echigo Prov.(!); Shimofuro, Mutsu

Prov. (!); Hakodate (H.S.A.) (H.H.F.) (!), Fushikido (H.S.A.), Kudo (H.H.F.), Esashi (H.H.F.), (H.S.A.), Toppu (H.S.A.), Oshima Prov.; Bikuni (H.H.F.), Otaru (H.H.F.), Temiya (H.S.A.), Suku-zushi (H.S.A.), Takashima (H.S.A.), Shiribeshi Prov.; Chikubetsu (H.H.F.), Yangeshiri (H.H.F.), Mashike (H.H.F.), Teshio Prov.; Abashiri (H.H.F.), Shiretoko (H.H.F.), Kitami Prov.; Shibetoro (H.H.F.), (H.S.A.), Etorofu Isl.; Shiranuka, Mutsu Prov. (!); Ōshima, Rikuchū Prov. (!); ? Nagasaki (MARTENS).

f. validum: Korea (CROUAN, J. AGARDH, under *S. validum*); Iwami Prov. (!); Hakodate (!) (KJELLMAN, J. AGARDH under *S. validum*); Ishikari Prov. (H.S.A.); Rebun Isl., Kitami Prov. (H.S.A.).

Sargassum Miyabei sp. nov.

Plate XIV. Fig. 13-14.

Diagnosis. Caule communi breve mox fasciculate ramosa, ramis cylindraceut filiformibus, in inferiore parte simplicibus, foliosissimis, in superiore ramulosis; foliis anguste linearibus, deorsum attenuatis, integerrimis, parce glandulosis; vesiculis in petiolo ipsas superante, ellipticis vel fusiformibus, mucronatis, glandulosis; receptaculis cylindraceut breve stipitatis, bracteolis in vesiculam transformatis, in ramulo racemosis.

Description of the species. In the specimens in our hands the root is incomplete and we are unable to determine its exact character. The primary stem seems not to exceed an inch or two in length, with several principal branches starting fasciculately near its apex, as in *Sargassum Thunbergii*. The stems of the principal branches are slightly angulate, measuring 1.5-2.0 mm. in diameter. A young branch is invariably covered densely with narrow lanceolate leaves, disposed approximately and spirally. When a frond has become old these rich leaves drop off, and the stems eventually become very rough with the

leaf-scars. Leaves are, as a rule, narrowly lanceolate, acuminate above, and gradually attenuated towards the base into a delicate filiform petiole. The margins are almost always entire but sometimes coarsely dentated in the upper portion of the leaf. A few obvious, elevated cryptostomata occur on the leaves.

Vesicles are elliptical, apiculated above, and acuminate below into a long filiform stipe. They are disposed racemosely on the lateral branches on which not a single leaf, except the fulcrant leaf, is usually to be found. And on the ultimate ramulets the fulcrant leaf itself is always transformed into a vesicle. Hence when a plant is sterile there is danger of its being mistaken for a *Cystophyllum*.

Receptacles are cylindrical, unarmed, tapering above, with a short filiform stipe; borne solitarily on each stipe of a vesicle or terminal on the ramulets.

Remark on the affinity. The plant has a close resemblance to *Sargassum confusum* on the one side, and to *Sargassum Thunbergii* on the other. One is liable to refer the young shoots, densely covered as they are with small leaves, to either of these two species, or to *Sargassum Kjellmanianum*. A fertile branch, however, readily distinguishes the present species from the others.

The disposition of the receptacles and vesicles of this species is somewhat aberrant among the *Bactrophyceus*. It may be taken as an extreme form of the *Racemosæ*, standing near *Sargassum nipponicum*, with the receptacular ramulets reduced to single receptacles only. But I am inclined to think it an ally of *Sargassum confusum*. The essential difference between them lies in the fact that in the former the bractlets on the ultimate fertile ramulets are invariably transformed into vesicles. Such a modi-

fication, however, though in a lesser degree than in this case, is very commonly met with in the fronds of *Sargassum*. The species next mentioned is an actual example.

Localities: Esashi and Hakodate, Oshima Prov. (H.H.F.); Zenibako, Shiribeshi Prov. (H.S.A.); Rishiri Isl. (H.H.F.); Cape Soya (H.H.F.), Kitami Prov.; Nikishoro and Chashitsu, Kunashiri Isl. (H.H.F.).

Sargassum Thunbergii O'KUNTZE.

Plate XV. Fig. 5.

- Revisio Sarg. p. 215.—*Id.*: Revisio Gen. Plant. III. 2. p. 427.
 =*Fucus Thunbergii* MERT.: in ROTH. Catalect. Bot. III. p. 104. Tab. III. fig. a, c-e.—TURN.: Hist. Fuc. Vol. II. p. 158. Tab. 133.
 =*Cystoseira Thunbergii* AG.: Spec. p. 81.
 =*Rhodomela Thunbergii* AG.: System. p. 199.
 =*Myagropsis Thunbergii* KÜTZ.: Spec. Alg. p. 635.—*Id.*: Tab. Phyc. X. Taf. 93. fig. II.
 =*Cystophyllum Thunbergii* J. AG.: Spec. Alg. I. p. 233.—DE TONI: Syll. Alg. III. p. 153.—*Id.*: Phyc. Jap. Nov. p. 47.—OKAM.: Enumer. Alg. of Jap. p. 140.
 =*Turbinaria* (?) *Thunbergii* YENDO: Prelim. List of Jap. Fuc. p. 153.

Remark on the species. The present species is one of the most common algæ found at the high tide mark along the coast of nearly the whole of Japan. The colour of the fronds is dark olive-brown, but it turns, except in the vesicles, an intense black on exposure to the air, as is usual with all brown algæ which occur between the tide marks. The external appearance of the plant is extremely variable according to its age as well as to the condition of the habitat. The essential characters which give the plants such a divergent appearance are the length of the lateral branches and the internodal distance.

In the embryonal stage of the plant, the principal branches,

not exceeding an inch in length, are provided, like the buds of the *Asparagus*, with spirally disposed, scale-like, imbricate leaves. Then they commence to send out a short lateral branch from each axil of the scale-like leaves. The whole aspect of a principal branch in this stage is simple and vermicular, apparently resembling *Rhodomela Larix*. When further grown with the lateral members eventually more distant and elongated, the frond becomes decompoundly and densely ramose. TURNER'S Hist. Fuc., l. c., illustrates these stages in a satisfactory manner, and the diagnosis hitherto given to the species very well applies to such forms. Some of the forms found in the northern parts as well as on the coast of the Japan Sea side have more or less distinctly marked characters to be distinguished from those above stated. Hence the following:—

f. typica, nov. nom.

= *Fucus Thunbergii* TURN. Hist. Fuc., l. c.

f. latifolia, form. nov.

Diagnosis. Ramis lateralibus brevioribus, foliis fulcrantibus lanceolatis, ramulorum subulato-lanceolatis, sæpe oblique cuneatis, parce glandulosis; vesiculis obovatis, mucronatis, sæpe muticis; receptaculis cylindraceis breve stipitatis.

f. nipponica, form. nov. Plate XV. Fig. 5.

Diagnosis. Ramis lateralibus longissimis densissime vesiculiferis; foliis fulcrantibus subulato-lanceolatis, angustissimis, ramulorum plerumque in vesiculas transformati; vesiculis minoribus, ellipsoideis, apiculatis; receptaculis cylindraceis, stipitatis, in ramulo abbreviato solitariis.

Description of the formæ. *Forma typica* flourishes in the warmer parts of the Pacific side of Japan from 30° to 40° N. latitude. It is characterized by having filiform leaves throughout the whole of the frond except at the base. The lateral branches are always

quite short, rarely attaining 3 cm. in length, and are densely beset with abbreviated ramulets. Vesicles are oblongo-obovate, with a long stalk at the base and apiculated at the top. They are evidently inflations of the upper portions of the filiform leaves. Receptacles are cylindrical, more or less narrowed above, with a short stipe, and disposed in a racemose manner. Some specimens found in the vicinity of Nagasaki had the lateral branches as long as several centimeters and the receptacles measured 1 cm. in length with a diameter of a little over 0.5 mm. The vesicles together with the receptacles are, as in the other formæ, generally limited to the abbreviated ramulets or to the terminal portions of the branches. The stems of the principal branches are ridged and measure 1.5–2 mm. in thickness in the middle portion.

Forma latifolia lives in the colder seas and is found on the coast of Hokkaido as far north as Etorofu Island. Its southern limit is near Kinkwasan Island, a little south of 40° N. latitude. The fulcrant leaves, i.e., the leaves on the principal branches, are lanceolate, and often as wide as 3 mm. Those on the lateral branches are complanated, subulato-lanceolate and usually have a few cryptostomata. On an average they measure ca. 0.5 mm. in width and 5 mm. in length. In the specimens from northern localities they apparently tend to have a greater width. In the specimens from the east coast of Hokkaido, these narrow lanceolate leaves are no longer found on the lower portions of the frond and in their place there are obliquely cuneate or spathulate leaves, 6–7 mm. long and 3–4 mm. wide. The assigning of *Sargassum hemiphyllum* to the northern part of Hokkaido may have been due to an erroneous identification of this forma. The vesicles begin to appear after the plant has grown more than a foot in height. At the beginning they are nothing but slight inflations

in the apical part of a more or less broadened leaf. When fully formed they become more spherical than those of *f. typica* and are frequently inermous. The receptacles are cylindrical, more or less narrowed above and have a short filiform stipe.

At an early stage of development, this forma is hardly separable from *f. typica*. But as soon as the fronds have reached half a foot in height, the characteristic broad fulcrant leaves serve unmistakably to distinguish it from the others. In a full grown individual the frond attains 3-4 feet in total height. The lateral members are much further apart than in *f. typica* and their average length is less than an inch. The stems of the principal branches are 2-3 mm. thick, and are five-ridged. A ridge is generated downwards from each insertion point of the leaves which are disposed spirally upwards in a screw-wise direction.

Forma nipponica also is not easily separable from *f. typica* while it is yet young. When it has attained to about a foot in total height, the lateral branches elongate to a considerable degree, often exceeding the principal branches in length. The ramulets on the lateral branches are quite stunted and approximate. The leaves on the ramulets are almost all transformed into small apiculated vesicles. The richness of the vesicles in the lateral branches is an important point in the practical distinction of this forma from *f. typica*. Receptacles are found at the terminal point of the stunted ramulet, and are usually solitary.

This forma is most abundant on the Japan Sea side from Nagasaki as far as Saghalin. On the coast of the Pacific side it seems to be confined to the vicinity of the eastern entrance of the Tsugaru Strait.

Remark on the systematic position. It can be easily demonstrated

from a fertile specimen that the receptacles or the receptacular ramulets are axillary. This character certainly excludes the plant from the genus *Cystophyllum* and necessitates its reference to *Sargassum*. Hence the name *Sargassum Thunbergii*, proposed by O'KUNTZE in the works referred to above, although his generic conception differs from ours, must be preferred according to the rule of priority. In *f. typica* and *f. latifolia*, the fulcrant leaves in the lower as well as in the middle portions of the fronds are filiform or lanceolate. In *f. nipponica*, they are almost always transformed into vesicles. Fig. 5 illustrates a portion of a fertile lateral branch of the latter form. In it one ramulet has an inflated fulcrant leaf and another a lanceolate one. This character, no doubt, suggests the close affinity of the present species to *Turbinaria(?) fusiformis*.

That the receptacles are axillary or apparently axillary is an important point in separating *Turbinaria* and *Sargassum* from the other genera of *Fucaceae*. I prefer to place the present plant and the following one under the genus *Sargassum*. In my former paper—the Preliminary List—I have referred it with some hesitation to the genus *Turbinaria* on the ground that it showed several points of morphological similarity to *Turbinaria(?) fusiformis*. The fulcrant leaves, however, of this and of the next species are in the majority of cases foliose and not vesiculiform, and this suggests the propriety of arranging the two species as is here done. Some of the specimens of this species, especially of *f. latifolia*, exhibit some resemblance to *Sargassum Kjellmanianum*. In some sterile specimens, indeed, it is often difficult to distinguish the two species except by close examination.

Localities: *f. typica*; Higo Prov. (!); Chikuzen Prov. (M. YANO) (!); Shirikishinai (H. H. F.), Fukuyama (H. H. F.), Esashi

(H. H. F.), Oshima Prov.; Raiden (H. H. F.), Bikuni (H. H. F.), Temiya (H. S. A.), Sukuzushi (H. S. A.), Shiribeshi Prov.; Moyoro (H. H. F.), Onnebetsu (H. H. F.), Kitami Prov.; Shitsukari, Hidaka Prov. (H. H. F.); Rikuchū Prov. (H. S. A.); Rikuzen Prov. (H. S. A.); Boshū Prov. (!); Sagami Prov. (!); Izu Prov. (!); Suruga Prov. (H. S. A.); Shima Prov. (!); Kii Prov. (H. SC. COLL.); Tosa Prov. (!); Bungo Prov. (H. S. A.); Osumi Prov. (H. S. A.).

f. latifolia; Hakodate (!); Shimofuro, Mutsu Prov. (!); Shari-utoro Cape, Kitami Prov. (H. H. F.); Nemuro (!); Shoya, Hidaka Prov. (H. S. A.); Rikuzen Prov. (!); Rikuchū Prov. (!).

f. nipponica; Hizen Prov. (!); Fusan, Korea (H. YABE, H. SC. COLL.); Tsushima Prov. (Y. YABE, H. SC. COLL.); Izumo Prov. (!); Tango Prov. (!); Wakasa Prov. (R. TSUGE) (!); Echigo Prov. (!); Todohokke (H. S. A.), Zenigamezawa (H. S. A.), Hakodate (!), Kamaya (H. S. A.), Oshima Prov.; Rishiri Isl. (!); Urakawa, Hidaka Prov. (H. H. F.); Tosa Prov. (!).

Sargassum Swartzianum nom. nov.

= *Fucus Swartzii* AG.: in Act. Holm. 1815. p. 105. t. 4. fig. a-b.

= *Rhodomela Swartzii* AG.: System. p. 198.

= *Cystoseira Swartzii* AG.: Spec. p. 82.

= *Myagropsis Thunbergii* var. *Swartzii* Kütz.: Spec. p. 635.

= *Myagropsis Swartzii* Kütz.: Tab. Phyc. X. Taf. 93. fig. 1.

= *Fucus Thunbergii* var. *racemosus* ROTM.: Catalect. Bot. III. Tab. 3. fig. b.

= *Cystophyllum Swartzii* J. AG.: Spec. Alg. I. p. 233.—DE TONI:

Syll. Alg. III. p. 157.—*Id.*: Phyc. Jap. Nov. p. 47.—OKAM.:

Enumer. Alg. of Jap. p. 140.

= *Turbinaria* (?) *Swartzii* YENDO: Prelim. List of Jap. Fuc. p. 153.

Remark on the species. This species has hitherto been distinguished from the preceding by the vesicles being evolved from the middle portions of the leaves. This, however, is never

accurate and often quite unreliable. KÜTZING¹⁾ illustrates some of the leaves as having two inflations successively or in a series. The greater number of the typical forms of the present species, when fully grown, have this sort of vesicles. I am tempted to believe that this character is rather important in the discrimination of the two species. Besides, this species may be easily distinguished from the preceding by its yellowish colour and soft texture. The fulcrant leaves are mostly as broad as, or broader than, those of *f. latifolia* and are spotted with a few well defined cryptostomata. In some specimens I found the basal leaves slightly dentated with the general outlines linear-lanceolate. It must be remembered, however, that given the young fronds alone, it is usually difficult to distinguish the present species from the preceding except with practice.

The occurrence of two inflations serially in a leaf is an uncommon character among the species of *Sargassum*. The same sort of arrangement of vesicles has been met with in several species of *Cystophyllum*. This fact made me hesitate to refer the present species to the genus *Sargassum*. But the receptacles are, as in the preceding species, evidently axillary, which, in the limitation of *Cystophyllum* by recent botanists, proves the impropriety of the generic position hitherto acknowledged.

Localities: "Pacific side, from Kiushū to the southern part of Hokkaido." (OKAMURA); Takashima, Shiribeshi Prov. (H.S.A.); Sawara (H.H.F.), Osatsube (H.H.F.), Oshima Prov.; Shiretoko, Kitami Prov. (H.H.F.); Enoura (H. SC. COLL.), Izu Prov. (!); Shima Prov. (!).

1) Tab. Phyc. X. Taf. 93. fig. 1.

MICRACANTHÆ.

Receptaculis ovatis, complanatis, ancipitibus, apice vel margine minute dentatis, petiolatis, nunc in axilla ramulorum solitariis nunc in ramulo contracto aggregatis.

The following three species present a remarkable peculiarity in the receptacles. The fertile ramulets are always so abbreviated that they are not able to carry more than three receptacles on each. In extreme cases, only one receptacle, accompanied by a single leaf at its base, represents a fertile ramulet. The receptacles are ovate, ancipitous, excavated on one surface and longitudinally elevated on the other, and minutely spinosodentated on the margin or at the apex. The roots are scutate or tuberculate, and the stems mostly angulate; leaves simple, pinnatisected or entire, with or without cryptostomata; vesicles coronated with a simple leaflet, or often apiculated.

These species should undoubtedly be included under the subgenus *Bactrophyucus* on account of the undivided receptacles and the other characters. But the dentation on the margin of the complanated receptacles claims for them a systematic position different from the other members. They might better be placed under an independent subgenus if preferred, but I choose to simply mention them in the new section above named under the subgenus *Bactrophyucus*.

Sargassum Kiushianum sp. nov.

Plate XV. Fig. 6-9.

Diagnosis. Caule....., ramis filiformibus, quadrangularibus, longitudine striatis, ramulis undique egredientibus; foliis linearibus, costatis, membranaceis, profunde alterne pinnatifidis, laciniis linearibus vel triangularibus sæpe apice bidentatis; vesiculis in petiolo filiformi ipsas subæquante sphericis, folio pinnatifido coronatis; receptaculis complanatis ovalibus dorso longitudine elevatis, margine minute dentatis, in axilla ramulorum solitariis.

Description of the species. The basal portion of the frond is unknown. The stem (possibly of the principal branch) is quadrangular, ca. 2mm. thick, with longitudinal furrows as in the case of *Sargassum Horneri*. It is loosely twisted with the lateral branches disposed spirally upwards. The leaves on the stem are thin and membranaceous, pinnatisected, with the general outline linear or linear-lanceolate. The lamina is almost reduced to an elevated, undulating midrib, which becomes a filiform petiole below. The laciniae are ascending, subulate, narrowly linear, acuminate or shallowly bi-tridentated at the apices. No cryptostomata are found in our specimen. The leaves on the lateral branches are essentially similar to those on the stem, but are smaller and narrower, with the laciniae obliquely triangular. The apices of the leaves on both parts are pointed or narrowly truncated.

Vesicles are solitarily disposed near the base of the lateral ramulets. Those found in the lower portions of the frond are spherical, but those in the upper, ovate or elliptical; they are coronated with a pinnatisected leaflet, or sometimes simply mucronated; stipes short and filiform.

Receptacles are complanated, obovate, ca. 5 mm. in length, with a cylindrical stalk. They are longitudinally elevated on one surface and shallowly concave on the other, and minutely serrated on the margin.

Remark on the affinity. The present species is closely related to the next. It may, however, be easily distinguished by the membranaceous texture of the leaves, the extremely narrow laciniae, the solitary receptacles, etc. It has also a strong resemblance to *Sargassum filicinum* in the vegetative organs, so that the sterile specimens of both plants are almost indistinguishable from each other.

Locality. Chikuzen Prov. (M. YANO) (!).

Sargassum micracanthum (KÜTZ.)

Plate XV. Fig. 10-21.

Sargassum (*Halochloa*) *micracanthum* was first established by KÜTZING from a plant collected in Japan by TILESIIUS. J. AGARDH mentions the same species in Anal. Alg. Cont. III. p. 52, based on material collected in the same place by KJELLMAN. The specimens which reached both writers were unfortunately sterile and the reproductive organ was consequently unknown. There is no little risk in identifying a plant with the above named species as we have within our boundaries at least three distinct plants, all worthy of specific rank and to all which, when sterile, KÜTZING'S specific definition of the above may be applied equally well: these are *Sargassum filicinum* HARV., *Sargassum kiushianum*, and the plant under consideration. The present identification is hence a provisional one, done with the hope that my doubts will be cleared away by some one who has the chance of studying the authentic specimens.

Among the specimens in our hands, which accord with the descriptions by the two writers, there are two well defined varieties, if not species. KÜTZING'S description is more applicable to the one, which I choose to call *var. typica*; the other, i.e., *var. stipulata*, has many characters coinciding with J. AGARDH'S description.

var. typica YENDO.: Prelim. List of Fuc. Jap. p. 158.

Plate XV. Fig. 10-17.

=*Halochloa micracantha* Kütz.: Ueber d. Eigent. (Bot. Zeitg. 1843) s. 56.—*Id.*: Spec. Alg. p. 633.—*Id.*: Phyc. Gen. p. 367.—*Id.*: Tab. Phyc. X. Taf. 98. fig. II.

Description of *var. typica*. Roots are complanated, disc-shaped, irregularly sinuated at the margin. From the upper surface of the disc there start usually several principal stems which ramify

at a short distance from the base. Not infrequently we meet with a form which has many unbranched stems starting multicapitally from a prostrate disc.

The stems of young shoots are cylindrical at the basalmost portion but soon become angulate above. In the middle portions of fronds they are, as a rule, triquetrous, more or less twisted, and occasionally complanated and ancipitous. The stems of the lateral branches are filiform and cylindrical; but in a well grown individual their basal portions are minutely denticulated by the scars of fallen leaves. The specific name comes probably from this character. A good-sized frond measures 30–35 cm. in height, with the lateral branches as long as 3–6 cm.

The basal leaves are spatulate or lanceolate with a short, complanated petiole. Those on the embryonal shoots are thick, mostly entire or undulating at the margin; but those above a short distance from the base are coreaceous, pinnately dentated, and evidently retrofractive; an elevated midrib runs almost to the apex. The edges of the complanated petiole run upwards into the ridges of the triquetrous stem and are often remarkably pronounced.

The leaves on the lateral branches are linear, alternately pinnately dentated, with a rib that runs undulating along the median line. The laciniae are more or less obliquely triangular, often, however, linear-subulate or truncated, and not seldom duplicatoserrated. The sinu are round and deep reaching almost to the rib. In the lower lateral branches the leaves are much smaller and approximately disposed. In most cases no obvious subordinate ramuli are seen on the lateral branches; but if one develops to any degree, the leaflets on it are linear-spathulate or clavate, attenuated below into long petiole, subentire at the margin and with an evident rib.

Vesicles are found solitary near the insertion point of a lateral branch. They are elliptico-spherical, with or without cryptostomata, and mucronated or crowned with a simple serrated leaflet on the apex. The stipe is usually shorter than the length of the vesicle.

Receptacles are obovate or elliptical, complanated with anticipitous edges, more or less concave on one surface and convex on the other; the apical, occasionally the whole, margin is minutely toothed. They are usually found solitary at the axil formed by a leaf and the stem of a lateral branch, but sometimes two or three of them, each accompanied by a leaflet at its base, are borne racemously on a poorly developed minor ramulet.

var. stipulata YENDO. Prelim. List of Fuc. Jap. p. 158.

Plate XV. Fig. 18-21.

= *Sargassum micracanthum* J. AG.: Anal. Alg. Cont. III. p. 52.

Diagnosis. Foliis fulcrantibus late stipulatis, stipulis margine dentatis sursum marginibus rachidis confluentibus.

Remark on var. *stipulata*. This variety has several noteworthy characters which enable us to distinguish it from *var. typica*. If only extreme forms of both varieties were compared, it would doubtless seem to be improper to range them under the same species. On comparing a large number of specimens, however, the characters to distinguish both varieties are often hardly detectable and they may be connected by various intermediate forms.

In this variety the basal portion of the complanated petiole of a fulcrant leaf is enormously expanded, with irregular dentation on the outer margins, and gives an appearance of stipules (fig. 20). The margins of the "stipules" become confluent with the

edges of the stem and traverse longitudinally up to the next node. Hence the edges are usually remarkably winged.

From the upper surface of the stipulated portion of a petiole a pair of opposite leaves start out. These leaflets are almost sessile and have a common insertion. From a point practically between the pair a lateral branch is given off. In comparison with other species these two leaves represent two unusually contracted basal nodes of a lateral branch. In the upper portions of a frond one of the pair is found at the base of the branch and the other a little above the first, but set in the opposite direction, thus clearly proving the above remark.

The leaves, except the basal ones, are dotted with prominent cryptostomata. In some specimens, however, this character is slightly developed, showing a gradual approach to *var. typica*.

Remark on the affinity. J. AGARDH at first doubted the validity of *Halochloa micracantha* KÜTZ. and referred it to *Sargassum Fengeri*, though with hesitation. In Anal. Alg. Cont. III. p. 52 he changed his former opinion and mentioned KÜTZING'S plant as a distinct species under the genus *Sargassum*. He further noted that the species stands close to both *Sargassum Horneri* and *Sargassum tortile*.

In describing *Sargassum micracanthum*, J. AGARDH mentions the wings on the stems and the cryptostomata on the leaves as important characters. These are very pronounced in *var. stipulata* while almost negligible in *var. typica*. One of the specimens collected by Dr. Y. YABE on Tsushima Island was wingless on the stem and showed every other character of *var. typica*, but had well-defined cryptostomata on the laciniae of the leaves.

That the resemblance of the present species to *Sargassum Horneri*, *Sargassum filicinum*, *Sargassum tortile*, etc., is merely

superficial is satisfactorily proved by the receptacles. *Sargassum kiushianum* is the only species which is closely related to the present in many respects. These two, however, may be easily separated by the shape of the leaves, the texture of the fronds, etc.

Localities: *var. typica*: Tsushima Prov. (Y. YABE, HERB. SC. COLL.); Nagato Prov. (!); Iwami Prov. (J. NIKAI, HERB. SC. COLL.); Izumo Prov. (!); Tango Prov. (!); Sado Prov. (!); Hakodate (!); Rikuzen Prov. (!); Boshu Prov. (!); Shima Prov. (H.S.A.); Kii Prov. (!); Awa Prov. (!); Tosa Prov. (H. YAMAMOTO) (!); Hiuga Prov. (!); Kudō (H.S.A.), Fukuyama (H.S.A.), Oshima Prov.

var. stipulata: Ugo Prov. (!); Rikuzen Prov. (!); Sagami Prov. (H.S.A.).

Sargassum nigrifolium YENDO.

Plate XVI. Fig. 1-3.

Prelim. List of Fuc. Jap. p. 158.

Diagnosis. Radice nodoso-prostrata, pluribus frondibus ex superficie exeuntibus; caule communi brevissimi mox ramoso plerumque radici confluenti; ramis triquetris, alterne complanatis, ramulis e margine spiraliter egredientibus; ramulis tenuioribus, teretibus, triquetris, foliis approximatis; foliis fulcrantibus verticalibus, crassis, cartilagineis, lanceolatis vel ovatis, immerse costatis, plerumque obliquis, petiolis complanatis, ramulorum lanceolatis vel clavatis, evanescente costatis; vesiculis subcompressis, ellipsoideis, mucronatis vel subulatis; receptaculis spatulatis vel subcuneatis, complanatis, apice minute dentatis, in axilla ramulorum solitariis, vel in brevissimo ramulo racemosis.

Description of the species. The root is a prostrate rugose mass with a number of shoots rising multicapitally from the surface. From the very base of each shoot, many protuberances are sent out confusedly, some of which elongate upwards into the principal branches. As a consequence the root of a well

developed plant has a very intricate appearance, and is likely to be mistaken for a sort of holdfast. The shoots, i.e. the axial stems, seem to develop very slightly, attaining not more than 1–2 cm. in height. Their stems are virtually smooth and cylindrical but have an irregular knotty appearance owing to the protuberances above noted.

The principal branches play the main part of a frond and in a well-grown individual may measure 2–2.5 feet in total length. The stem at the lower portion of a principal branch is essentially triquetrous with the leaves spirally disposed on it, the angle of their divergence being $\frac{1}{3}$. This, however, is not readily recognized as the stem is more or less twisted. From the insertion point of each leaf there passes downwards a prominent, almost wing-like ridge, to the lower third insertion. Hence the stem becomes complanated with the successive internodes compressed, by the twisting of the stem, in different planes.

Leaves on the principal branches are thick, cartilaginous, and dark olive-brown in colour even in the fresh condition. They are simple, obliquely spatulate or hemiphyllous, evanescently costated, attenuating and recurving downwards to a compressed petiole. The margin is absolutely entire. The lamina of a leaf is disposed perpendicularly and the petiole is horizontally flattened. No cryptostomata are seen.

The lateral branches appear after the principal branches have attained their full length. They are axillary, and not more than 3–4 inches in length. Their stems are thinner than the principal branches but have similar characters; and the leaves on them are much narrower, being obliquely cuneate or lanceolate, attenuated toward the base.

Vesicles are subcompressed, elongato-elliptical, mucronated

or with a short ligule which often runs downwards for a short distance forming a narrow wing-like appendage. They are usually found solitary on the basal portion of a lateral branch but not infrequently at the base of a minor fertile ramulet.

Receptacles are spatulate or subcuneate, complanated, with ancipitous margin, and with a few dentations at the apex. They are, as in the preceding species, mostly solitary at each axil formed by a leaf and the stem of a lateral branch, but often 2-3 or more of them are racemously disposed on an extremely short ramulet.

Remark on the affinity. The present species has very well marked characters and no other species hitherto known to us seems to be closely related to it. The receptacles, however, suggest that this species should be placed near *Sargassum micracanthum*.

Localities : Misaki, Sagami Prov. (!); Izu Prov. (!); Iwami Prov. (!).

EUSARGASSUM J. AG.

Tribe 1. CARPOPHYLLÆ J. AG.

Sargassum graminifolium AG.

Plate XVI. Fig. 4.

Spec. p. 18.—*Id.*: System. p. 209.—J. AG.: Spec. I. p. 303.—*Id.*: Spec. Sarg. Austr. p. 81.—Kütz.: Spec. p. 615.—*Id.*: Tab. Phyc. XI. Taf. 28. fig. 1.—DE TONI: Syll. Alg. III. p. 38.

=*Fucus graminifolius* TURN.: Hist. Fuc. Vol. IV. p. 32. Tab. 210.

=*Sargassum Vachellianum* GREV.: Alg. Orient. p. 204. Tab. IV.

Remark on the determination. We have several specimens which accord with the descriptions and figures of the above named species as given by various writers. In our specimens, the stems on the upper portions of fronds are compressed and ancipitous,

measuring 3–5 mm. in breadth; and the vesicles are found mostly solitary near the base of the lateral branches. These characters accord especially well with the illustration given by TURNER in Hist. Fuc. l. c.

I have not seen any reproductive organ on our specimens. A fragmentary piece of a plant which has various characters referrible to *Sargassum serratifolium* or its allies, was collected at Shishikui, Awa Prov. Its receptacles, however, proved the plant to belong to the *Carpophyllæ*; and the vesicles on it were apiculated, or coronated with somewhat broadened leaflets (Pl. XVI. fig. 4). As we have not been able to find in Japan any species, except the present, which might be included in that tribe, I have provisionally connected the fragment with the plant above remarked upon, though not without considerable doubt.

Localities: Nemoto, Boshū Prov. (H. S. A.); Enoshima, Sagami Prov. (!); Shimoda, Izu Prov. (!); ? Shishikui, Awa Prov. (!).

Tribe 2. *GLOMERULATÆ* J. AG.

There are at least three species of plants within our boundaries which should be enumerated under the tribe *Glomerulatæ*. They are exclusively from the warmer regions and are more or less related to *Sargassum duplicatum* J. AG. But the exact characters of the last mentioned species, as well as its relationship to other allied members are not very clear to me. I can not but repeat what was said by Major REINBOLD¹⁾ when he described the *Sargassum* of the East Indies, viz.:—“Ohne Kenntniss der schwer zu beschaffenden Original-Exemplare, auf welche J. AGARDH die oben angeführten Arten basirt hat, lediglich aus

1) Sarg. v. Ind. Arch. p. 71.

den gegebenen Diagnosen und Bemerkungen heraus, dürfte es sehr schwer halten, *S. duplicatum* J. AG. genügend sicher und scharf von den ähnlichen Arten zu unterscheiden."

I was especially careful in determining our plants but the result was not very satisfactory, as might be expected from the above noted circumstance. A few of the specimens were sent to Major REINOLD. He was kind enough to take the trouble to compare them with the reliable specimens at his command and has given me much valuable advice together with authentic specimens of BORY, GRUNOW, etc. The determination of the following three species is for the most part based on his opinion.

I have a few other specimens, sterile and fragmentary, which should probably be counted in this tribe. They are however so incomplete as to make impossible even to speculate upon their relation to any known species. We have reason to believe that a careful research in the warmer regions of Japan may add to her flora a few other species of *Sargassum*, especially of the present tribe.

Sargassum Illicifolium var. *duplicatum* J. AG.

Plate XVI. Fig. 5-9.

Spec. Alg. I. p. 318.—REINB.: Sarg. v. Ind. Arch. p. 70.

=*Sargassum cristæfolium* HARV.: Alg. Felf. in HOOK. Lond. Journ. Bot. I. p. 147. (sec. J. AG.).

=*Sargassum Pfeifferæ* GRUN.: Fidsch. p. 5.

Remark on the determination. Our specimens answer very well to the description of the above named variety given in J. AGARDH'S Spec. Alg., l. c. They also accord most satisfactorily with *Sargassum Pfeifferæ* GRUN., a part of an original specimen

of which I have obtained through the kindness of Major REINBOLD. The leaves in the present plant are soft and membranaceous, sometimes "duplicated" but often not, and turn a brownish colour on drying. The receptacles are less densely aggregated and are frequently isolated by a short stalk, partly exhibiting a character of the *Biserrulae*. Dentated and smooth receptacles are mingled together in the same individual or even in the same ramulet. These points remind one of *Sargassum oocyste var. conduplicatum* J. AG. (in Spec. Alg. I. p. 317, but struck out in Sarg. Austr.).

J. AGARDH established a new species in Sarg. Austr. p. 90, calling it *Sargassum duplicatum*, reducing *Sargassum Ilicifolium var. duplicatum*, *Sargassum cristæfolium* HARV. and *Sargassum Pfeifferæ* GRUN. to the synonyms. It is very doubtful, however, whether the plant on which the new species was based is identical with all of the synonymized species. There is reason to believe that the plant probably differed from *Sargassum Ilicifolium var. duplicatum* as he says:—"Folia ad basem vix sunt excisa, hinc in vicinia *Sargassum Ilicifolia* vix disponenda; folia in hac præterea sunt multo tenuior, fere membranacea dicenda," I prefer to retain here the old name as has been done by REINBOLD.

A specimen from Kashiwajima in Tosa Prov., has all its characters similar to the plant in question, except that the receptacles are never separated from one another by the stalk and are minutely spinulated without exception. It is a ♂. Unfortunately we have only one fragmentary piece and further discussion is impossible at present.

Localities: Hiratsuka, Sagami Prov.(!); Tosa Prov. (H.S.A.). Boshū (OKAMURA) (!).

Sargassum cristefolium AG.

Spec. p. 13.—*Id.*: System. p. 297.—J. AG.: Spec. Alg. I. p. 325.—*Id.*: Spec. Sarg. Austr. p. 91.—REINB.: Sarg. v. Ind. Arch. p. 70.—DE TONI: Syll. Alg. III. p. 52.—YENDO: Prelim. List of Fuc. Jap. p. 158. (*excl. syn.*).

?=*Sargassum duplicatum* BORY: Voy. Coquil. No. 22.

In 1900, I found a *Sargassum* species in Hiuga Prov., which had thick, leather-like, "duplicate" leaves and seemed to answer to the remark on *Sargassum cristefolium* given by REINBOLD in Sarg. v. Ind. Arch. p. 71. Unfortunately my specimens were all sterile, and as I was not without doubt about the species, one of the specimens was sent to the author of the above mentioned paper for examination. He kindly examined the specimen, compared it with the authentic specimens kept in BINDER'S herbarium, and wrote me that the plant I had sent him was referrible, though provisionally, to *Sargassum cristefolium* AG. and that it had a close resemblance to *Sargassum duplicatum* BORY., as well as to *Sargassum cristefolium* var. *Upolense* GRUN.

J. AGARDH¹⁾ refers, with some degree of doubt, *Sargassum duplicatum* BORY. to his *Sargassum beriberifolium*. The relation between the two species will be discussed under the next species.

Localities: Bindare Isl., Hiuga Prov. (!); Numazu, Suruga Prov. (H.S.A.).

Sargassum beriberifolium J. AG.

Plate XVI. Fig. 10-14.

Spec. Alg. I. p. 337.—*Id.*: Spec. Sarg. Austr. p. 90. Tab. XXVI. fig. V.—DE TONI: Syll. Alg. III. p. 50.

1) Spec. Sarg. Austr. p. 123.

?=*Sargassum cristæfolium* var. *condensatum* SOND.: Alg. Trop. Austr. p. 42. No. 15.

?=*Sargassum duplicatum* OKAM.: Enumer. Alg. of Jap. p. 153.

Remark on the species. Numerous specimens of marine algæ were brought home by Dr. H. HATTORI of the Botanical Institute, collected by himself while on a trip to the Bonin Islands. Among them there are a good number of *Sargassum*, all fertile and complete. After careful examination they all proved to belong to a single species, to which the descriptions and figures of *Sargassum beriberifolium* given by J. AGARDH in the papers above referred to were exactly applicable. As the establisher of the species seems not to have had access to a complete specimen, some additional remarks on the points which escaped his observation will not be superfluous.

The root is disc-shaped in a young and isolated individual but is usually prostrate, sometimes overlapping the surface of a *Lithothamnium* and eventually assuming a hemispherical or tuberculate shape of irregular outline. On its upper surface there stands in most cases several principal stems which are cylindrical, smooth and hardly a centimeter in height. A number of principal branches are sent out in all directions around the short stem, frequently apparently multicipitally. These branches play the important part of frond and attain 3-4 feet in length when fully developed.

The stem of a principal branch is complanated, giving rise to the lateral branches on its ancipitous margins distichously and alternately. But as the stem is generally more or less loosely twisted the arrangement is in some degree disturbed.

The leaves on the lower portions of the principal branches are elliptical or oblongo-obovate, evanescently costated, and sharply

but coarsely subduplicately dentated on the margin. Some of the leaves on the lateral branches are evidently "duplicated" while the larger number of them are simple.

Vesicles are spherical with a complanated stipe as long as their diameter. In the majority of cases those on the lower portion of a frond are marginated or even have coarsely dentated wings.

Remark on the synonymy. J. AGARDH¹⁾ has referred *Sargassum cristafolium* var. *condensatum* SOND. and *Sargassum duplicatum* BORY to the present species though with hesitation. On comparing our plant with a specimen of the former variety, determined by GRUNOW, it seems to me that J. AGARDH had good grounds for doing so. As for *Sargassum duplicatum* BORY, Major REINBOLD wrote me that it is very likely a species distinct from the present.

Mr. OKAMURA reported *Sargassum duplicatum* J. AG. to have been collected in the Bonin Islands. Dr. HATTORI observed that no other species seemed to occur there beside that which he had collected. It is not impossible that there occurs *Sargassum Illicifolium* var. *duplicatum*, which may have been mentioned by Mr. OKAMURA under the name *Sargassum duplicatum* J. AG. At present, however, I can only mention his statement here, though I doubt if his plant can be identified with *Sargassum beriberifolium*.

Locality. Bonin Isl. (HATTORI), ? (OKAMURA).

Tribe 3. *BISERRULÆ* AG.

Sargassum heterocystum MONT.

Cent. III. No. 54.—*Id.*: Voy. Bonite. p. 43. Tab. 142.—J. AG.: Spec. Alg. I. p. 346.—*Id.*: Spec. Sarg. Austr. p. 93.—DE TONI: Syll. Alg. III. p. 55.

1) Spec. Sarg. Austr. p. 90 and 123.

=*Carpacanthus heterocystus* Kütz.: Spec. p. 623.—*Id.*: Tab. Phyc. XI. Taf. 40.

?=*Sargassum armatum* J. AG.: Spec. Alg. I. p. 313.—Kütz.: Spec. p. 626.

Our plant is sterile, but satisfactorily accords with the descriptions of the present species. The stems in ours are spotted with conspicuous cryptostomata and seem muricated on drying. The vesicles are glandulated and frequently have minute spinous processes on the surface.

Locality. Loochoo (K. MIYAKE, H. SC. COLL.).

Sargassum brevifolium Kütz.

Spec. Alg. p. 608.—*Id.*: Tab. Phyc. XI. Taf. 4. fig. 2.—DE TONI: Syll. Alg. III. p. 117.—HEYDRICH: Algflora v. Ost-Asien. p. 288.

A specimen of *Sargassum* sent me by Mr. SAITO for determination, answered very well to the description and illustration of the species mentioned above. Unfortunately the specimen was sterile and fragmentary, so that I am unable to add anything to the original remarks. The systematic position, therefore, is not certain, and I am compelled to follow the opinion of DE TONI¹⁾ who notes that the present plant seems to stand near *Sargassum heterocystum*.

Localities: Loochoo (WARBURG, HEYDRICH); Nagasaki (TILESIUS, KÜTZING); Misaki, Sagami Prov. (SAITO).

Sargassum biserrula J. AG.

Spec. Alg. I. p. 318.—*Id.*: Spec. Sarg. Austr. p. 94. Tab. XXVII. fig. 4.—Kütz.: Spec. p. 626.—DE TONI: Syll. Alg. III. p. 58.—HEYDRICH: Algflora v. Ost-Asien. p. 287.—OKAM.: Enumer. Alg. of Jap. p. 154.

=*Sargassum squarrosum* GREV. in Ann. and Mag. of Nat. History. III. p. 254 and in Trans. Bot. Soc. Tab. XI.

?=*Sargassum distichum* SOND.: Plant. Preiss. p. 15.

1) Syll. Alg. III., l. c.

HEYDRICH reports the present species from the Bonin Islands as well as from Formosa. For the reason given under the head of *Sargassum beriberifolium* (p. 135), the occurrence of this species at the Bonin Islands seems to me rather doubtful.

Locality. Bonin Islands (WARBURG, HEYDRICH).

Sargassum cinctum J. Ag.?

Plate XVI. Fig. 15-16.

Spec. Alg. I. p. 324.—*Id.*: Spec. Sarg. Austr. p. 95 Tab. XXVII. fig. III.—KÜRTZ.: Spec. Alg. p. 627.—DE TONI: Syll. Alg. III. p. 59.

?=*Sargassum acanthicarpum* GREV. Alg. Orient. in Ann. Mag. of Nat. Hist. II. p. 432 Tab. XIII. and in Trans. Bot. Soc. Edinb. Tab. VIII.

=*Sargassum odontocarpum* SOND.: Alg. Trop. Austral. p. 43. No. 16.

A fragmentary but fertile specimen, cast ashore in Hiuga Prov., exhibited characters of the present species, so far as they went. As the specimen lacks the lower portion, I am not able to refer it to any of the formæ which have been described by GRUNOW¹⁾ under this species.

Locality. Takamatsu, Hiuga Prov. (!).

Sargassum microphyllum Ag.?

Plate XVI. Fig. 17.

Spec. p. 33.—*Id.*: System. p. 306.—J. Ag.: Spec. Alg. I. p. 312.—*Id.*: Spec. Sarg. Austr. p. 99.—DE TONI: Syll. Alg. III. p. 71.—YENDO: Prelim. List of Fuc. Jap. p. 159.

?=*Sargassum Gaudichaudii* MONT.: Voy. Bonite. p. 47 Tab. 141.—KÜRTZ.: Tab. Phyc. XI. Taf. 39.

?=*Carpacanthus Gaudichaudii* KÜRTZ.: Spec. Alg. p. 632.

Remark on the determination. Our plant has much external resemblance to the plant identified with *Sargassum heterocystum*

1) In Proc. Alg. Vettor Pisani, etc. Cf. DE TONI: Syll. Alg. III. p. 60 *et seq.*

MONT. in the present work, but is rather to be referred to the species here mentioned. The leaves of this plant are not oblique, as in *Sargassum heterocystum*, and the vesicles are generally much smaller. The receptacles are triquetro-cylindrical, verrucose, and each separated by a short stalk. Had not J. AGARDH¹ remarked that the receptacles on the upper portion of the fronds of the present species were poorly spinulated, I should not have hesitated to include our plant under the section *Malacocarpicæ*. It is to be noted that the elevated cryptostomata on the softer parts of the stems, leaves, and often on the receptacles, give a spinulose appearance to these parts in a dried specimen.

Locality. Loochoo (K. MIYAKE, H. SC. COLL.).

Sargassum microcystum J. AG.

Spec. Alg. I. p. 323.—*Id.*: Spec. Sarg. Austr. p. 94 Tab. XXVIII. fig. 1.—Kürz.: Spec. Alg. p. 608.—*Id.*: Tab. Phyc. Bd. XI. Taf. 6. —DE TONI: Syll. Alg. III. p. 57.

I have only one sterile specimen, collected at Bindare, Hiuga Prov., and which exactly agrees with descriptions of the present species. Our plant has the leaves somewhat narrowed above, but the characteristic sharp and rich dentation on them is perfectly manifested.

Locality. Hiuga Prov. (!).

Tribe 4. FRUTICULIFERÆ J. AG.

The following four species of this tribe have hitherto been assigned to the Japan coast. Their specific limits are by no means very clear. Besides, there exist several species of *Acantho-*

1) Spec. Sarg. Austr. p. 99.

carpicæ, which have a close resemblance to them in the vegetative organs. Hence it is very often beyond our power to determine a sterile specimen of these species without more or less uncertainty. In addition to the specimens reported below, I have a few others which, owing to their incomplete state, can not be referred to any of the species, though they undoubtedly stand in near relation to one or the other of the latter. I therefore omit mentioning those incomplete specimens any further, reserving them for future study.

Sargassum aquifolium Ag.?

Plate XVI. Fig. 18-19.

Spec. p. 12.—*Id.*: System. p. 297.—J. AG. Spec. Alg. I. p. 330.—*Id.*: Spec. Sarg. Austr. p. 102.—KÜTZ.: Spec. Alg. p. 607.—*Id.*: Tab. Phyc. Bd. XI. Taf. 3.—REINB.: Sarg. Ind. Arch. p. 73.—DE TOXI: Syll. Alg. III. p. 75.

=*Fucus aquifolius* TURN.: Hist. Fuc. Vol. I. p. 112, Taf. 50.

=*Sargassum virescens* FIG. et DE NOT.: Alg. Mar. Rosso. p. 21.—ZANARD.: Pl. Mar. Rubr. p. 239.

Remark on the species. Our specimen is the upper portion of a fertile plant. The basal leaves and other characters of the lower portion are not known. So far as the specimen reveals, the axial stem is smooth and filiform, sending out lateral branches in all directions. The leaves on the branches are thin but rigid, obovate or oblong, often more or less oblique at the base, and are frequently duplicato-serrated on the margin. The ribs are delicate but evident, disappearing above at the middle of the leaf length. Leaves on the ultimate ramulets are spatulate with acute dentations. Vesicles elliptical, unarmed, some of the younger ones glandulated, with compressed stipe nearly as long as the vesicles. Receptacles axillary, subcylindrical, sessile, often furcate, somewhat verrucose, and cymoso-racemose on a short ramulet.

Our specimen seems to accord pretty well with the diagnosis of *Sargassum aquifolium* Ag. The species is defined as having a complanated stem and repando-dentated leaves. These characters, however, can not be tested in our specimen as it lacks the lower portion of the frond. REINBOLD¹⁾ states that the fact that the ribs are nearly entirely wanting or are scarcely visible clearly characterizes the leaves of *Sargassum aquifolium* Ag. Other writers also agree in describing the plant as having semi-ennervous leaves or subevanescent ribs on the leaves, while KÜTZING delineates the ribs very clearly in his Tab. Phyc., l. c.

I cannot but mention with query the present species as occurring in our region, as the specimen on hand is fragmentary. Anyway it is plain from the specimen that a species belonging to the tribe *Fruticulifera* and closely related to this species, should be added to the algal flora of Japan.

Locality. Izu Prov. (K. TANI) (!).

Sargassum obtusifolium J. Ag.

Spec. Alg. I. p. 339.—*Id.*: Spec. Sarg. Austr. p. 103.—MARTENS: Preus. Exped. Tange. p. 116.—DICKIE: Alg. Jap. in Journ. Linn. Soc. Bot. XV. p. 449.—DE TONI: Syll. Alg. III. p. 79.—*Id.*: Phyc. Jap. Nov. p. 45.—OKAM.: Enumer. Alg. Jap. p. 156.

I doubt the occurrence of this species within our boundary.

Localities: Nagasaki (SCHOTTMÜLLER, MARTENS); Akashi channel (MOSELEY, DICKIE).

Sargassum latifolium J. Ag.

Spec. I. Alg. p. 336.—*Id.*: Spec. Sarg. Austr. p. 103.—DE NOT: Alg. Mar. Rosso. p. 18.—DE TONI: Syll. Alg. III. p. 78.—O'KUNTZE: Revisio von Sarg. p. 217.

1) Sarg. v. Ind. Arch. p. 74.

=*Fucus latifolius* TURN.: Hist. Fuc. Tab. 94.

=*Sargassum polycarpum* DE NOT.: l. c. p. 17.

=*Sargassum subrepandum* KÜTZ. Tab. Phyc. XI. Taf. 2.—MARTENS:
Preus. Exped. Tange. p. 129.—Cf. DE TONI: Phyc. Jap. Nov.
p. 45 No. 172.

Remark on the species. MARTENS¹⁾ reports *Sargassum subrepandum* FORSK., collected at Nagasaki by SCHOTTMÜLLER. He mentions KÜTZING'S Tab. Phyc., l. c., fig. 1, as an illustration of FORSKAL'S species and not of *Sargassum subrepandum* AG. J. AGARDH²⁾ refers KÜTZING'S illustration to the present species. As I have never seen any specimen regarded as authentic by any of these writers, I can only follow J. AGARDH'S opinion.

MARTENS³⁾ assigns also *Carpacanthus latifolius* KÜTZ. to Nagasaki. But J. AGARDH⁴⁾ discredits the presence of any *Carpacanthus* structure in the receptacles of *Sargassum latifolium* J. AG. If MARTENS had mentioned *Carpacanthus latifolius* KÜTZ. after identifying his specimen with the illustration in Tab. Phyc. Bd. XI, Taf. 47, the specimen might possibly have been a basal portion, or a young sterile frond, of *Sargassum serratifolium* or of one of its allies.

Localities. Nagasaki (SCHOTTMÜLLER, MARTENS); Japan (O'KUNTZE).

Sargassum assimile HARV.

Plate XVII. Fig. 2-3.

Charact. of New Alg. p. 328.—DE TONI: Syll. Alg. III. p. 39.—*Id.*:
Phyc. Nov. Jap. p. 46.—OKAM.: Enumer. Alg. of Jap. p. 152.—
YENDO: Prelim. List of Jap. Fuc. p. 159.

Description of the species. A specimen, collected at Naga-

1) Preus. Exped. Tange. p. 116.

2) Spec. Sarg. Austr. p. 103.

3) l. c., p. 130.

4) Spec. Sarg. Austr. l. c.

saki in May 1879 and kept in the herbarium of the Science College of Tokyo, accords pretty well with the original diagnosis and the photograph of the authentic specimen of the above mentioned species. The species was rather briefly defined and as no comment on it nor a figure of it has since been given, the following observations on our specimens may not be superfluous.

The specimen in the herbarium lacks the root, but seems to have been cut off quite near the base. The total length of the specimen is about 30 cm. The stems of the principal branches are cylindrical and smooth, gradually tereto-compressed above and subpinnately or vaguely ramose. The leaves on the principal branches, i. e., the fulcrant leaves, are oblongo-spathulate, generally oblique at the base and blunt at the apex; the ribs are hardly elevated above the surface of the laminae and appear as obscure dark streaks running longitudinally in the median line. In most cases they reach quite to the apex of the leaf, but sometimes become evanescent above. The leaves on the lower portion of the frond are frosted with a few rows of cryptostomata, but the upper narrow ones have only a single row of them on each side of the rib; margins, sparingly dentated, with each tooth subapiculated; substance of leaves, thin and membranaceous, turning yellowish brown on drying.

The vesicles are spherical, rounded at the apex and mostly margined. They are found solitary at the base of each lateral branch. Those found on the upper portion of the fronds are evidently glandulated; but in the second specimen, collected in Kii Prov. by the writer, they were entirely unspotted. The stalks are from a half to a whole length longer than the diameter of the vesicle, dilatated upward so as to become confluent with the marginal wings, if any, of the vesicle.

The reproductive organ is not developed in our specimens.

var. stipulata YENDO.

Plate XVII. Fig. 2-3.

Prelim. List of Jap. Fuc. p. 160.

Diagnosis. Petiolis foliorum complanatis, ancipitibus, alatis, marginibus acute dentatis.

Description of the variety. *Var. stipulata* has the petioles complanated with coarsely dentated wings along the ancipitous edges. In other respects as in the type.

Remark on the affinity. Our plants have a close affinity with that illustrated by KÜTZING in his Tab. Phyc. XI. Taf. 2, fig. 2, under the name of *Sargassum herbaceum*. J. AGARDH¹⁾ doubtfully referred KÜTZING's figure to *Sargassum aquifolium* AG. But this referring of KÜTZING's plant to AGARDH's could have resulted only from uncertainty as to the specific conception of the latter. REINBOLD²⁾ has already pointed out this matter in full.

The present species belongs without doubt to the "latifolium" type; but none of the species under this type are by any means well defined, as may be seen from REINBOLD's remarks. The present species has also a certain resemblance to a form of *Sargassum ilicifolium* J. AG. The latter is, indeed, very hard to separate from the species of the "latifolium" type when sterile. It is, therefore, very probable that HARVEY's species may be reduced to some of the known species of the type mentioned, and still more probable that *var. stipulata* should not be placed under the present species but under some other. These are highly interesting problems which ought to be solved in the future. It

1) Spec. Sarg. Austr. p. 102.

2) Sarg. v. Ind. Arch. p. 74.

may be safely inferred that after careful researches on a large set of fertile specimens of these species we shall probably be able to strike off several from the list of those we at present include under the type.

Localities: Nagasaki (H. SC. COLL.); Kushimoto, Kii. Prov. (!)
var. stipulata: Tosa Prov. (!)

Tribe 5. CYMOSÆ. J. AG.

Sargassum vulgare AG.

Plate XVII. Fig. 4-5.

Spec. p. 3.—*Id.*: System. p. 293 *partim*.—J. AG.: Spec. Alg. I. p. 342.
 —*Id.*: Spec. Sarg. Austr. p. 108.—DE TONI: Syll. Alg. III. p. 85.
 = *Fucus natans* TURN.: Hist. Fuc. I. Tab. 46 (*excl. form. plur.*).
 = *Sargassum leptocarpum* KÜTZ.: Phyc. Gen. p. 362.—*Id.*: Spec. Alg.
 p. 608?

Remark on the species. So far as hitherto reported, *Sargassum vulgare* and its varieties seem to have been confined to the Atlantic Ocean and the Mediterranean Sea, and none of the members belonging to the tribe *Cymosæ* were ever thought to exist in our region. During the course of the present study, however, I have met with two specimens which seem to come under the limits of the above mentioned species.

I am not very familiar with *Sargassum vulgare* and its varieties, having had access to only a few specimens which bear that name. Yet I can not refrain from thinking that the species, taken in the sense of J. AGARDH, covers many widely divergent forms, so that some of the plants referred to by J. AGARDH as synonyms of the varieties can hardly be considered to belong to the same species. Here, however, I can not but dispose our plants according to the classification of the well known algologist.

var. linearifolium J. AG. Plate XVII. Fig. 5.

- Spec. Sarg. Austr. p. 108.—DE TONI: Syll. Alg. III. p. 86.
 =*Sargassum vulgare* GREV.: Alg. Brit. Tab. 1.
 =*Sargassum flavifolium* KÜTZ.: Spec. Alg. p. 615.—*Id.*: Tab. Phyc. XI. Tab. 26.
 =*Sargassum megalophyllum* MONT.: Fl. d'Algerie. s. 1. f. 1.—KÜTZ. Spec. Alg. p. 615.—*Id.*: Tab. Phyc. XI. Taf. 23.

Remark on the variety. A fragmentary but fertile specimen, which accords very well with the descriptions and figures of *Sargassum megalophyllum* MONT., is kept in the herbarium of the Sapporo Agricultural College. The specimen was collected in the province of Tosa by MR. T. MAKINO. J. AGARDH placed MONTAGNE'S species, l. c., together with two others under the present variety as above quoted. The accompanying figure (Pl. XVII, Fig. 5) shows a portion of the specimen in our hands, which is open to the criticism of those who are familiar with the present variety.

var. foliosissimum J. AG. Plate XVII. Fig. 4.

- Spec. Sarg. Austr. p. 108.—DE TONI: Syll. Alg. III. p. 86.
 =*Fucus foliosissimus* LAMX.: Essai. Alg. Tab. VII. fig. 1.
 =*Sargassum pteropus* KÜTZ.: Spec. Alg. p. 608.—*Id.*: Tab. Phyc. XI. Taf. 5, fig. 1.
 =*Sargassum Bahiense* KÜTZ.: Alg. Spec. p. 608.—*Id.*: Tab. Phyc. XI. Taf. 5, fig. 2.
 =*Sargassum trachyphyllum* KÜTZ.: Spec. Alg. p. 609.—*Id.*: Tab. Phyc. XI. Taf. 8, fig. 1.
 =*Sargassum polyphyllum* KÜTZ.: Spec. Alg. p. 609.—*Id.*: Tab. Phyc. XI. Taf. 8, fig. 2.
 =*Sargassum brevipes* KÜTZ.: Tab. Phyc. XI. Taf. 9 fig. 1.

Remark on the variety. A fragmentary but fertile specimen, kept in the herbarium of the Science College of Tokyo, has many points referable to *Sargassum Bahiense* KÜTZ., l. c. The

receptacles are well developed in the specimen and prove it to be a member of the tribe *Cymosæ*. J. AGARDH brought down KÜTZING'S species to the present variety. But I can not be easily convinced by the opinion that such a plant as that in our hands, with such characteristic receptacles, should be united with *Sargassum vulgare* Ag., however considerable the variations which the latter may undergo. If our plant be exactly identical with KÜTZING'S, the species *Sargassum Bahiense* KÜTZ., I believe, had better be restored.

Localities: *Var. linearifolium*; Tosa Prov. (H. S. A.).

Var. foliosissimum; Loochoo (K. MIYAKE, H. SC. COLL.)

Tribe 6. *RACEMOSÆ*. J. AG.

Sargassum Ringgoldianum HARV.

Plate XVIII.

Charact. of New Alg. p. 327.—J. AG.: Spec. Sarg. Austr. p. 57.—*Id.*: Anal. Alg. Cont. III. p. 51.—DE TONI: Syll. Alg. III. p. 22.—*Id.*: Phyc. Jap. Nov. p. 44.—OKAM.: Enumer. Alg. of Jap. p. 146.—YENDO: Prelim. List of Jap. Fuc. p. 156.

=*Sargassum coreanum* J. AG.: Spec. Sarg. Austr. p. 58.—*Id.*: Anal. Alg. Cont. III. p. 51.—DE TONI: Syll. Alg. III. p. 22.—OKAM.: Enumer. Alg. of Jap. p. 145.

Description of the species. The present species has several unique characters and is readily distinguished from all the other species. While it is yet very young, measuring some one or two feet in height, with the basal leaves still unfallen, the stem is compressedly triangular, ancipitous, usually not twisted, and sparingly serrated on the margins. The leaves are linear-spathulate, 4-6 cm. long 1.5-2 cm. wide, rounded at the apex and attenuated below, ending finally in a short ancipitous petiole. They grow alternately from the flat surface of the stems and are strongly

retrofractive, recurving and gently ascending. The strong retrofraction of the leaves gives a versatile appearance to the upper node (fig. 1.). The interfolial distances range from 2 to 7 cm. In substance the leaves are thick and coreaceous, with an elevated rib which dies away near the apex.

As the plant grows further, the lower portions of the ancipitous stem gradually become cylindrical, measuring 0.5-0.75 cm. in diameter. The basal alternate leaves drop off by degrees and their insertion points now appear as dilated and angulate elevations with apices like a chisel edge. The result is a stout thick stem bent more or less zigzag in a plane (fig. 3). The leaves and stems in the upper portions retain characters similar to those of the younger lower portions described above, and the leaves therein often attain a length of 37.5 cm. with a nearly equal breadth.

In a well developed plant the root is disc-shaped, elevated on the upper surface, usually conical but frequently hemispherical. The diameter at the base measures 2-3 cm.

Branches and branchlets are sent out from the upper surface of the flat petioles. The branches starting from the basal leaves become by further development indistinguishable from the primary stem, acting as the principal members of the frond. They ramify mostly in a plane, apparently in a dichotomous or subdichotomous way. Hence, a full-grown plant bears a considerable number of fastigate, stout branches, each richly provided with gigantic leaves. In total length a plant often measures 7 feet or more.

The vesicles are oblong ellipsoid, slightly compressed, with a comparatively short ancipitous stalk. Those on the sterile lower portions are more roundish and larger, coronated with a short

wing-like leaflet. They are often so large as to measure 3 cm. in length, 1.7 cm. in width, and 1.5 cm. in thickness. The vesicles on the upper branches as well as on the receptaculiferous ramulets are generally elongated and much compressed. The wings traverse the margin, continuous with the long linear leaflet at the upper end of the vesicle, and frequently with the flattened stalk at the lower end (Fig. 4,9).

The vesicles on the younger portions of a frond are mostly found solitary upon the petiole. But in a fully grown though not fertile individual, we frequently find a cluster of two or more vesicles with the "anlage" of a receptacular ramulet on each stalk.

Receptacles differ greatly in external shape and size according to the sexes. The male receptacles are linear-spathulate, rarely obliquely cuneate, foliaceous, minutely verruculose, often measuring 5 cm. long, 7 mm. wide, and 1 mm. thick; both ends are for the most part rounded, with a stalk 2-5 mm. in length at the base. They are paniculately disposed on an upper branchlet (fig. 6-8). The receptacles of female plants are compressed siliquaeform, much smaller in size, and measure 5-11 mm. long and 2-3 mm. wide. They are disposed in the same manner as male receptacles, but are more regularly paniculate; and usually a larger number are found on a ramulet (fig. 5).

Remark on the synonymy. HARVEY'S original diagnosis sharply defines the present species. He says, however, that the branches are pinnate and the leaves decomponently pinnate. This description is hardly recommendable for such a plant as this, with strongly retrofractive leaves and branches, and is not applicable to well grown forms with fastigate branches.

J. AGARDH described a new species "in Spec. Sarg. Austr. p. 58, under the name of *Sargassum coreanum*. He already

recognized the close relation between his species and *Sargassum Ringgoldianum* HARV., but did not observe the difference in full. Afterward, in Anal. Alg. cont. III., p. 51, he described a plant in detail which he identified with HARVEY'S species. He seemed to have had great doubts on the validity of his species when he wrote the latter paper. The distinguishing point between his and HARVEY'S species lay essentially in the characters of the receptacles. DE TONI¹⁾ also notes the strong resemblance of the two species when he says "Huic speciei (*S. Ringgoldianum* Harv.) paraffine videtur *Sargassum coreanum* J. AG." It is not hard to see from J. AGARDH'S later publication²⁾ that he was very uncertain as to the propriety of describing them separately.

I have seen authentic specimens of neither J. AGARDH'S nor HARVEY'S species. I am, however, strongly of the belief that I am not in error in referring our plant to the above named species, which has no confusable form on our coast. The receptacles differ in external form according to the sex as described above. J. AGARDH'S description of *Sargassum coreanum* I have found satisfactorily applicable to the female plants; while the description of *Sargassum Ringgoldianum* in Anal. Alg., l. c., applies very well to the male individuals. I therefore do not hesitate to say that J. AGARDH described the sexually differing forms of *Sargassum Ringgoldianum* HARV. as two distinct species.

The differences in the vegetative characters of male and female individuals are quite negligible. A difference, if any, will be found in the crown leaflets of the vesicles. In the male, abruptly truncated leaflets predominate, while in the other,

1) Phyc. Jap. Nov. p. 44.

2) Anal. Alg. Cont. III. p. 51-52.

sex, linear-elongated, acuminate ones do so. But this of course is not always strictly carried out.

Systematic position of the species. The present species has been placed under the subgenus *Bactrophycus* by J. AGARDH; but there seems to be no affinity between it and the remaining members of that subgenus except in the fact that the leaves are strongly retrofractive. The *Bactrophycus* is characterized by having each receptacle accompanied by a bractlet at its base; the terminal one or two only being free from any appendage. In this species, as described above, the receptacles are bractless from the beginning and are disposed in a raceme on an ultimate ramulet. This character suggests that the present species belongs to the tribe *Racemosa* and should be placed near *Sargassum Henslowianum* J. AG.

Localities: Nagato Prov. (J. NIKAI, H. SC. COLL.); Tsushima Prov. (H. S. A.); Korea (CROUAN, J. AGARDH); Izumo Prov. (!); Tango Prov. (!); Sado Prov. (!); Shakubetsu (H. S. A.); Mouth of Amur River (FENGER, J. AGARDH); Kushiro Prov. (H. S. A.); Rikuzen Prov. (!); Hitachi Prov. (!); Bōshū Prov. (!); Izu Prov. (!); Shimoda (WRIGHT, HARVEY); Sagami Prov. (!); Shima Prov. (!); (H. S. A.); Awa Prov. (!); Iyo Prov. (!); Bungo Prov. (!); "Warmer parts of the Pacific coast of Japan" (OKAMURA).

Sargassum siliqosum J. AG.

Plate XVII. Fig. 1.

Spec. Alg. I. p. 316.—*Id.*: Spec. Sarg. Austr. p. 121, Tab. X.—Kütz.: Spec. Alg. p. 619.—DE TONI: Syll. Alg. III. p. 107.—*Id.*: Phyc. Jap. Nov. p. 45.—MARTENS: Preus. Exped. Tange p. 116.

=*Sargassum ornatum* GREV.: Alg. Orient. in Ann. and Mag. of Nat. Hist. Vol. II. p. 205 Tab. IV. and in Trans. Bot. Soc. Edin. p. 87 Pl. VI.

Our specimen is sterile, but very well accords with the descriptions of this species. The leaves in the upper portions of the frond exhibit some monstrosity. The terminal parts of the leaves are swollen—the remaining parts undergoing no modification—to an obovate vesicle with the narrow end tapering downwards to become confluent with the rib. The accompanying figure (Pl. XVII, fig. 1) will explain much better than a description.

Localities. Nagasaki (SCHOTTMÜLLER, MARTENS); Kushimoto, Kii Prov. (!)

Sargassum sagamianum YENDO.

Plate XVII. Fig. 6–10.

Prelim. List of Fuc. Jap. p. 157.

Diagnosis. Radice primaria scutellata, adultiore nodoso-prostrata, pluribus frondibus ex facie multicipite exeuntibus; caule communi cylindraceo verrucoso brevissimo mox ramoso; ramis exacte triquetris spiraliter alterne ramulosis, sæpe tortilis, ramulis ad orto retrofractis; foliis inferioribus lanceolatis vel spathulatis, immerse costatis, dentatis vel integris, mediis superioribusque anguste lanceolatis vel clavatis, ancipitibus, integerrimis, sæpe parce dentatis, crassis coreaceisque, nonnunquam secundis; vesiculis ellipsoideis vel pyriformibus, mucronatis vel aristatis, petiolis complanatis, in inferiore parte ramulorum solitariis; receptaculis.....

Description of the species. The present species has remarkably unique characters and is readily distinguished from others. Although a fertile specimen has not yet been found, I do not hesitate to give a new specific position to the plant. The root is disc-shaped while yet very young, but soon spreads horizontally, sending out a number of erect stems multicipitally from the upper surface. The stems of the decayed fronds are cleared from their bases, leaving knob-like protuberances on the prostrate

root. The result is an irregularly knotty mass as shown in Pl. XVII, fig. 6.

The stems of the shoots or the branches are triangular with sharp edges, with strongly retrofractive leaves spirally disposed. The leaves on the basal portions are lanceolate or spathulate, ancipitous or immersedly costated, and entire or sparingly dentated on the margins. Those on the upper portions are linear clavate, 2–4 mm. wide and 2–5 cm. long; in the typical plants the margins are entire but often coarsely denticulated. In substance the leaves on all parts are thick and coreaceous. Cryptostomata are entirely wanting.

Not infrequently the stems are loosely twisted and arched in the upper portions and send out the leaves in a secund manner towards the convex side (fig. 10).

Vesicles are elliptical, measuring 4–5 mm. in diameter and 5–7 mm. in length. When fully grown they are mucronated or aristated at the top, and have a short ancipitous stipe at the base. They are found solitary near the base of a lateral branch or branchlet.

Receptacles unknown.

Remark on the systematic position. As our plant has not been found in fructification, the exact systematic position is uncertain. The present disposition is therefore a provisional one. It may be considered to have some resemblance to *Sargassum virgatum* AG. or *Sargassum concinnum* GREV., but the angulate stems and the non-glandulated leaves do not accord with the description of either species.

Localities. Sagami Prov. (!); Shima Prov. (!); Hiuga Prov. (!);

Sargassum nipponicum YENDO.

Plate XVII. Fig. 11-16.

Prelim. List of Fuc. of Jap. 158.

Diagnosis. Radice fibrillosa, rhizinis¹⁾ longissimis, filiformibus; caule simplici, filiformi, undique ramis egredientibus; foliis lineari-clavatis, deorsum attenuatis, apice acutis, immerse subcostatis, superioribus ramorumque angustis sæpe subulatis vel hemiphyloideis, integerrimis rarius bidentatis; vesiculis fusiformibus in inferiore parte ramulorum paucioribus; receptaculis cylindraceis breve petiolatis in ramulo abbreviato racemosis.

Description of the species. The root is fibrous, consisting of radially extending, filiform rhizines which are sent out from the very base of the frond without any obvious rule as to arrangement. As far as our specimen shows, the primary stem of a frond seems to be simple, that is, it does not ramify at the basal portion to give rise to the members which correspond to the principal branches of other species. But very often numerous shoots are found with their roots entangled together into a large mass.

Stem is 1-4 feet long, filiform, smooth, often slightly angulate, with short lateral branches spirally arranged on it. The basal as well as the fulcrant leaves are linear-clavate, gently attenuated below and acute at the apex. Some of the upper leaves are often subulate above and slightly hemiphyllous. Most of the leaves have a very insignificant immersed midrib. Leaf margin is generally entire, often undulating and frequently with one or two dentations.

The lateral branches are short, measuring a few inches in length, simple or slightly decomposed, with a delicate, filiform stem. The leaves on them are narrowly lanceolate or filiform,

¹⁾ In the same sense as KJELLMAN used in "The Alge of the Arctic Sea." p. 238.

spirally disposed. Those on the ultimate branchlets are sometimes replaced by vesicles, but very frequently no vesicle is to be found in a frond.

Vesicles, if present, are narrowly spindle-shaped, 2–4 times longer than the diameter, attenuated towards both ends into a filiform stalk and an awn.

Receptacles are cylindrical, each with a short stipe at the base. They are disposed in a short raceme on an ultimate ramulet. Those on the terminal portion of a ramulet are generally simply geminate or solitary upon the petiole of a small subulate, bract-like leaflet.

Remark on the affinity. This species without doubt belongs to the subgenus *Racemosæ* J. AG. and should be placed near *Sargassum Henslowianum* J. AG. It resembles a form of *Sargassum hemiphyllum* in general appearance as well as in having the fibrous root. When fertile, however, each may be readily distinguished from the other; and when sterile, the present species is easily recognized by the coreaceous texture of the leaves.

Localities. Cape Shiomisaki, Kii Prov. (!); Hiuga Prov. (!)

ISHIGE¹⁾ Gen. nov.

Ishige Okamurai sp. nov.

Plate II. Fig. 1–8.

=*Pelvetia Babingtonii* OKAM. (*nec* HARV.). Alg. Jap. Exsic. No. 37.

—*Id.*: Enumer. Alg. Jap. p. 137.

=*Pelvetia Babingtonii* HARV.? YENDO: Prelim. List of Jap. Fuc. p. 151.

Diagnosis. Planta duabus formis; una forma radice scutellata rachide brevi tereti, mox expansa, fronde complanata, regulariter decomposite dichotoma, flabellata, laciniis late linearibus, sursum latioribus, sinibus

1) From the Japanese name of the plant.

rotundis, apicalibus bifidis, cryptostomatibus numerosis; alter forma radice scutellata rachide brevi cylindracea decomposito-dichotome ramosa, laciniis inferioribus mediisque cylindraceis vel tercto-angulatis, sursum tenuioribus, apicalibus bifidis, cryptostomatibus nullis. Frons ex cellulorum duobus stratis constructa, inarticulata; corticali cellulis minoribus anticlinale dispositis, chromatibus, et interiori cellulis elongatis articulatis cylindraceis in reticulum densissimum undique anastomosantibus, hyalinis. Receptaculis.....

Description of the species. This plant is one of the most common algae on the coast of the warmer regions of Japan. It is always found above low-water mark and is exposed to the air during the ebb-tide hours, sometimes lying in intensely hot sunshine and sometimes thoroughly washed by fresh rain water.

The plant has two forms of an entirely different appearance. One has all its segments, except in the aberrant cases remarked upon below, cylindrical or terete; while in the other they are flat and leaf-like. I shall call the former the "filiform" type and the latter the "foliose" type, for convenience sake.

The foliose type has scutellate root a few mm. in diameter, with one or more shoots arising from the same root. The stem is cylindrical, hardly attaining a few mm. in diameter at the base and soon expanding into a flabellate frond. The frond ramifies in a regularly dichotomous manner, unless an arm is checked in its development. The axils are wide with the sili round; hence the appearance of an entire frond is fan-shaped. The segments are linear or linear-cuneate ranging from 5 mm. to 40 mm. in length and from 3 mm. to 20 mm. in width. Average thickness, ca. 0.6 mm. The apices of the ultimate segments are narrowed and bifid, and have a slit-like depression at each apical point, the longer axis of the depression being parallel to the surface of the segment. Occasionally we find a specimen of this type with an inflated segment containing gaseous matter in it. But the inflation is

never a constant character and is accidental. It is most frequently found in those plants which live on rocks at low-tide marking open seas.

Numerous sterile cryptostomata are found throughout the whole of the frond except in the basal cylindrical portions. They are globular in shape, situated just below the cortical layer, with a communicating opening through the latter. Hairs are given off from the bottom of the cryptostoma and extrude through the opening above the surface of the frond. In dried specimens the hairs appear as inconspicuous white specks on the dark brownish frond.

The filiform type has a scutellate root a few mm. in diameter, with one or more shoots starting from the same root. The stem is cylindrical measuring 1.-1.5 mm. in diameter and ramifies subregularly dichotomously with acute axils. The segments are cylindrical or terete, more or less compressed, and broadened at the point below each axil. They are similar in size and shape everywhere in a frond, except the ultimate ones which are much thinner and shorter. As the apical segments are pointed in this type, the slit-like depression found in those of the foliose type, now appears as an inconspicuous excavation. The substance of the frond is cartilaginous and the colour is dark brown while in the water, but turns black when exposed to the air. The total height of a frond often reaches 15 cm. Cryptostomata are wanting in this form.

It is quite common to find a branch of the foliose type in a part of a filiform frond. The foliose branches may be near the basal portion or at the middle of a filiform frond, and in most cases several of them occur close to one another in the same individual (Pl. II, fig. 3). This is due to the extraordi-

nary growth of abnormal branches which start out from the surface of an internode of the filiform segment. We could never find any segment in a normal filiform frond dilatated or complanated to such a degree as is found in a foliose frond; nor could we find any of the segments of the foliose branch narrowed to a cylindrical or terete one, except the basal portion which is inserted in the filiform segment. The point of insertion is more or less intumescend, which is probably never met with in the case of ordinary ramification (Pl. II, fig. 2-4). After carefully studying the nature of this foliose branch I have arrived at the conclusion that the abnormal branch was due to a parasitic organism (*Streptothrix*-like) invested in the frond.

The segments in the middle or the upper portion are often verruculose instead of smooth. By cutting these portions crosswise we find small ovate pits, in shape apparently the conceptacles of a Fucaceous alga. But so far as my observation extends nothing that could be suspected to be the reproductive cells of the present plant could be found in them. Nor could there be found any single hair growing from them. A large number of the pits, if not all, belong to the parasite.

Structure of the frond. The frond is constructed essentially of two parts, the medulla and the cortex. The medullary portion is composed of hypheal cells much entangled with one another so as to form a compact and elastic tissue. The cortical part is built up of rows of cubical cells disposed anticlinally. They are connected with the hypheal cells by the innermost ones which are much larger and more spherical than the peripheral ones. The cubical ones are rich in brownish chromatophores which give the frond a dark olive colour when fresh.

In the middle portions of the frond we find two sorts of the

hypheal cells. The one extends almost always longitudinally along the axial part of the frond and has a much thinner wall than the other. It is rich in contents and has transverse septa at intervals of certain distances. The other is much narrower than the axial ones and extends in all directions, occasionally running from one surface to the other, binding together the cortical layers. It is destitute of a septum throughout its entire length (Pl. II, fig. 6).

By cutting a longitudinal (meridional) section of a terminal segment of a well-grown plant through the depression at an apical point, we find in the middle a notch, around which numerous cells are aggregated without any obvious regularity. The cortical layer at the external margin is much thinner, being composed of 3-5-celled rows. The cells are smaller than those of the cortical layer of other portions of the frond and are radially elongated. The cells of the medullary portion are exclusively septated and loosely arranged. They are all alike, but those situated in the axial part are slightly larger in diameter than the neighbouring ones. The former mostly run longitudinally while the latter are directed obliquely outward and ramify simultaneously to join with the cortical cells (Pl. II, fig. 5).

The lower portions of the foliose type are terete or cylindrical, and have a structure similar to the complanated part in essential characters. The cortical parts in these portions, however, are nearly twice as thick and the cells in a row are 18-20, or nearly twice as many as in the complanated part. The hypheal cells are more compactly arranged, compressing one another with much thicker cell-walls.

The structure of the filiform frond is exactly similar to

that of the cylindrical portion of the foliose ones just alluded to. In some cases the upper segments are much complanated, more or less resembling the segments of a narrow form of the foliose type. The structure of such portions has no marked difference from that of the foliose type, except that the cryptostomata are entirely absent.

Relation between the two forms. Specimens of the filiform type have been distributed by MR. OKAMURA under the name of *Pelvetia Babingtonii* HARV., as No. 37 of "Algæ Japonicæ Exsiccatae." The foliose type was suspected by many people to belong to a different species from the filiform one and some went so far as to consider them to belong to different genera.

Those who consider the two forms to belong to different species are inclined to regard the foliose branches upon the filiform frond as a parasitic or symbiotic combination. The fact that one of the forms never partially reveals the character of the other stands strongly in favor of this view. A dimorphic plant may very often show an intermediate or mixed form. But in the present plant none of the ordinarily ramified segments of one type assumes the form of the other in any satisfactory degree. The upper segments of a filiform frond may be more or less broadened or complanated but never to such an extent as to link the two types; in like manner, the segments of the foliose type often considerably decrease its breadth but never entirely lose the characters of that type. When a branch with foliose segments is found in a filiform frond, it always starts from an internodal point with a peculiar mode of insertion, as has been already mentioned (Pl. II, fig. 3, 4).

I am, however, strongly of the belief that the two types belong to one and the same species. We have not been

able to find a case in which a frond of the foliose type was growing on any alga other than either of the two types under consideration. Repeated examinations have been made on sections through the adjoining points of the two forms. In every case it was revealed nothing except that the hypheal cells of the segment of the filiform frond passed into the stem of the foliose one without any indication that the two different forms belonged to separate plants. And in the case in which the abnormal foliose branches were found on a frond of the foliose type, the section through the point of insertion showed only a slight disturbance in the cortical tissue at that point, and nothing else. The two types will be regarded as the two forms of a dimorphic plant, though positive proof for doing so is lacking. The determination is, therefore, a provisional one to be held until it has been proved that the two types belong to different species.

The facts that the abnormal foliose branches, whether they be on a frond of the foliose type or of the filiform type, are always accompanied by the parasitic organism infesting the principal frond, and that they are found fasciculately at the same point, remind us of the witches' broom of a flowering plant. The malformations of *Ascophyllum* and *Cystoseira* have been reported by BARTON¹⁾ and VALLIANTE.²⁾ But in these cases no disturbance in the ramification of a frond was observed. We are familiar with the fronds of *Fusus evanescens*, which have numerous stunted branches growing at an internodal point or on

1) BARTON: Malformation of *Ascophyllum* and *Desmarestia*, in MURRAY, Phyc. Mém. Pl. II. p. 21.

2) VALLIANTE: Le *Cystoseirae* del Golfo di Napoli. Fauna u. Flora des Gofes von Neapel. 7.

a torn-off end.¹⁾ This is not, in many cases, a result of regeneration on a wounded part, but is a witches' broom caused by certain endophytic alga. In *Fucus evanescens*, however, differently from ours, the broom branches are similar in shape to the principal frond. It is a widely known fact that some flowering plants, such as *Abies*, *Euphorbia*, etc., when attacked by parasitic fungi, undergo a considerable modification in the mode of ramification as well as in the shape of the leaves. So far as the knowledge of the present writer extends, no example parallel to our case has ever been recorded from the algae. More details on this subject, I hope to present in another paper.

Systematic position of the species. On what grounds OKAMURA has identified this plant with *Pelvetia (Fucus) Babingtonii* HARV. is not satisfactorily clear to me; it might have been because this is the only plant on the Pacific coast of middle Japan, whose structure has a certain resemblance to *Pelvetia*. Judging from the remark made by him in Enumer. Alg. of Jap. p. 137, he seems to have laid too much stress on the locality of *Pelvetia Babingtonii* HARV. mentioned by the original author. And he seems to have believed the foliose type to belong to other species. There is very little ground for referring this species to the genus *Pelvetia*, but we have many points separating it from that genus.

The characters of the cryptostomata in foliose type exactly answer to those of the other Fucaceous genera hitherto studied (Pl. II, fig. 8). Cf. the figures of the cryptostoma of *Sargassum filipendula* newly illustrated by SIMONS.²⁾

Although MURRAY³⁾ seems to have differed from OLTMANN'S

1) Cf. SAUNDERS: HARRIMAN'S Alaska expedition. Pl. LXII, fig. 1.

2) A morphol. study of *Sarg. filip.* Pl. X. fig. 22. The Bot. Gazette, vol. 49. 1906.

3) Phyc. Memoir. Part. II. p. 30.

view, in preferring those characters on which the latter rests his sections to that afforded by the growth of the plants, there is no doubt that the occurrence of an apical cell at the growing point characterizes certain groups of *Fucaceae* genera. Unfortunately the material of the present species in my hands was not fitted for the purpose of examination on this point. But there is little doubt left that our plant belongs to the *Fuco-Ascophyllum* group of *OLTMANN'S*, or at least stands nearer to it than to the others.

The uncertainty of the systematic position of the present genus comes from our lack of knowledge of its propagating organ; and there is no positive proof that the foliose and filiform types belong to one and the same species. So far as the vegetative characters of the fronds of the present species shows, the disposition of this genus in the family *Fucaceae* will be the most legitimate one.

I am strongly inclined to believe that the conceptacles, when found in our plant, will be in the filiform type. If this be really the case, what is the use of the foliose frond? If, again, fructification be found on both types, what is the relationship between the two? The solution of these interesting problems must be reserved for future investigations.



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List of Abbreviations.

(H. S. A.)Herbarium of the Sapporo Agricultural College.

(H. H. F.)Herbarium of the Department of Fisheries of the Hokkaido Local Government.

(H. COLL. SC.)...Herbarium of the College of Science, Tōkyō Imperial University.

(!).....This sign indicates that the specimen has been collected by the present writer or is kept in the writer's herbarium.

Errata.

Page	Line	For	Read
12.	11 from below.	<i>S. confusum f. validum</i> ,	<i>S. confusum f. valida</i> .
18.	8 & 11 from above.	<i>Pelvetia Babingtonii f. japonica</i> ,	<i>Pelvetia Wrightii f. japonica</i> .
„	15 from above.	<i>Pelvetia Babingtonii f. Wrightii</i> ,	<i>Pelvetia Wrightii f. Babingtonii</i> .
20.	8 from below.	E.P. WRIGHT,	P.E. WRIGHT.
26.	6 & 14 from below.	<i>Fucus furcatus f. distichus</i> ,	<i>Fucus inflatus f. distichus</i> .
29.	9 from above.	<i>Cystophyllum hypocarpa</i> KÜTZ.,	<i>Cystoseira hypocarpa</i> KÜTZ.
32.	9 from above.	Plate II., Fig. 13-15.,	Plate II., Fig. 13-16.
32, 42, 60, 69, 72, & 73.	In diagnosis.	scntelata,	scntellata.
44.	2 from below.	rhizine,	rhizines.
70.	10 from below.	int,	into.
78.	14 from below.	AGARDH,	J. AGARDH.
91.	7 from above.	<i>Carpacanthus trichophyllum</i> KÜTZ.,	<i>Carpacanthus trichophyllus</i> KÜTZ.
102.	13 from above.	Plate XV., Fig. 1-5,	Plate XV., Fig. 1-4.
112.	9 from above.	<i>f. validum</i> ,	<i>f. valida</i> .
115.	15 from below.	<i>Fucus Thunbergii</i> TURN. &c.,	<i>Fucus Thunbergii</i> MERT. in TURN. &c.

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PLATE I.

Plate I.

(All figures in this and all following plates are in natural size, unless specially mentioned).

Figs. 1-2. *Fucus evaneszens* AG.

1. From a specimen collected at Onnebetsu, in the prov. of Kitami. This form is referrible to *f. angusta* KJELLM.
2. The same, from a specimen collected at Esashi in the prov. of Kitami. This approaches both *f. nana* KJELLM. and *f. bursigera* KJELLM. at once.

Fig. 3. *Fucus inflatus* VAILL. *f. edentatus* ROSENV.

Fig. 4. *Pelvetia Wrightii* var. *typica*. *a.* An ultimate branch with blister-like ampula. *b.* A fertile branch.

Fig. 5. *Pelvetia Wrightii* var. *japonica*. *a.* A typical branch. *b.* Fertile segments.



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PLATE II.

Plate II.

Figs. 1-8. *Ishige Okamurai*.

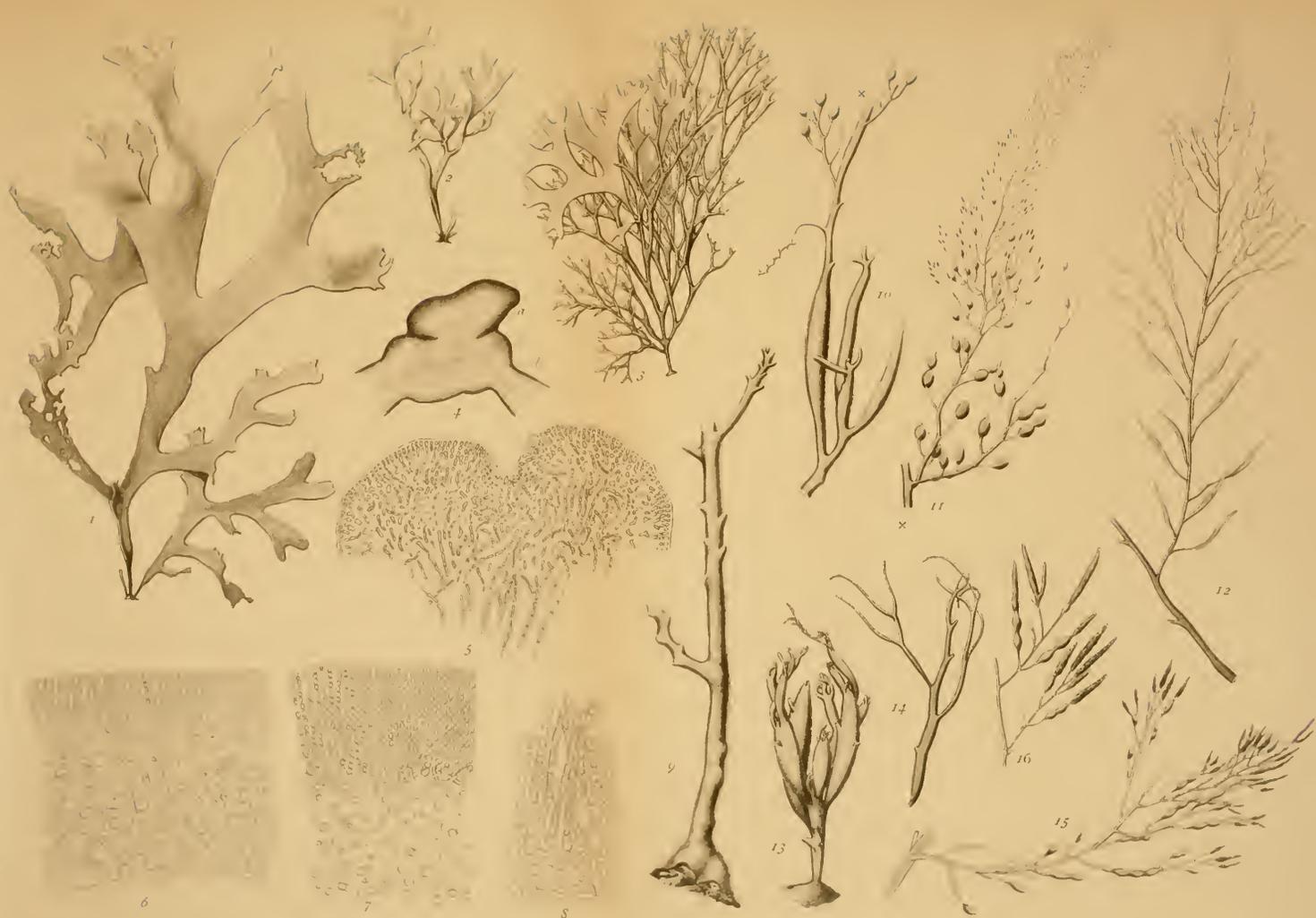
1. Frond of the foliose type; one of the broadest fronds in our collections. The ramification is somewhat irregular in this specimen owing to injuries in many parts of the frond.
2. Frond of the foliose type with abnormal foliose branches on one of its segments.
3. Frond of the filiform type with abnormal foliose branches on one of its segments.
4. Cross-section of a frond of the filiform type through an insertion point of two abnormal foliose branches. *a*, filiform frond; *b*, basal portion of a foliose branch; *c*, the swollen part at the insertion of the foliose branches. ca. $\times 15$.
5. Longitudinal section of an apex of a foliose frond. $\times 165$.
6. A part of longitudinal section of a frond of the foliose type; about the middle portion of a frond. $\times 165$.
7. A part of cross section of a frond of the filiform type; about the middle portion of a frond. $\times 165$.
8. Cross section of a frond of the foliose type to show a cryptostoma. $\times 285$.

Figs. 9-12. *Cystophyllum crassipes* J. Ag.

9. Basal portion of a well grown individual.
10. Apical portion of the axial stem with basal parts of incrassate branches.
11. Lateral branches, one of which is fertile. The end marked with \times is to be connected below to the part with the same mark in the preceding figure.
12. Basal region of a branch with a sterile lateral branch.

Figs. 13-16. *Cystophyllum hakodatense*.

13. A young axial stem with many "fusiform" branches, some of which have been cleared away.
14. A young lateral branch growing from the swollen side of a fusiform branch. The part marked with \times is to be connected to the part with the same mark in the preceding figure.
15. A φ fertile lateral branch.
16. φ fertile ramulets with fully developed receptacles.



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PLATE III.

Plate III.

Figs. 1-6. *Cystophyllum sisymbrioides* J. Ag.

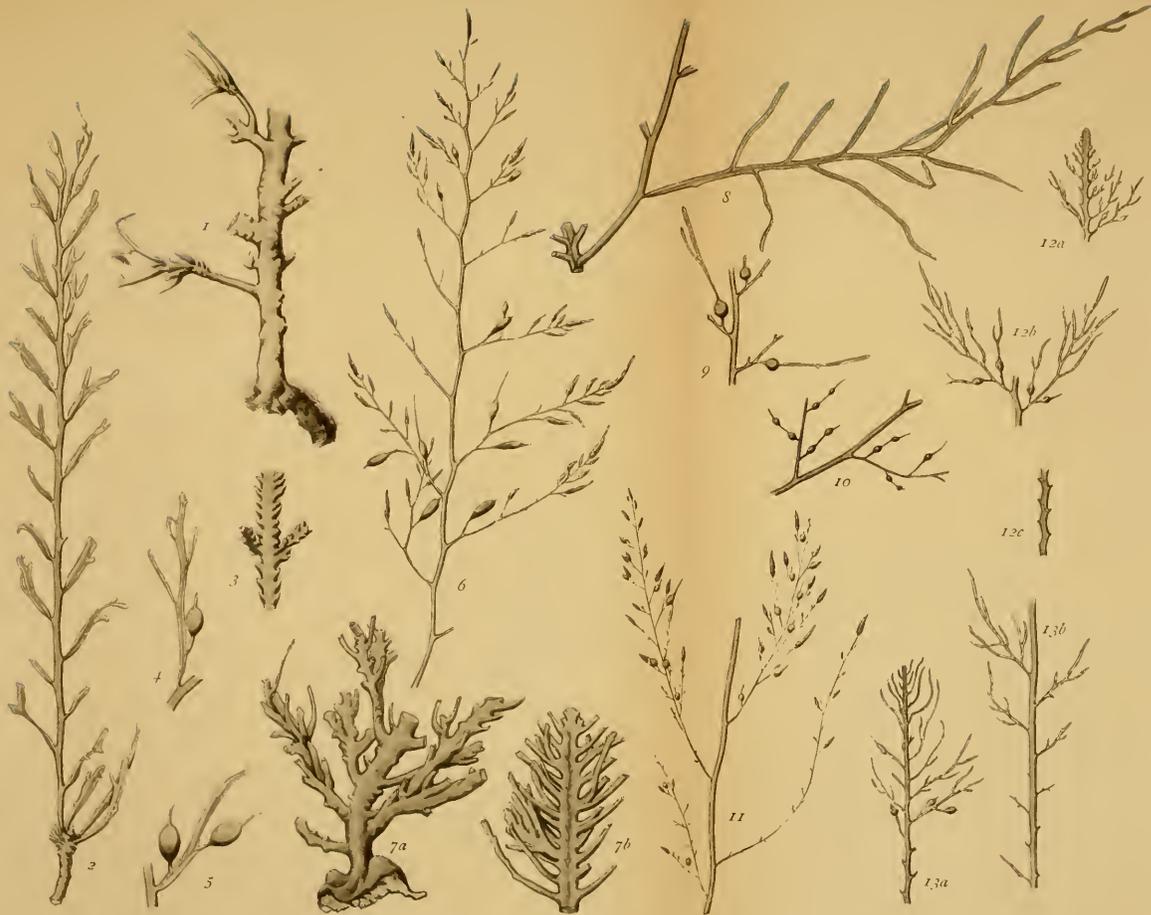
1. Basal part of a well grown plant.
2. A principal branch of a sterile frond, with one lateral branch.
3. A portion of withered principal branch; the approximate lateral branches have been worn away, leaving their pinnately disposed basal parts only.
4. A basal leaf at the basal part of a sterile lateral branch; one of the laciniae transformed into vesicle.
5. Same as above, with two transformed laciniae.
6. Upper portion of a fertile lateral branch.

Figs. 7-11. *Cystophyllum Turneri* (Kütz.)

7. Axial stem measuring about 20cm. in length, with the lateral branches cut off near the insertion points. *a*, basal region; *b*, apical region.
8. A leaf at the base of a lateral branch.
9. Vesicles at the basal portions of ramulets.
10. Two consecutive vesicles in a ramulet.
11. Middle portion of a lateral branch with fertile ramulets.

Figs. 12-13. *Cystophyllum caespitosum*.

12. *a, b, c.* Upper, middle and lower portion respectively of a branch of 39cm. length.
13. *a, b.* Upper and middle portion respectively of a branch of 23 cm. length.



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PLATE IV.

Plate IV.

- Figs. 1-6. *Turbinaria? fusiformis* (HARV.)
1. A branch of sterile frond.
 2. A young frond with leaf-like "rami."
 3. The same. *a*, a leaf.
 4. A part of fertile branch with cymose receptacles at the axils.
 5. The same; a fertile lateral branch growing at the axil formed by a fulcrant "ramus" and the stem.
 6. A sterile lateral branch, the fulcrant "ramus" being leaf-like.
- Fig. 7. *Forma clavigera*. A branch of sterile frond.
- Figs. 8-12. *Coccophora? Imperata*.
8. Frond in ca. $\frac{2}{3}$ nat. size; one branch shown in full.
 9. A lateral ramulet in nat. size.
 10. A leaf in nat. size.
 11. A bifurcated leaf. $\times 2$.
 12. A lateral ramulet with upper portions of the basal leaves left out. $\times 10$.



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PLATE V.

Plate V.

Coccophora Langsdorffii GREV.

The Langsdorf and the Phyllamphora form starting from one and the same stunted stem. From a photograph. Ca. $\frac{1}{3}$ nat. size.



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PLATE VI.

Plate VI.

Figs. 1-7. *Sargassum piluliferum* Ag.

- 1, 2 and 3. Basal, middle and upper portion respectively of a frond; in fig. 2 the upper portions of the lateral branches are left out.
4. A fertile branchlet in a full-grown lateral branch, whose uppermost portions are left out.
5. Ramulets with young receptacles.
6. A leaf at the basal part of a frond.
7. A fertile ramulet with mature ♀ receptacles. ×2.

Figs. 8-11. *Sargassum piluliferum* var. *pinnatifolium* (Ag.)

8. Basal portion of a frond.
9. A receptacular ramulet on a lateral branch.
10. A part of a fertile lateral branch.
11. A receptacular ramulet on the apical part of a frond.



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PLATE VII.

Plate VII.

Figs. 1-3. *Sargassum pinnatifidum* (HARV.)

1. Sterile lateral branches in the lower region of a frond; from a specimen collected at Misaki.

2 and 3. Lateral branches in the upper and the middle portion of a frond respectively; from a specimen collected in Loochoo.

Fig. 4. *Sargassum kashiwajimanum*.

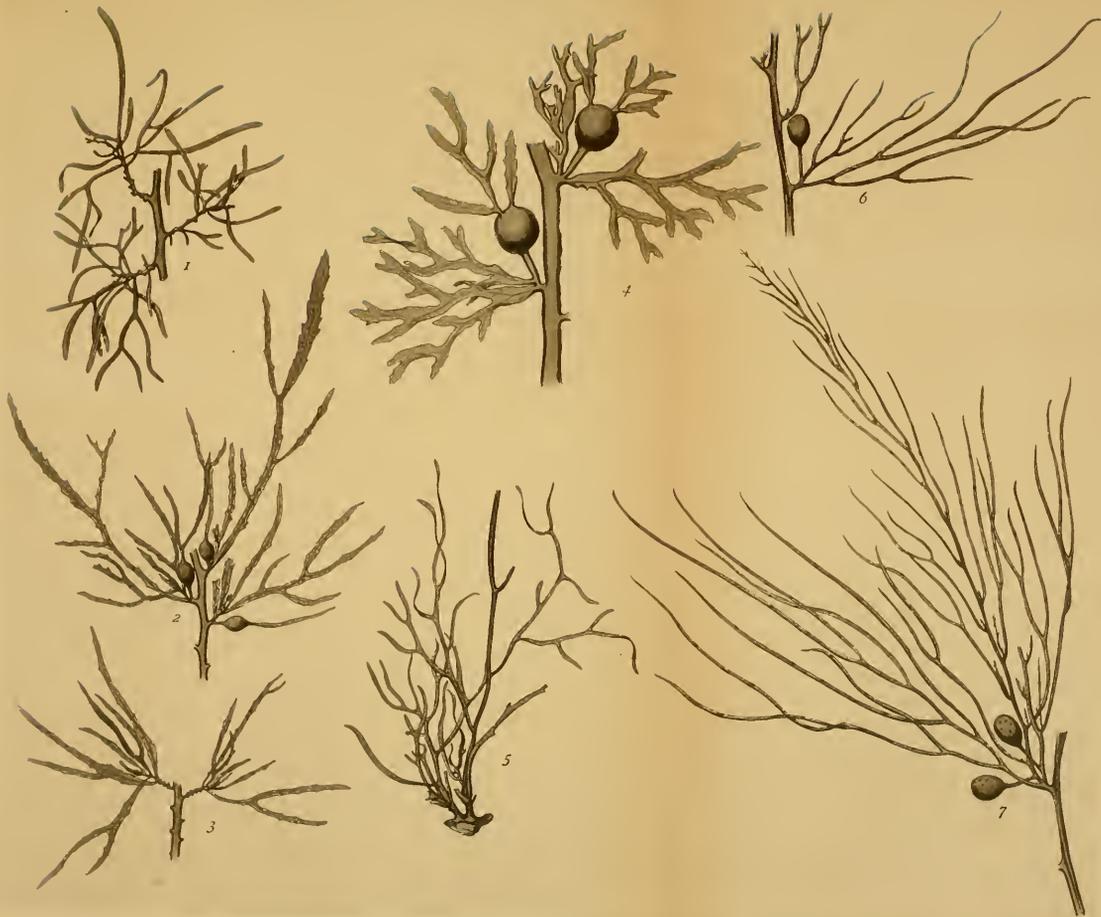
Middle portion of a frond, showing typical fulcrant leaves.

Figs. 5-7. *Sargassum setaceum*.

5. Basal portions of two shoots starting from a common scutellate root.

6. A lateral branchlet in the lower portion of a frond.

7. Lateral branches germinate at an axil; one of them not drawn in its upper portion.



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PLATE VIII.

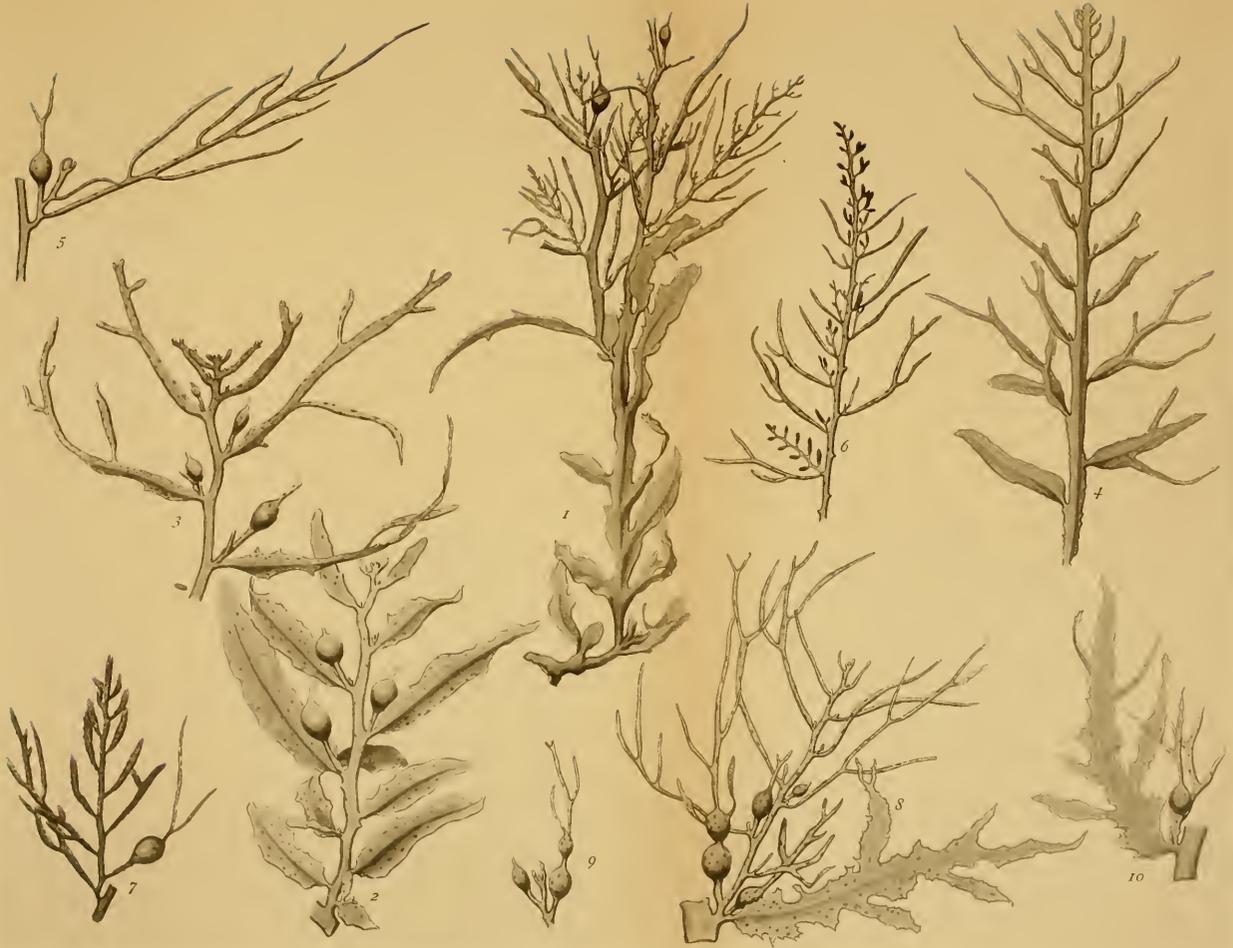
Plate VIII.

Figs. 1-7. *Sargassum patens* Ag.

1. Basal portion of a frond showing the lower region of a principal branch.
2. A lateral branch in the basal region of a frond.
3. Apical portion of a sterile principal branch.
4. A lateral branch in the lower part of a well-developed principal branch.
5. A ramulet on a lateral branch of the frond shown in fig. 4.
6. Apical portion of a lateral branch.
7. A mature receptacular ramulet.

Figs. 8-10. *Sargassum patens* var. *Schizophylla* (Kütz.)

8. A lateral branch in the lower portion of a frond.
9. A young lateral branch.
10. A lateral branch in the middle portion of a frond.



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PLATE IX.

Plate IX.

Figs. 1-4. *Sargassum tosacense*.

1. Basal portion of a frond.
2. Lower portion of a lateral branch. The fulcrant leaf as well as the three leaves on the lateral branch show well the peculiarity of the species.
3. A fertile lateral branch in the upper portion of a frond.
4. A simple fulcrant leaf often met with in the lower part of a well developed frond.



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PLATE X.

Plate X.

Figs. 1-7. *Sargassum Horneri* Ag.

1. A sterile young frond.
2. Basal part of an old plant with a lateral branch.
3. Basal part of a well developed plant showing naked basal stems and a lateral branch, with cross-sections of stems.
4. *a*, Insertion point of an upper lateral branch. *b*, cross sections of the stem. $\times 2$.
5. A ♀ fertile branchlet.
6. A ♂ fertile branchlet.
7. *a*, *b*, *c*, Leaves on the terminal, middle and basal part respectively of a terminal branchlet.

Fig. 8. *Sargassum Horneri f. furcatodentatum* O'KUNTZE.
A typical fulcrant leaf. $\times 2$.



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PLATE XI.

Plate XI.

Figs. 1-7. *Sargassum serratifolium* Ag.

1. Terminal portion of a well developed but sterile frond.
2. Basal portion of the same.
3. Basal portion of a full-grown frond.
4. Middle portion of the same; with a crosssection of the stem.
5. A typical lateral branch just before maturity; with cross-sections of stems.
6. Basal region of a fertile lateral branch to show the receptacular ramulets. The lower ramulet has all its bractlets dropped off. With a cross-section of the stem.
7. A typical leaf.



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PLATE XII.

Plate XII.

Figs. 1-7. *Sargassum tortile* AG.

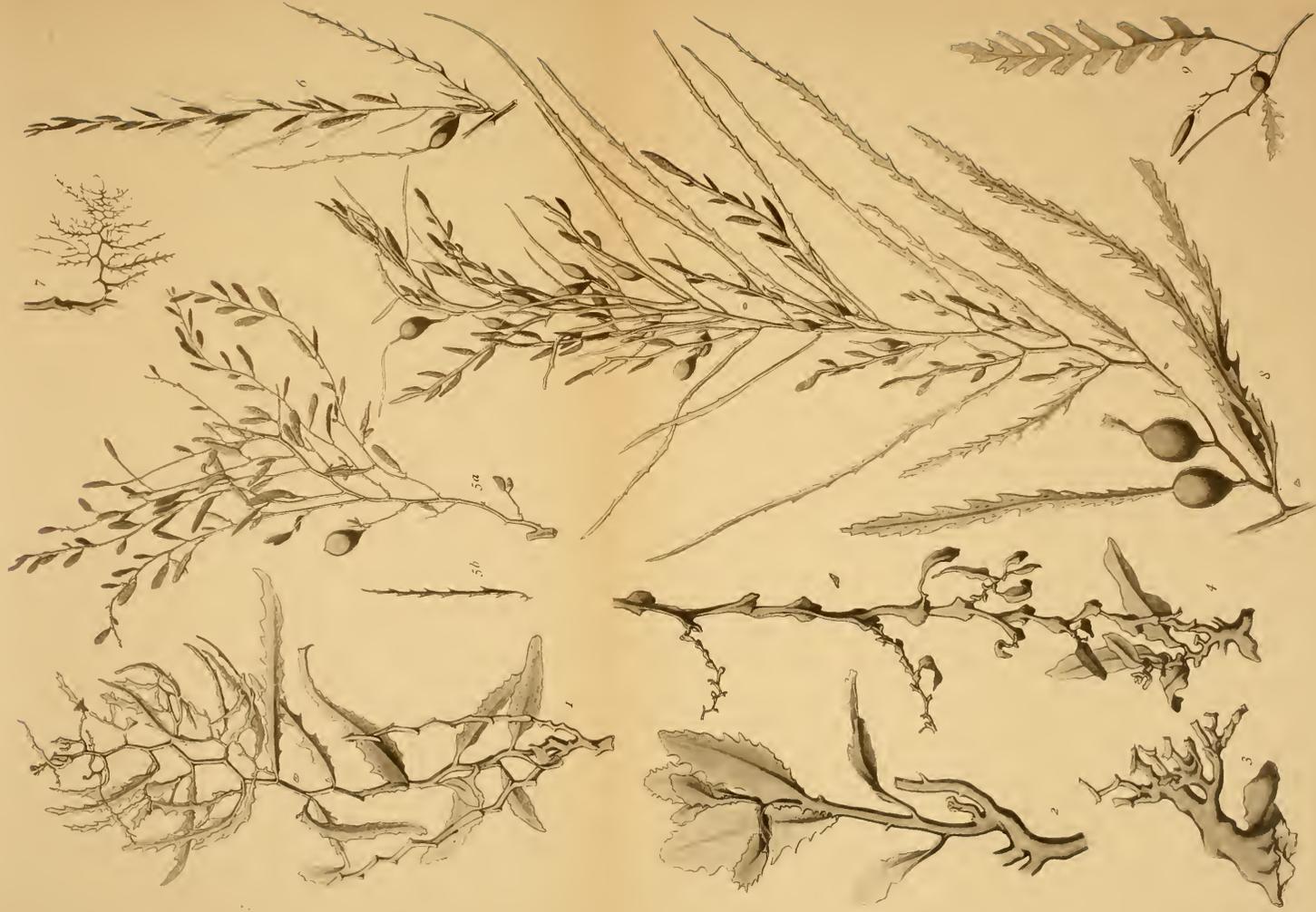
1. A sterile branch in the basal region of a well developed frond; with cross section of the stem.
2. A young principal branch. In this sort of branches the leaves are not refractive.
3. Basal part of a full-grown plant, showing the copious ramification; each branch is cut off near at its insertion point.
4. Lower portion of a frond collected at Hamajima, Prov. of Shima. This form answers to that which was mentioned by KÜTZING under the name *Halochloa pachycarpa*. With cross section of the stem.
5. *a.* A fertile lateral branch in the upper portion of a matured frond; not a single leaf is to be found on it. This sort of branch, when there is no leaf on it, is often difficult to distinguish from *Sargassum serratifolium*. If, however, even a single leaf remain attached to it as shown in fig. 5*b*, it can be safely be referred to this species.
6. A typical fertile ramulet.
7. Densely pinnatifid lateral branch, often found in the lower part of a frond.

Fig. 8. *Sargassum tortile* f. *macrocarpum* (AG.)

A fertile lateral branch. In the present specimen most of the receptacles lack the bractlet. In others, however, each receptacle, except the ultimate ones, is supplied with a bractlet as shown in fig. 6. With cross-sections of various parts of the stems.

Fig. 9. *Sargassum filicinum* HARV.

A fertile ramulet.



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PLATE XIII.

Plate XIII.

Figs. 1-6. *Sargassum enerve* Ag.

1. *a*, Middle portion of a fertile frond, showing a characteristic lateral branch. *b*, cross sections of the principal stem. *c*, a typical leaf on the lateral branches.
2. A fertile lateral branch from the upper portion of the same individual as shown in fig. 1.
3. *a, b*, Receptacular ramulets. In *b*, a receptacle bears a minor receptacle accompanied with a bractlet.
4. Terminal portion of a full-grown sterile frond.
5. A typical, young lateral branch of the same.
6. Lower portion of the same frond, with a cross-section.

Figs. 7-17. *Sargassum hemiphyllum* Ag.

7. Basal portion of a frond with symmetrical leaves.
8. Middle portion of the same frond, with lateral branches, two of the fulcrant leaves still remaining attached.
9. A young lateral branch. ca. $\times 3$.
10. Insertion point of a full-grown lateral branch.
11. Vesicles with a flat, short crown leaflet. $\times 2$.
12. A ♀ receptacular ramulet of the form typical of the species. ca. $\times 3$.
13. A receptacular ramulet from a south-sea form.
14. Basal portion of a frond with hemiphyllous basal leaves.
15. A lateral branch in the upper part of the same.
16. Large fulcrant leaves on well-developed sterile fronds.
17. Marginated vesicles.

Figs. 18-20. *Sargassum fulvellum* Ag.

18. Basal part of a well-grown fertile plant, with cross-sections of the stems.
19. Upper portion of a branch of the plant illustrated in fig. 18; the lower end marked with \times is to be connected to the upper end with the same mark in fig. 18. In this branch the receptacles are not yet fully mature.
20. Terminal portion of a branchlet with ♂ receptacles. ca. $\times 2$.



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PLATE XIV.

Plate XIV.

Figs. 1-7. *Sargassum confusum* Ag.

1. Basal part of a plant with a young branch.
2. Middle portion of a principal branch with four lateral branches, the fulcrant leaves of which have dropped off.
3. Basal part of a lateral branch with its fulcrant leaf remaining attached.
4. Basal part of a plant destitute of the broad basal leaves.
5. Lower portion of a well-developed plant with a sterile branch. In this plant all the vesicles were aristated.
6. A fertile lateral branch in the middle part of a principal branch; from the same frond shown in the preceding figure. The lower end marked with \times is to be connected to the point with the same mark in fig. 5 with some intermediate space between.
7. Fertile ramulets from the upper space of a lateral.

Figs. 8-12. *Sargassum confusum f. valida* (J. Ag.)

8. Basal part of a well-developed fertile plant with sterile young branches and with middle portion of a branch of a more advanced stage.
9. A typical basal leaf.
10. A fertile ramulet from the upper part of the branch which is marked in fig. 8 with \times .
11. A lateral branch with several fertile ramulets.
12. A fertile ramulet from a well-developed plant.

Figs. 13-14. *Sargassum Miyabei*.

13. A middle sized principal branch, showing basal portion of the plant.
14. Apical portion of a branch with well-developed receptacular ramulets.



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PLATE XV.

Plate XV.

Figs. 1-4. *Sargassum Kjellmanianum*.

1. Basal part of a plant, with a very young branch at the base.
2. Middle portion of a branch with a fertile lateral branch.
3. A fertile ramulet. ca. $\times 3$.
4. A part of a fertile ramulet showing the vesiculiferous receptacles. ca. $\times 3$.

Fig. 5. *Sargassum Thunbergii* f. *nipponica*.

A portion of a principal branch, showing three nodes and two stunted fertile ramulets. In the right hand ramulet the fulcrant leaf is filiform lanceolate, and in the left hand one it assumes a vesicular form. ca. $\times 5$.

Figs. 6-9. *Sargassum liushianum*.

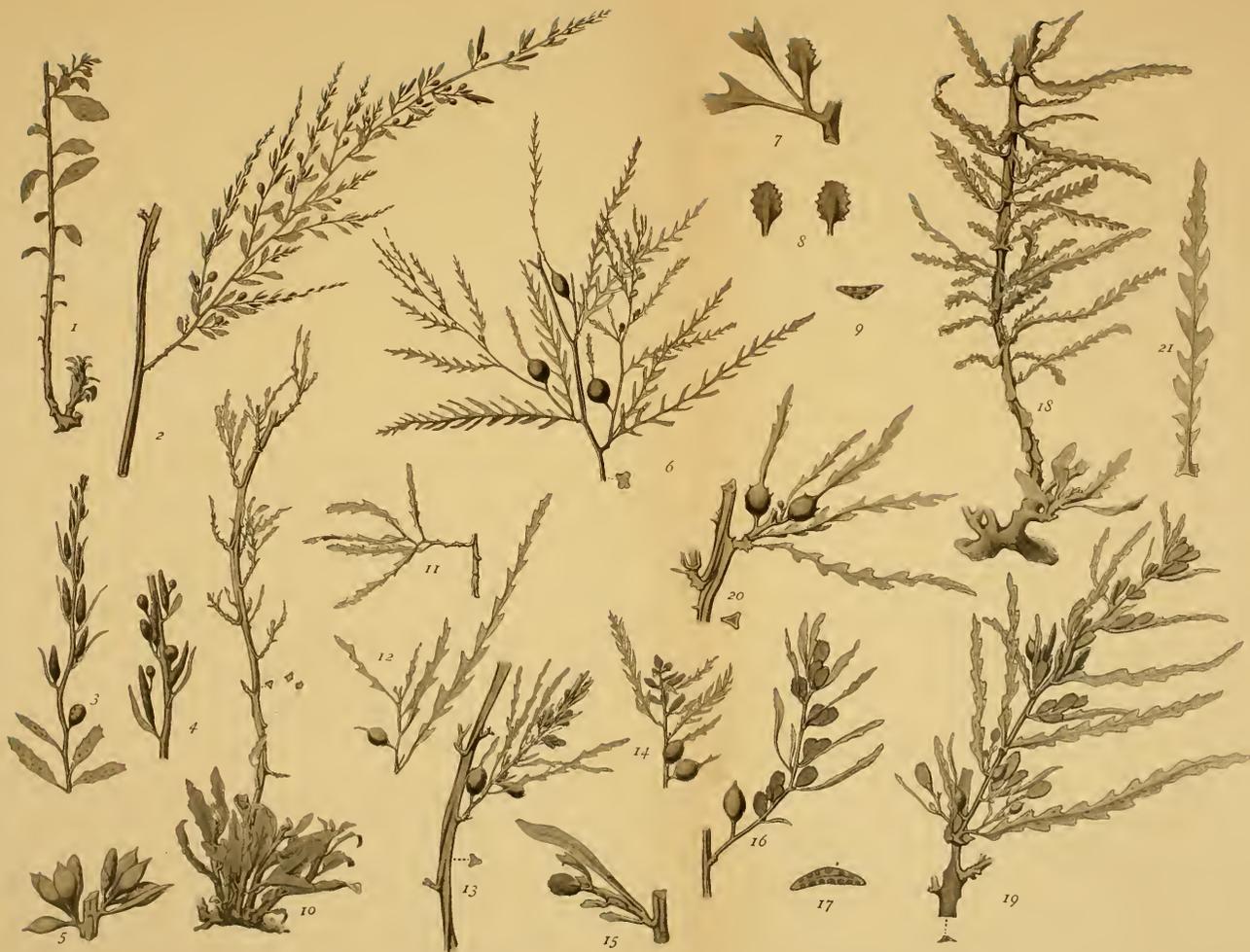
6. Middle portion of a frond, with a cross-section of the stem.
7. A receptacle with a leaf at the basal part of its stipe. The leaf as well as the fulcrant leaf is partly shown. ca. $\times 4$.
8. Receptacles seen from the elevated side. ca. $\times 4$.
9. Cross section of receptacle. ca. $\times 5$.

Figs. 10-17. *Sargassum micracanthum* (Kütz.)

10. Basal part of a well-developed plant, with cross-sections of the stem. Observe many young shoots are starting from the same root.
11. A typical lateral branch in the upper portion of a sterile frond.
12. The same near at the apical portion of a well-developed sterile frond.
13. A fertile lateral branch in the upper portion of a full-grown frond.
14. A fertile branch from a comparatively small plant.
15. A fertile ramulet near the terminal portion of a frond.
16. The same from a well-developed frond.
17. Cross section of a \uparrow receptacle Ca. $\times 8$.

Figs. 18-21. *Sargassum micracanthum* var. *stipulata*.

18. Basal part of a plant. Observe the basal leaves are entire, as in the typical form (fig. 10).
19. A fertile lateral branch.
20. Insertion point of well developed lateral branches, with one fulcrant leaf still remaining. Observe the vesicles are coronated and slightly winged.
21. A typical fulcrant leaf.



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PLATE XVI.

Plate XVI.

- Figs. 1-3. *Sargassum nigrifolium*.
1. A young sterile branch.
 2. Middle portion of a full-grown frond, showing ♀ fertile lateral branches.
 3. Part of a fertile lateral branch to show the arrangement of receptacular ramulets.
- Fig. 4. *Sargassum graminifolium* Ag.
A fertile lateral branch, from a specimen from Prov. of Awa.
Cf. text p. 130.
- Figs. 5-9. *Sargassum Illicifolium* var. *duplicatum* J. Ag.
5. Receptacular ramulet, with most of the receptacles spinescent. Ca. × 2. (from a specimen collected at Hiratsuka, Prov. of Sagami).
 6. The same, with some of the receptacles smooth; from the same branch which bears the ramulet shown above. Ca. × 2.
 7. A fertile lateral branch, probably of the present species. (From a specimen from Prov. of Tosa. Cf. Text. p. 132). ♂.
 8. A receptacular ramulet of the same. Ca. × 2.
 9. A receptacle cluster enlarged.
- Figs. 10-14. *Sargassum beriberifolium* J. Ag.
10. Basal part of a well-developed plant.
 11. A fertile lateral branch in the middle part of a branch.
 12. The same with a vesicle.
 13. A receptacle cluster enlarged.
 14. A typical leaf.
- Figs. 15-16. *Sargassum cinctum* J. Ag. ?
15. A fertile lateral branch. ♀.
 16. A receptacle cluster enlarged.
- Fig. 17. *Sargassum microphyllum* Ag. ?
a, b. Two receptacular ramulets. Ca. × 4.
- Figs. 18-19. *Sargassum aquifolium* forma. ?
18. A part of a fertile lateral branch. Ca. × 2.
 19. A receptacle cluster. Ca. × 3.
- Fig. 20. *Sargassum kushimotoense*.
A part of the frond showing two sterile lateral branches.

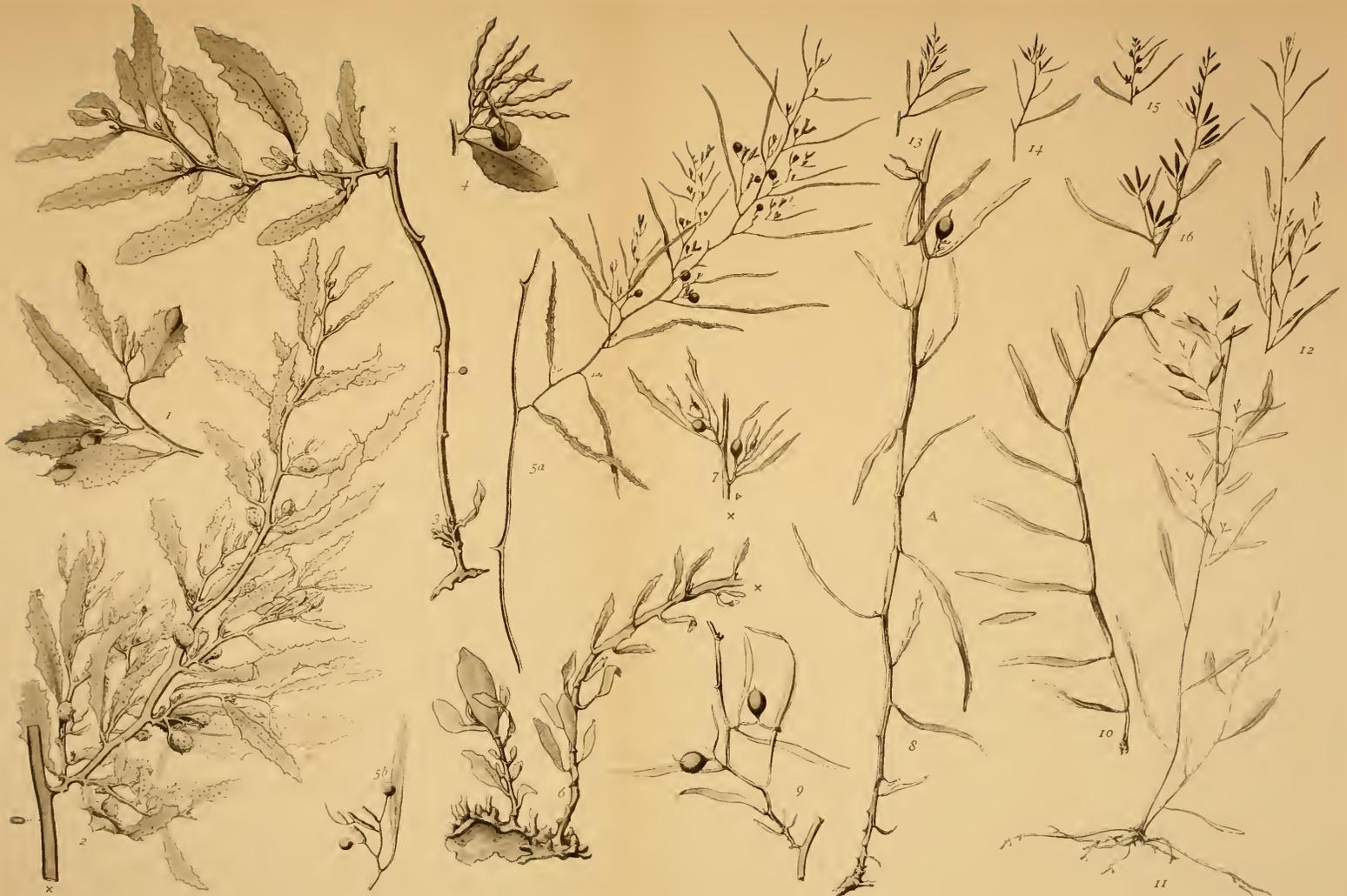


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PLATE XVII.

Plate XVII.

- Fig. 1. *Sargassum siliquosum* J. Ag.
The upper part of a sterile frond, with the peculiar ampullated leaves.
- Figs. 2, 3. *Sargassum assimile* var. *stipulata*.
2. A full-grown lateral branch from near the middle of a frond.
3. Lower portion of the same frond. In both figs. 2 & 3 the ends marked with \times are continuous with some intervening space.
- Fig. 4. *Sargassum vulgare* var. *foliosissimum* J. Ag.
A receptacular ramulet. Ca. $\times 2\frac{1}{2}$.
- Fig. 5. *Sargassum vulgare* var. *linearifolium* J. Ag.
a. A part of a branch with a fertile lateral branch.
b. A receptacular ramulet. Ca $\times 3$.
- Figs. 6-10. *Sargassum sagamianum*.
6. The knotty root. A young branch and a part of a well-grown branch are shown in the figure; other branches are all left out.
7. Middle portion of a well-grown branch with two lateral branches. The end marked with \times is to be connected with the same-marked end in the preceding figure.
8. Lower portion of a full-grown branch.
9. Basal portion of a full-grown lateral branch.
10. A young sterile branch with the secund leaves.
- Figs. 11-16. *Sargassum nipponicum*.
11. Lower portion of a frond.
12. Apical part of a principal shoot.
13-16. Receptacular ramulets in various stages of development.



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PLATE XVIII.

Plate XVIII.

Figs. 1-9. *Sargassum Ringoldianum* HARV.

1. A sterile frond with some parts left out.
3. Basal portion of a well-developed plant showing dichotomously branching stems.
4. Insertion point of a lateral branch. In this as in the next figure the fulcrant leaf is transformed into a large vesicle.
5. A fertile lateral branch with ♀ receptacles. *b*, cross-section of a receptacle. Ca. $\times 4$.
- 6-8. ♂ Receptacular branches of various forms; those in figs. 7 and 8 are somewhat decayed with age. *6 b*, cross-section of a receptacle. Ca. $\times 4$.
9. Vesicles with winged margins.

