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Japanese species of *Sargassum* subgenus *Bactrophycus* (Phaeophyta, Fucales)

Tadao YOSHIDA

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Introduction

The genus *Sargassum*, the largest genus in the Phaeophyta with more than 400 described species, is distributed in the tropical to temperate regions of all around the world. Along the Japanese coast, the genus constitutes an important part of the marine flora, forming an extensive vegetation in shallow rocky coasts.

Our present knowledge on the taxonomy of Japanese species is largely dependent on an eminent work of YENDO (1907), entitled "the Fucaceae of Japan". Since that time, fragmentary works were published from time to time by various authors.

Most of the species common in temperate regions of our coast are included in the subgenus *Bactrophycus* J. AGARDH. I tried to make collections and my own observations in the field, in addition to plenty herbarium specimens mainly collected by the late Prof. Y. YAMADA and housed in the herbarium of Faculty of Science, Hokkaido University (SAP), to bring about a clearer knowledge of the species concerned. Up to present, I recognized 28 species of this subgenus including the *Micracanthae* proposed by YENDO. As has been noticed that the species has its own period of reproduction

restricted to a certain season of the year (SEGAWA *et al.* 1959), process of growth and reproduction in several species was followed in Oshoro, Hokkaido (MARUI *et al.* 1981). Culture of eggs to a certain stage of development gave us a clearer understanding of the subgeneric relation in the genus. The *Bactrophycus* is known to have a wide range of diversity in the morphology of basal part of the thallus as to relations of holdfast, stem and branches, as well as reproductive structures. I propose to use these characteristics in discriminating sections and species, resulting in a recognition of 4 sections in the subgenus. Comparison of external morphology of adult thallus as well as knowledges concerning the developmental process is a major base of the present study. Informations from the other fields such as cytology and chemical constituents are obtainable only for a restricted number of species (cf. KUSUMI *et al.* 1981), and therefore at present it is difficult to use these informations in the considerations of general classification. In this study, I did not try to recognize subspecific taxa except in *S. ringgoldianum*. Until more informations from various fields of research are available, subspecific discrimination basing on dried herbarium specimens is not convincing. For the preparation of distribution maps, I consulted only specimens deposited in SAP and SAPA, except a few cases. At the same time, efforts were made to follow a strict type method. Types were located and examined as for the taxa described by YENDO in the herbaria of Tokyo University (TI) and Faculty of Agriculture, Hokkaido University (SAPA) (YOSHIDA 1980). Types of the taxa described by OKAMURA and YAMADA were examined in either TI or SAP, and I lectotypified some of them. Most of the types of the taxa described by European phycologists were also examined except those of GRUNOW, GREVILLE and HARVEY. By these procedure I made efforts to determine the original application of the name as far as possible.

Abbreviation for herbaria are those in 'Index Herbariorum' ed. 7 (1981), except for SAP (Herbarium of Faculty of Science, Hokkaido University) which is in accordance with ed. 2 (1954).

A brief history of research on *Sargassum* of Japan

History of taxonomic research on the genus *Sargassum* as a whole was concisely described by YENDO (1907) and SETCHELL (1931).

As for the Japanese species of this genus, THUNBERG was the first botanist who collected specimens during his stay in Japan in 1775 and published later a short note on 3 species under the genus name *Fucus* in 1815. As the first contribution to the knowledge of Japanese *Sargassum* in a Linnean system of classification, a publication of the species of THUNBERG

collection was made by ROTH, who received the specimens through MERTENS in Brehmen, and named it as *Fucus thunbergii* ROTH (1806, p. 104). Scientists in a Russian Mission, TILESIUS, LANGSDORFF and HORNER, collected many specimens from Japanese coast during a circumnavigation under the command of Captain KRUSENSTERN on board a ship 'Nadeschda' (cf. YOSHIDA 1978). The collections were made mainly in Nagasaki Port in a period of about 6 months from 1804 to 1805. Those specimens were passed over to MERTENS, who sent them with his provisional names to TURNER and to C. AGARDH. In his 'Historia Fucorum', TURNER (1808–1819) gave descriptions and figures of many taxa relating to *Sargassum*, among which 16 taxa were based on the specimens of Japan and adjacent seas. Of these 16 taxa, *Fucus thunbergii* was already published by ROTH, and *F. sisymbrioides*, *F. myagroides* and *F. langsdorfii* were the species now attributed to genera other than *Sargassum*. Types and their duplicates of TURNER's taxa are now deposited in the British Museum of Natural History (BM). Certain of them were formerly kept in the Hooker herbarium in Kew Garden (K). As for *F. acinaria β pycnocystus*, specimen was not located in BM. Although SETCHELL (1933 a, p. 191) supposed that the specimens not located in K at that time were lost after they were returned to MERTENS, they are preserved in BM. C. AGARDH also published 12 taxa in several times during 1812 to 1824, based on the specimens of TILESIUS and others collected in Japan and sent from MERTENS. Among the taxa of C. AGARDH, 2 belong to genus other than *Sargassum*. He gave figures only for *F. swartzii* and *F. pinnatifolius*. All specimens studied by him are housed in the Botaniska Museum, University of Lund (LD, Herbarium Agardh). C. AGARDH established the genus *Sargassum* in 1820, and included 62 species in the genus. THUNBERG (1815) gave descriptions of 3 species of *Fucus* from Japan, but they were synonymized with the taxa of TURNER. KÜTZING also studied the specimens from Japan constituting a part of MERTENS collection which he obtained through HENSCHEL in Breslau after the death of MERTENS, and described in 1843 9 new taxa under several genera. Later he gave figures of most of them in his 'Tabulae Phycologicae' vols 10 and 11 (1860, 1861).

More than a decad later, HARVEY studied the specimens collected by members of the United States North Pacific Exploring Expedition and sent by Asa GRAY to him. He (1859) published 8 species of Fucales with many other new taxa. Figures to be accompanied his descriptions were recently discovered by DAWSON, who published them in 1959.

Von MARTENS (1866) reported the botanical collection of 'Thetis' expedition. Among many new species described by him, *Anthophycus japonicus* and *Halochloa heterophylla* credited to Asian coasts have some concern

here. Without an accompanying figure, however, these 2 taxa were variously treated by later workers.

J. AGARDH (1889, 1896) added 5 species of *Sargassum* from Japan, based on the specimens sent from KJELLMAN. A system of subdivision of the genus into 5 subgenera was proposed by him (1889), and this system was followed by most of recent phycologists with or without slight modification. GRUNOW, in his posthumous monograph (1915), treated all species in a world wide scale including also Japanese species. His collection was until now not inspected by other students of the group.

First intensive studies on the genus by Japanese phycologist were made by YENDO (1905, 1907, 1909). In his excellent work, YENDO (1907) described 7 new species along with a revision of the species of earlier phycologists, based on the specimens of his own collection (TI) and those in Miyabe herbarium (SAPA). This work was made before he visited European herbaria, and regrettably he did not publish his comments on important specimens of the group concerned, although he made annotations on herbarium sheets.

In his 'Icones of Japanese Algae', OKAMURA (1923–1925) gave excellent illustrations for many species of the genus. SETCHELL (1931–1936), in his treatment of Hong Kong Seaweeds, presented many discussions which are relevant to the species distributing also in Japan. More recent works of YAMADA (1942, 1944), though centered his chief attention to the subgenus *Sargassum* (=*Eusargassum*), added 2 taxa of the *Bactrophycus*, along with 8 new species and new records belonging to other subgenera. He described with SEGI (1948) a new species *S. racemosum* (=*S. segii*), and later *S. sagamianum* var. *yezoense* from Hokkaido (in YAMADA & KINOSHITA 1950). He visited many European herbaria and inspected important collections, but did not publish the results except a fragmentary note on the herbarium of THUNBERG (1955).

SAWADA (1955, 1956), KAWASHIMA (1963) and OGAWA (1977) added new knowledges to a certain species. YOSHIDA (1978 a) made clear a synonymous relation of *S. kjellmanianum* and *S. miyabei*. He (1980) designated the types of the taxa described by YENDO and settled the application of names. Recently, 3 new species of the *Bactrophycus* were proposed by himself and KONNO (KONNO & YOSHIDA 1982, YOSHIDA & KONNO 1983).

On the other hand, TAHARA (1909–1941) and INOH (1930–1947) made morphological studies on many species giving us a clearer understanding of the group concerned. Process of development of conceptacle gives us a clue to consider the relationship among the subgenera, and among other characters, division mode of rhizoid cell and embryonal development have some

meanings at generic level in the Fucales. Observations on the development of eggs to mature plants were made by TERAWAKI *et al.* (1982, 1983). Apical organization of the stem was studied by YOSHIDA *et al.* (1983). Cytological informations on chromosome numbers were obtained in several species (OGAWA *et al.* 1969).

General discussion on the subgenus *Bactrophycus*

The subgenus Bactrophycus *and its relation to the other subgenera*

An early development of the thallus is summarized as follows. Liberated eggs are fertilized and begin to develop while they are retained in the mucilaginous substance surrounding the receptacle. Young germlings develop 8 or 16 primary rhizoids according to the species. After attaching to the substratum, the germling elongates to become an upright terete body. At this stage, cryptostomata begin to differentiate in some species. The upper part flattened as they grow longer. This flattened part can be called as

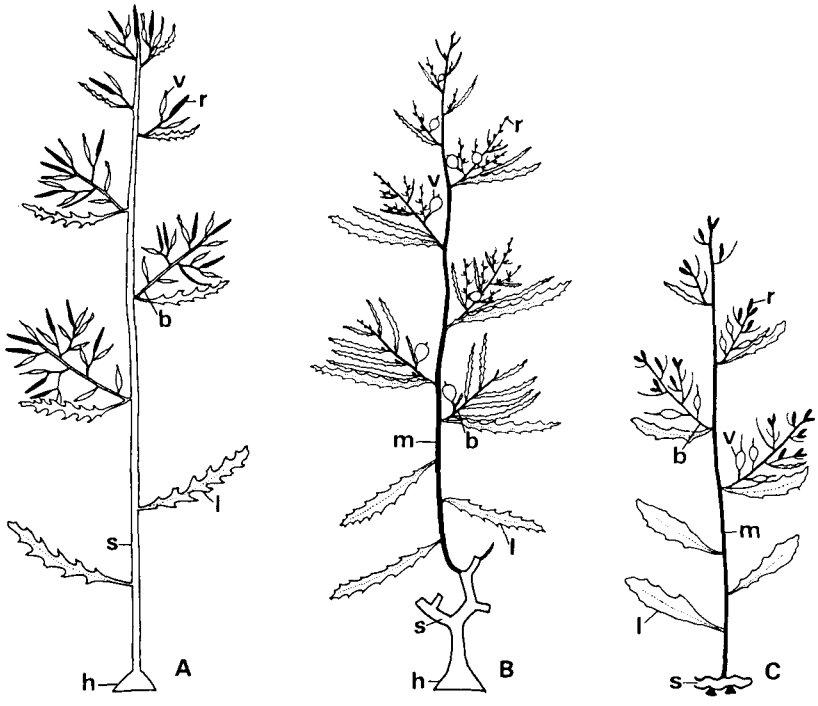

Fig. 1. Schematic representation showing types of thallus construction. A, section *Spongocarpus*. B, sections *Halochloa* and *Teretia*. C, section *Repentia*. b, lateral branch; h, holdfast; l, leaf; m, main branch; r, receptacle; v, vesicle.

first "cauline leaf" or "primary leaf" (TERAWAKI *et al.* 1982). In case of *Cystoseira*, this is called primary frond by FRITSCH (1945). The elongation of the first cauline leaf is caused by the differentiation of an apical cell. But this apical cell soon ceases to grow further. Another apical cell differentiates laterally some distance from the base. This newly formed one establishes the growing point of a "stem" (Fig. 1, s) or a "main axis" (JENSEN 1974), and continues to be active in whole life of the shoot. The apical cell situates in the bottom of an apical depression, and is always triangular in cross section and lenticular in longitudinal section (YOSHIDA *et al.* 1983). Those of lateral formation are differentiated while they are inside the apical depression. The cauline leaf becomes obliquely directed as the apex of the stem differentiates. The second cauline leaf is formed nearly opposite direction to the first. As the stem grows, successive cauline leaves are formed with a divergence of phyllotaxis converging to 2/5, spreading always horizontally. The first cauline leaf is simple with entire margin in the species observed up to date. Later formed ones show a morphology characteristic to the species as to the serration on the margin or presence of midrib. The cauline leaves are always simple in the species of the *Bactorphycus* so far observed. While in other subgenera, they often become pinnatilobed (TERAWAKI *et al.* 1982, 1983). Up to this stage of development, there is a close similarity between the species of *Sargassum* and those of *Cystoseira* (OLTMANNS 1922). Differences according to the group or species become apparent in later stages. After a period of formation of cauline leaves, lateral formations on the stem change their morphology to those called here "main branches" (Fig. 1, m). The main branch is defined as a lateral formation from the stem without a subtending leaf and gives rise to leaves, lateral branches, vesicles and receptacles. In this respect, the main branch differs from other lateral formations in that they arise from the axil of subtending leaves. Once the main branches appear, no cauline leaf is formed any more. In perennial species, the stem continues to grow slowly, may or may not branch, issuing annually several main branches which fall off after maturation period and leave knotty appearance on the stem. The main branch grows much longer than the stem (Fig. 1, B, C). In this respect, *S. horneri* and *S. filicinum* are quite different from all other species of the genus. In these 2 species, the stem continues to elongate and lateral formations always arise in axils of leaves (Fig. 1 A). So it can be said that these 2 species have no main branch, as defined here, and produce cauline leaves until the apex changes into receptacle. Differentiation at subgeneric level becomes apparent from a stage when leaves are formed on the main branch.

Agardhian system of subdivision of the genus *Sargassum* into 5 subgenera

must be taken as a starting point of discussion on the grouping at subgeneric levels. J. AGARDH (1889) used as a main characteristic for the subdivision of the genus morphogenetic relations of stem and leaf. In the subgenera *Phyllotrichia* and *Schizophycus*, main branches emerge as foliar expansions, according to J. AGARDH. As a matter of fact, cauline leaves and main branches are distinct structures as shown by TERAWAKI *et al.* (1982). Early stages of development of the main branch in the species of the subgenus *Sargassum* (=*Eusargassum*) are very similar to those of the *Phyllotrichia* and the *Schizophycus* (TERAWAKI *et al.* 1982, 1983, 1983 a, 1983 b). J. AGARDH considered that the subgenus *Sargassum* had "true horizontal leaves". But observations on some Japanese representatives show that the species belong to the subgenus *Sargassum* develop their leaves as vertically flattened primordia, and always expand in a plane same as the flattening of the main branch. Whereas the species of the *Bactrophycus* issue their leaves as a horizontally expanding structure, that is to say at right angles to the branch on which they are borne, at least several leaves first formed on the main branch. In this respect, the *Arthrophycus* shows the same feature as for the plane of expansion of the lower leaf, though there is few data on the early development of the thallus in this subgenus.

It can be safe to divide the species of *Sargassum* into 2 groups by the plane of expansion of leaf:

With only vertical leaves···*Phyllotrichia*, *Schizophycus* and *Sargassum* (subgenus, =*Eusargassum*)

With horizontal leaves (at least lower one)···*Bactrophycus* and *Arthrophycus*

Distinction between the *Bactrophycus* and the *Arthrophycus* seems to be rather difficult. J. AGARDH (1889, p. 33) defined that the *Bactrophycus* had receptacles "simplicia siliquaeformia et inermia" and the *Arthrophycus* "plus minus composita, demum in ramulo axillari racemosa aut rarius subcymosa, nunc teretiuscula et saepe inermia, nunc angulata et saepe dentibus armata". As shown in the following enumeration of species, receptacles in Japanese species are not only siliquaeform, but also of rather divergent features. Until much comparative studies are made, I simply place all species with horizontally expanding leaves distributed in the northern hemisphere in the *Bactrophycus* and those of the southern hemisphere in the *Arthrophycus*.

Previously, SEGI (1948) assumed that his *S. racemosum* (=*S. segii*) was a species of the *Arthrophycus*. I treat it in the *Bactrophycus* because of the reason stated above. Though SETCHELL (1933) included his *S. macclurei* and *S. herklotsii* in the *Arthrophycus*, I prefer to include them also in the *Bactrophycus*.

The subgenus *Sargassum* (=*Eusargassum*) has compound receptacles often with spinal processes and leaves well differentiated than those of the *Phyllotrichia* and the *Schizophycus*. WOMERSLEY (1954) discussed that the distinction between the *Phyllotrichia* and the *Schizophycus* could not be maintained at subgeneric level.

Morphological characters used to distinguish the species in the subgenus Bactrophycus

Basal morphology

Holdfast is at first formed by primary rhizoids issued from the bottom of germinating embryo, then the secondary rhizoids develop to contribute the construction of the holdfast. As the stem grows in length, the holdfast increases in size. In annual species, the holdfast becomes established its full aspect in a few months. In perennial species, characteristic features of the holdfast are completed after one or two years of growth. Morphology of basal part including holdfast and stem vary considerably according to the species especially in the *Bactrophycus*, where the basal morphology falls into several types. The holdfast can be called as "disc shaped" when it is round in outline and is rather flat, elevation is less in comparison with its diameter. A single stem arises from a discoid holdfast. It is "conical" when the elevation is rather high. When it grows bigger by the activity of its meristoderm, lower part of the stem is buried in it, resulting in an appearance that several stems arising from a conical holdfast, because of overgrowth to the branching of the stem. In such species as *S. horneri* and *S. fulvellum*, filamentous or finger-like projections from the lower part of the stem are formed radiately and later they fuse with each other to form a disc, leaving radiating furrows on the surface (Fig. 6 B). This state of holdfast is called as "scutellate". The filamentous outgrowths are variously developed according to the species. In *S. miyabei*, development of filamentous outgrowths is rather restricted in length (Fig. 36 A, B), while in *S. hemiphyllum* (Fig. 30 B) and *S. nipponicum* (Fig. 33 A), the filaments develop well and no coagulation occurs between them. Thick filamentous outgrowths are formed in *S. ammophilum*. These filaments fuse with each other to form a flat disc (KONNO & YOSHIDA 1982, figs. 2–4). In such species with a prostrate stem as *S. okamurae* (Fig. 86 A) and *S. yezoense* (Fig. 92), secondary attaching discs are formed on the ventral surface of the stem. They grow in size and can fuse with each other forming an irregularly shaped disc.

Among the 5 subgenera proposed by J. AGARDH, the subgenera *Phyllotrichia*, *Schizophycus* and *Sargassum* have similar basal morphology. From a disc shaped holdfast, an upright stem is located in the center, and later

secondary shoots are formed on the surface. The stem is rather short in length and without branching. Several flat main branches are issued spirally at the distal part of the stem. This type of basal part is similar to that encountered in the species of the *Bactrophycus* such as *S. muticum* except that the main branches are angular in the latter. As far as I know from inspection of Agardhian herbarium, the species of the *Arthrophycus* have a type of basal morphology similar to that met with in *S. siliquastrum, i. e.*, the abbreviated stem is upright and branches several times.

Maximum length of the thallus is rather variable according to the habitat. A species may be smaller in a habitat of shallow water or exposed to strong wave action, and may become longer in calm subtidal zone with swift tidal current. But a maximum of growth is of some taxonomic value.

In such species as *S. nigrifolium* and *S. okamurae*, the length of thallus always less than 1 m, usually around 0.5 m. Most of the species in this group have thalli 1 to several meters long. *S. horneri* and *S. filicinum* can grow to a length more than 10 m.

Main Branch

As defined earlier, the main branch is lateral formations from the stem without a subtending leaf and issues leaves and lateral branches arising in axil of the leaf. The main branches are issued spirally or alternately in one plane, or on dorsal side of the stem if it has dorsiventral tendency to prostrate state. The main branch may be terete or angular with longitudinal furrows, triquetrous with sharp or round edges, or ancipitous with longitudinal costal elevation in the middle part and thinner marginal regions. There are spinal processes on the surface or edges of the main branch as well as on the stem or petiole of some species (Fig. 2). The spinal processes may be

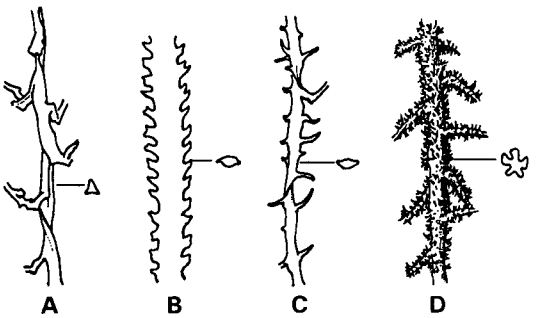

Fig. 2. Various types of main branch. A, triquetrous with smooth margin. B, ancipitous with obtuse spinal projections. C, ancipitous with acute spines. D, angulate with spines.

simple with or without acute apex or may forked. In some cases, the spines are deciduous.

Leaf

Leaves are here defined as filiform or foliose appendages issued on the branch. Some authors prefer a term "phyllode". Here I use the term "leaf" as an analogy to the higher vascular plant.

The leaf is always simple in the *Bactrophycus* (Fig. 3). Outlines of the leaf vary from broad elliptical to filiform (Fig. 3F) with an acute or obtuse apex. The leaf has cuneate or abrupt base. It is clearly stipitate or its basal part is decurrent to ancipitous stipe. Retroflexy, that means downward direction of the stipe, is conspicuous in certain species. Size also varies from minute filamentous structure to that 20 cm or more in length and 2 cm or more in width. Leaf margin is entire in several species (Fig. 3 A, G). Various grades of dissection from minute dentation to pinnatisection can be observed even in one individual (Fig. 3 B–E). Irregular incision also encountered rarely. One extreme is those skeletonized to a state with filiform midrib and alter-

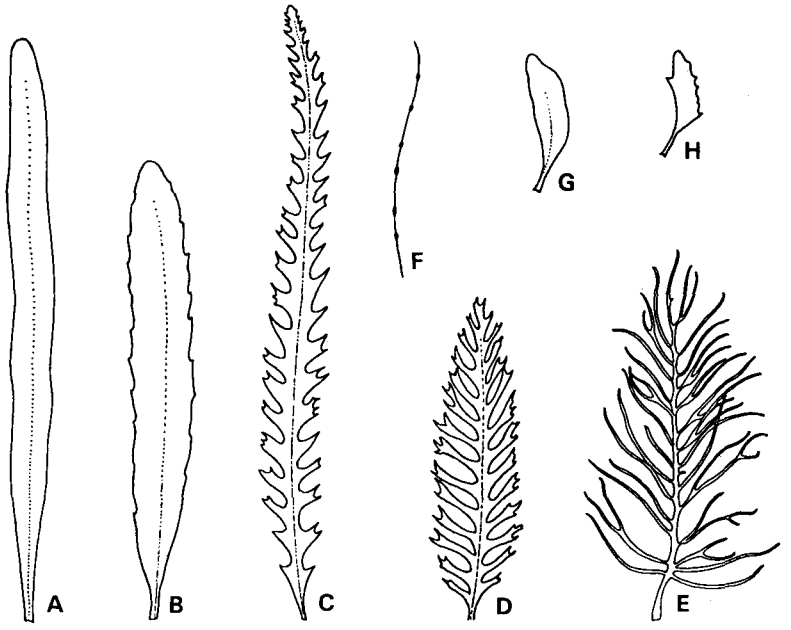

Fig. 3. Various types of leaf in the *Bactrophycus*. A, linear with entire margin. B, linear lanceolate with serrulate margin. C, linear with double serrated margin. D, deeply alternately pinnatisected. E, alternately pinnatisected skeletonized. F, filiform. G, obliquely spatulate. H, hemiphyllous.

nately disposed filiform pinnae as is seen in *S. trichophyllum* (Fig. 3 E). Presence of a midrib has some diagnostic value. Texture of the leaf can be expressed as papyraceous in thinner leaf to coriaceous in other extreme. Cryptostomata are rather common occurrence. In the species with thinner leaves, they are easily recognized even by the naked eye. However, their frequency is variable even in an individual. In the species with thick coriaceous leaves, they are difficult to discern with the naked eye.

Disposition of leaves on the branch is always spiral. Divergence of phyllotaxis varies according to species, in relation to morphology of branch. An ancipitous branch issues leaves alternately, and this is expressed as a phyllotaxis 1/2. A triquetrous branch bears its leaves in 120° divergence, *i. e.*, phyllotaxis 1/3. Phyllotaxis is 2/5, when the branch is terete or angulate. Divergence may change in a branch.

Leaves spread horizontally at least those formed in the basal part of the main branch. In several species, leaves turned to spread vertically in the upper part of the branch.

Vesicle

As a vesicle is usually formed by a transformation of lower part of a leaf, it has a coronal leaf on its apex and is shortly stipitate (Fig. 4 A-E). Coronal leaves vary from a small mucro to longer one similar to ordinally leaves on the branch. They are often petiolated, while in some species, the coronal leaf extends downwards to form wings along the vesicle (Fig. 4 C). There are several species with muticous vesicles (Fig. 4 F). The vesicle is usually single, although seriate vesicles were reported in certain population of *S. thunbergii*.

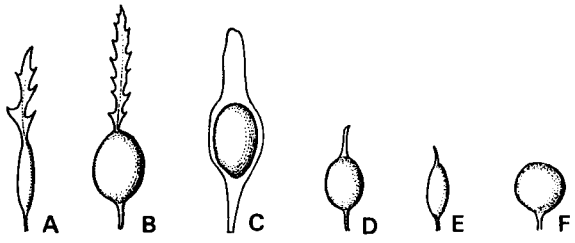

Fig. 4. Variation in vesicle morphology. A, terete with coronal leaf. B, elliptical with coronal leaf. C, elliptical with coronal leaf running down to form wings. D, elliptical with filiform coronal leaf. E, fusiform with mucro. F, spherical without mucro.

Receptacle

Receptacles are terminal portion of a branch, bearing numerous embed-

ded conceptacles, and are usually simple in external form in this subgenus. They are terete (Fig. 5 A, B), or compressed, foliose or triquetrous (Fig. 5 C–I). Size varies according to the species. Proliferation of small vesicle and receptacle on the surface of larger receptacle is often encountered on terete receptacles. Degree of flatness also varies. In several species, receptacles have serrulate or denticulate margin (Fig. 5 G, I). Forking of receptacle is also of rare occurrence (Fig. 5 F).

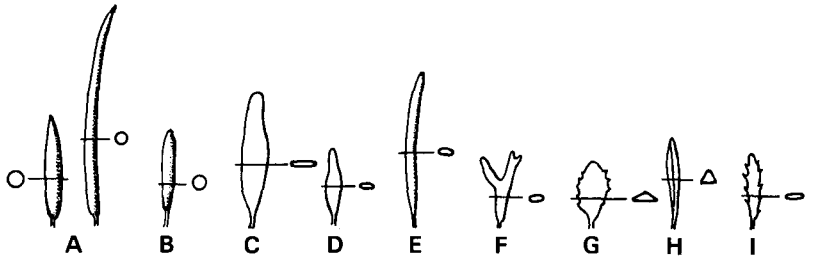

Fig. 5. Variation in receptacle morphology. A, B, terete. C–E, compressed. F, forked. G, I, armed with spines. H, triquetrous.

Receptacles are with or without subtending leaf. Those formed on terminal end of the branchlet are often devoid of leaf. Disposition of receptacles in the distal part of the branches is racemose or paniculate in most species. An axis of a raceme or a panicle may elongate or abbreviate.

Sexuality

Most of the species of this subgenus are dioecious in sexuality. Male receptacle is usually longer and slenderer than the female one. Monoecious species are few in number, whereas monoecism is often recorded in the subgenus *Sargassum*.

As shown by SAWADA (1958), sexual expression is variable in *S. filicinum* where androgynous state is common, but certain individuals have androgynous and male receptacles (andromonoecious). *S. muticum* and *S. tenuifolium* have androgynous receptacles. *S. yezoense* is usually dioecious. OGAWA (1977) reported the presence of monoecious population in this species.

Maturation period

Production of receptacles and liberation of reproductive bodies are restricted to a certain season of a year. Table 1 summarizes the data obtained during this study. Difference in maturation period has a certain diagnostic meaning because it implies a sexual isolation. In the species with wide distributional range, maturation is earlier in southern districts and later in northern locality.

Table 1. Maturation period of the species of the *Bactrophycus*

Species	Spring	Summer	Autumn	Winter
S. horneri	——— - - -	- -		———
S. filicinum	———			
S. microceratium	———			
S. confusum	———	- -		
S. pallidum	———			
S. muticum	———			———
S. thunbergii	———			
S. fulvellum	———			———
S. ammophilum	———			
S. hemiphyllum	———			
S. nipponicum	———	———		
S. miyabei	———	———		
S. segii			———	
S. yamamotoi	———			
S. tenuifolium		———		
S. ringgoldianum	———	———		
ssp. *coreanum*		———	———	
S. trichophyllum			———	
S. sagamianum			———	
S. micracanthum	———			———
S. giganteifolium			———	
S. macrocarpum	- -	———		
S. autumnale			———	
S. siliquastrum	———			
S. serratifolium	———			
S. okamurae			———	
S. nigrifolium	———	———		
S. yezoense		———		
S. yamadae	———	———		

Subdivision of the subgenus Bactrophycus

Species of the *Bactrophycus* can be divided into 3 groups by their basal morphology. One group is those with elongated erect stem. Here the stem grows rapidly and produces leaves until the apex is transformed to receptacle or damaged. Lateral branches always arise in axils of leaves and usually shorter in length than the stem. Therefore there is no main branch as defined above. In this group receptacles are terete. This group is represented by *S. horneri* and called as the section *Spongocarpus*, reviving the genus name of KÜTZING.

Second group has more or less abbreviated erect stem, which is either unbranched or branched. Main branches arise from the terminal part of the stem. They are ancipitous, triquetrous or angulate, issuing leaves and axillary laterals. This group can be subdivided by the shape of receptacles whether they are terete or not. In some species male receptacles are only slightly compressed, although female ones are more conspicuously flattened. Subdivided group with terete receptacle is named here as the section *Teretia*. For the rest with flattened or rarely triquetrous receptacles, the name, section *Halochloa*, can be used.

The species with decumbent or procumbent stem constitute the remainder of the subgenus. In these species, the stem issues on its ventral side secondary attaching discs which in some species fuse to form an irregular shaped holdfast. The name, section *Repentia*, is given for this group.

They can be summarized by following key:

1. Stem upright throughout the life 2
1. Stem decumbent or procumbent . . . . . Section *Repentia*
   2. Stem elongated, no main branch formed . Section *Spongocarpus*
   2. Stem more or less abbreviated, main branch well developed . . 3
3. Receptacle terete . . . . . Section *Teretia*
3. Receptacle complanated or triquetrous . . . . . Section *Halochloa*

Key to the Japanese species of the subgenus *Bactrophycus*

1. Stem elongate, main branch absent, branches always arising in axil of subtending leaf (Section *Spongocarpus*) 2
1. Stem more or less abbreviated, main branches elongated, arising without subtending leaf 3
   2. Vesicle cylindrical, dioecious . . . . . 1. *S. horneri*
   2. Vesicle spherical to elliptical, monoecious . . . 2. *S. filicinum*
3. Stem upright, branched or unbranched 4

3. Stem prostrate, branched, forming secondary attaching discs on ventral surface (Section *Repentia*) 26
   4. Receptacle terete (Section *Teretia*) 5
   4. Receptacle compressed, flat or triquetrous (Section *Halochloa*) 14
5. Stem unbranched, attaining 10 cm or more in several years, main branches issued alternately in one plane 6
5. Stem abbreviated, branched or unbranched, usually less than 3–4 cm, main branches issued spirally in most species 8
   6. Leaf filiform throughout the branch . . . 3. *S. microceratium*
   6. Lower leaf broad, elliptical to lanceolate 7
7. Main branch usually armed with spines, leaf coriaceous in texture, vesicle smaller, less than 5 mm in diameter . . . . 4. *S. confusum*
7. Main branch without spines, leaf papyraceous in texture, vesicle larger, up to 10 mm in diameter . . . . . 5. *S. pallidum*
   8. Holdfast discoid 9
   8. Holdfast scutellate or with filamentous outgrowths 10
9. Vesicle spherical . . . . . 6. *S. muticum*
9. Vesicle fusiform . . . . . 7. *S. thunbergii*
   10. Holdfast scutellate . . . . . 8. *S. fulvellum*
   10. Holdfast with filamentous outgrowths 11
11. Creeping filamentous outgrowths thick, 2 mm in diameter, fused to form a flat disc . . . . . 9. *S. ammophilum*
11. Creeping filamentous outgrowths thin, less than 1 mm in diameter, free from each other 12
   12. Lower leaf hemiphyllous without midrib . . 10. *S. hemiphyllum*
   12. Lower leaf not hemiphyllous 13
13. Creeping filament well developed . . . . . 11. *S. nipponicum*
13. Creeping filament short in length, less than 1 cm . . . 12. *S. miyabei*
   14. Stem abbreviated, unbranched, usually less than 1 cm in length 15
   14. Stem branched once to several times, usually attaining more than 10 cm long 17
15. Leaf ovate to lanceolate with entire margin, coriaceous in texture . . . . . 13. *S. segii*
15. Leaf lanceolate to linear with more or less dentate or incised margin, papyraceous in texture 16
   16. Receptacle oblanceolate to linear with smooth margin, dioecious . . . . . 14. *S. yamamotoi*
   16. Receptacle spatulate with spinal processes on the margin, monoecious . . . . . 15. *S. tenuifolium*
17. Leaf lanceolate to linear with entire margin 18

17. Leaf in the middle part of the branch with more or less serrate margin 19
    18. Receptacle foliose . 16. *S. ringgoldianum* subsp. *ringgoldianum*
    18. Receptacle oblanceolate to linear . . . . . 16 a. *S. ringgoldianum* subsp. *coreanum*
19. Receptacle (at least female one) often triquetrous 20
19. Receptacle spatulate to oblanceolate 21
    20. Upper leaf skeletonized to filiform midrib and filiform pinnae, receptacle armed with spinal processes . . 17. *S. trichophyllum*
    20. Leaf with serrate margin, receptacle without spinal process . . . . . 18. *S. sagamianum*
21. Receptacle formed in abbreviated panicle 22
21. Receptacle formed as more or less elongated raceme 23
    22. Receptacle spatulate, often with dentate margin or apex, leaf pinnatisected . . . . . 19. *S. micracanthum*
    22. Receptacle linear with smooth margin, leaf larger, with serrate margin . . . . . 20. *S. giganteifolium*
23. Main branch armed with obtuse processes on the margin, phyllotaxis 1/2 in the lower part of main branch . . . . . 21. *S. macrocarpum*
23. Main branch usually with smooth margin, sometimes with acute spines on the edge 24
    24. Lower leaf ovate to lanceolate with entire margin, maturation in spring to early summer 25
    24. Leaves narrow lanceolate to linear with serrate margin, maturation in autumn to winter . . . . . 22. *S. autumnale*
25. Leaf coriaceous in texture, upper leaf deeply serrate to midrib . . . . . 23. *S. siliquastrum*
25. Leaf membranaceous to papyraceous in texture, serration not reaching to midrib . . . . . 24. *S. serratifolium*
    26. Lower leaf ovate or linear, with entire margin 27
    26. Lower leaf lanceolate, with serrate or dentate margin 28
27. Leaf linear, receptacle flat clavate, often forked . . . 25. *S. okamurae*
27. Leaf ovate, receptacle spatulate, often with serrate margin . . . . . 26. *S. nigrifolium*
    28. Lower leaf not retroflexed, branches triangular with round edges . . . . . 27. *S. yezoense*
    28. Lower leaf retroflexed, branches triangular with sharp edges . . . . . 28. *S. yamadae*

Description of the species

Sargassum C. AGARDH, Spec. Alg. 1 : 1. 1820, nom. cons.

LT : *S. bacciferum* (TURNER) C. AGARDH, typ. cons. (=*Fucus bacciferus* TURNER)

Subgenus ***Bactrophycus*** J. AGARDH, 1889 : 33, 57.

LT : *S. horneri* (TURNER) C. AGARDH (=*F. horneri* TURNER)

Leaves on the lower part of a main branch spreading horizontally. Receptacles usually simple. Distribution in the Northern Hemisphere.

The type species had not been designated to the *Bactrophycus* by J. AGARDH. His original characterization of this subgenus includes the possession of siliquaeform unarmed simple receptacles. This fits best to the receptacle of *S. horneri* (Fig. 5 A). In almost all enumeration of the species, *S. horneri* is treated in the first place. By these reasons, it is appropriate to designate this species as the lectotype of the subgenus *Bactrophycus*.

Section ***Spongocarpus*** (KÜTZING) YOSHIDA, stat. nov.

Basionym : *Spongocarpus* KÜTZING 1843 : 55.

LT : *S. horneri* (TURNER) C. AGARDH.

Stem erect, elongated, branches always arising in axils of leaves and shorter in length than the stem, receptacle terete, siliquaeform.

1. *Sargassum horneri* (TURNER) C. AGARDH 1820 : 38. (Figs. 6–8)

C. AGARDH 1824 : 307. J. AGARDH 1848 : 290 ; 1889 : 57. MARTENS 1866 : 116. DE TONI 1895 : 20. YENDO 1907 : 74, *pl. 10*. GRUNOW 1915 : 340. OKAMURA 1916 : 198 ; 1923 : 3, *pl. 202* ; 1936 : 328. SETCHELL 1933 : 38, *pl. 10*. YAMADA & KINOSHITA 1948 : 12, *pl. 11*. SEGAWA 1956 : 49, *pl. 28*, No. 216.

Fucus horneri TURNER 1808 : 34, *pl. 17*. C. AGARDH 1815 : 48. Lectotype : BM (K) "In the straits of Corea, Dr. HORNER" (Fig. 7 A).

Spongocarpus horneri (TURNER) KÜTZING 1843 : 55 ; 1843 a : 365 ; 1849 : 631 ; 1860 : 31, *pl. 89, f. 1*.

Sargassum spathulatum J. AGARDH 1889 : 58 ; 1896 : 50. Lectotype : LD (Herb. Agardh No. 2877 "Japan, C. WRIGHT") (Fig. 7 D).

Sargassum horneri var. *spathulatum* (J. AGARDH) OKAMURA 1902 : 144. GRUNOW 1915 : 341.

Sargassum polyodonthum J. AGARDH 1896 : 50. Lectotype : LD (Herb. Agardh No. 2880 "Goto, Japan, Januari 1883, PETERSEN") (Fig. 7 C).

Fucus horneri var. *denseramosus* C. AGARDH 1815 : 48.

Sargassum horneri var. *densum* C. AGARDH 1820 : 38. Lectotype : LD (Herb. Agardh No. 2867 "e mari japoniae, TILESIUS") (Fig. 7 E).

Sargassum horneri f. *furcatodentatum* O. KUNTZE 1880 : 224, *pl. 2, f. 25*. YENDO 1907 : 79, *pl. 10, f. 8*. OKAMURA 1916 : 198 ; 1923 : 4, *pl. 202, f. 4* ; 1936 : 328. Type not located "Japan".

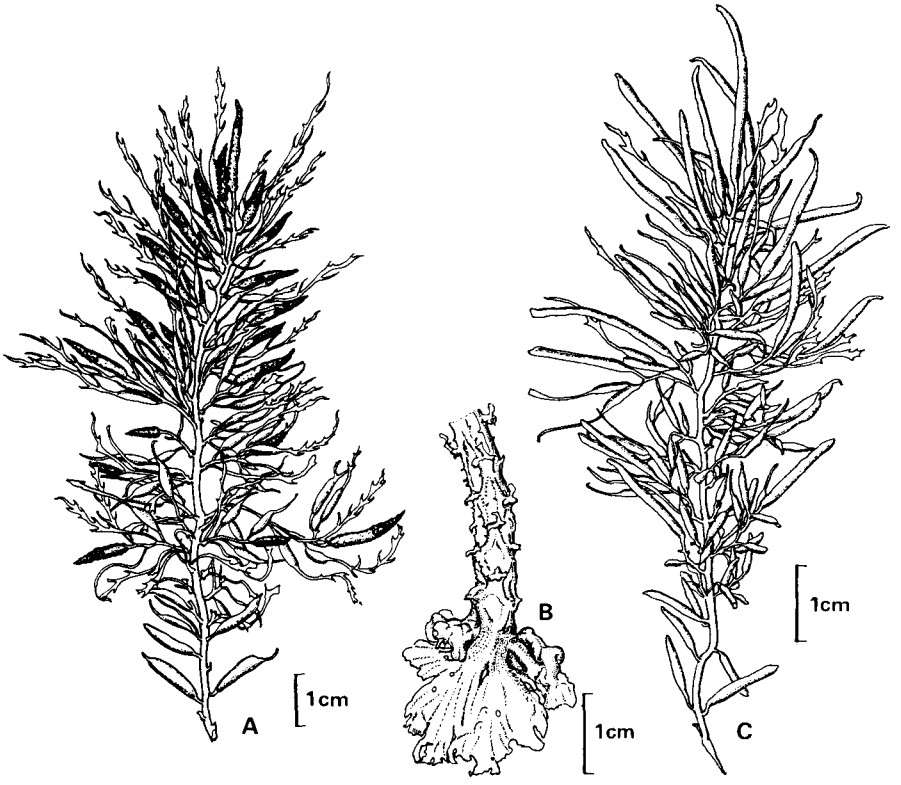

Fig. 6. *Sargassum horneri* (TURNER) C. AGARDH. A, terminal part of female plant with receptacle. B, basal part with scutellate holdfast and a stem. C, terminal part of male plant with receptacle.

Sargassum horneri var. *furcatodentatum* (O. KUNTZE) GRUNOW 1915 : 341.

Sargassum horneri f. *minus-dentatum* GRUNOW 1915 : 341. Type not located "ad oras orientales Japoniae".

Japanese name : Aka-moku.

Thallus often reaching several meters high. Holdfast scutellate dics up to 3 cm in diameter, constructed by radiating protuberances from the basal part of the stem (Fig. 6 B). A single stem arising on top of the holdfast, unbranched, angulate with longitudinal furrows, 3–5 mm wide. Many spinal processes, simple or forked, 1–2 mm long, ornamenting the stem surface and petiole of lower leaf. Spines torn off later. Branches always formed in axil of subtending leaf which soon dropped off. Lower leaf lanceolate to linear in shape with obtuse apex, 7 cm long and 1.5 cm wide, more or less conspicuously pinnatisected with rounded sini. The sini often reaching the

percurrent midrib. Segments of pinnatisected leaf directed slightly upward, truncated or dentate at the apices, or sometimes narrow segments once or twice digitately or dichotomously divided. The lower leaf weakly retroflexed at the insertion to the stem, with petiole slightly dilate to stipule-like expansion at the base. Leaf on the upper part of the branch becoming narrower, often deeply alternato-pinnatisected and the segments almost filiform and ascending. Leaves delicate membranaceous in substance. Cryptostome absent. Vesicle terete, 1-1.5 cm long and 2-3 mm in diameter, ending downward to a short stipe and upward to a sessile or petiolated simple serrated or pinnatisected coronal leaf.

The plant dioecious. Receptacle terete, shortly stipitate, tapering upward. Female receptacle 2-3 cm long and 3 mm in diameter. Male one 4-7 cm long and 2 mm in diameter, often slightly curved. Receptacle formed at first terminally on branchlet, and later smaller ones arising in basipetal order resulting in a raceme. Maturation in winter to early spring in the southern part of its distribution, and in summer in northern extreme.

This species grows in the subtidal zone. An annual species.

Specimens examined: HOKKAIDO: Muroran, Iburi Prov., Jul. 6, 1958, leg. T. FUNANO, SAP 034453; Shirakami, Oshima Prov., Apr. 7, 1947, leg. M. KUROGI, SAP 025592; Esashi, Hiyama Prov., Apr. 26, 1978, leg. T. YOSHIDA, SAP 034450; Okushiri-jima, Hiyama Prov., Jul. 8, 1943, leg. Y. HASEGAWA, SAP 025116; Tomari, Shiribeshi Prov., Aug. 3, 1954, leg. Y. TSUJI, SAP 034818; Oshoro, Shiribeshi Prov., Jul. 9, 1982, leg. T. YOSHIDA, SAP 042202; Teuri-jima, Rumoi Prov., Aug. 20, 1960, leg. I. YAMADA, SAP 035394.
HONSHU: Kuji, Iwate Pref., Jul. 22, 1952, leg. S. KAWASHIMA, SAP 026895; Ozuchi, Iwate Pref., Jul. 24, 1979, leg. T. YOSHIDA, SAP 034714-5; Onagawa, Miyagi Pref., Jul. 1935, leg. Y. YAMADA, SAP 034445; Enoshima, Miyagi Pref., Jul. 31, 1974, leg. T. YOSHIDA, SAP 031220-1; Matsushima, Miyagi Pref., Apr. 18, 1965, leg. T. YOSHIDA, SAP 035267; Matsugahama, Miyagi Pref., Mar. 28, 1978, leg. T. YOSHIDA, SAP 034448; Nagasaki, Fukushima Pref., Jul. 12, 1976, leg. T. YOSHIDA, SAP 034443; Kawarako, Ibaraki Pref., May 17, 1935, leg. S. KAWABATA, SAP 042044; Kominato, Chiba Pref., Mar. 30, 1978, leg. T. YOSHIDA, SAP 034446; Futomi, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 042077; Nemoto, Chiba Pref., May 10, 1955, leg. Y. TSUJI, SAP 042052; Tateyama, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 042071; Jyogashima, Kanagawa Pref., Apr. 28, 1979, leg. T. YOSHIDA, SAP 034665-6; Misaki, Kanagawa Pref., Jan. 15, 1962, leg. Y. YAMADA, SAP 028772; Aburatsubo, Kanagawa Pref., Apr. 1942, leg. Y. YAMADA, SAP 026493; Zushi, Kanagawa Pref., Dec. 29, 1977, leg. H. MOROHOSHI, SAP 034434; Hayama, Kanagawa Pref., Apr. 7, 1969, leg. T. YOSHIDA, SAP 034435; Chojyagasaki, Kanagawa Pref., Apr. 3, 1981, leg T. YOSHIDA, SAP 035497; Kamakura, Kanagawa Pref., Apr. 5, 1969, leg. T. YOSHIDA, SAP 034436; Shimoda, Shizuoka Pref., June 27, 1981, leg. Y. YOKOHAMA, SAP 035711; Okue, Shizuoka Pref., June 3, 1981, leg. F. HAYASHIDA, SAP 035721; Sugashima, Mie Pref., Apr. 24, 1955, leg. Y. TSUJI, SAP 042005; Wagu, Mie Pref., Apr. 25, 1955, leg. Y. TSUJI, SAP 042004; Hamashima, Mie Pref., May 11, 1979, leg. T. YOSHIDA, SAP 034668; Goza, Mie Pref., May

11, 1979, leg. T. YOSHIDA, SAP 034670; Nagashima, Mie Pref., May 13, 1979, leg. T. YOSHIDA, SAP 034669; Kushimoto, Wakayama Pref., Apr. 1933, leg. K. INAGAKI, SAP 010569; Mihama, Wakayama Pref., May 15, 1969, leg. T. YAMAMOTO, SAP 034441; Suma, Hyogo Pref., Mar. 18, 1931, leg. K. UNO, SAP 034440; Ichinotani, Hyogo Pref., Feb. 7, 1933, leg. K. UNO, SAP 034439; Kako-gun, Hyogo Pref., Mar. 17, 1936, leg. K. UNO, SAP 034438; Yoshimi, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034422; Futami, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034421; Kiwato, Yamaguchi Pref., Apr. 23, 1979, leg. T. YOSHIDA, SAP 034667; Omi-jima, Yamaguchi Pref., June 8, 1978, leg. T. YOSHIDA, SAP 034417; Tatamigaura, Shimane Pref., June 9, 1978, leg. T. YOSHIDA, SAP 034416; Hinomisaki, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 034418; Uppurui, Shimane Pref., Mar. 28, 1933, leg. Y. IKOMA, SAP 014445; Katsura-jima, Shimane Pref., May 21, 1982, leg. S. KAWAGUCHI, SAP 042203; Shichirui, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 034420; Kasumi, Hyogo Pref., June 11, 1978, leg. T. YOSHIDA, SAP 034419; Tango, Kyoto Pref., May 18, 1982, leg. S. KAWAGUCHI, SAP 042205; Kammuri-jima, Kyoto Pref., Apr. 9, 1981, leg. H. KAWAI, SAP 035496; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 034415; Ohwi, Fukui Pref., Sept. 23, 1981, leg. M. OHTA, SAP 042076; Wajima, Ishikawa Pref., Aug. 27, 1934, leg. T. MURAOKA, SAP 034938; Ogi, Ishikawa Pref., May 6, 1962, leg. S. FUNAHASHI, SAP 034413; Ushitsu, Ishikawa Pref., May 23, 1976, leg. K. TANIGUCHI, SAP 042026; Takenoura, Ishikawa Pref., May 15, 1982, leg. S. KAWAGUCHI, SAP 042204; Kashiwazaki, Niigata Pref., June 1981, leg. H. ISHIBASHI, SAP 035730; Sado, Niigata Pref., Mar. 31, 1956, leg. M. NODA, SAP 034427; Awashima, Niigata Pref., June 19, 1957, leg. M. NODA, SAP 034425; Oga, Akita Pref., June 21, 1959, leg. S. FUNAHASHI, SAP 034412; Toga, Akita Pref., Apr. 23, 1982, leg. M. TSUKIDATE, SAP 042130-1; Fukaura, Aomori Pref., June 17, 1955, leg. S. KAWASHIMA, SAP 034894; Tanosawa, Aomori Pref., Nov. 29, 1982, leg. M. NOTOYA, SAP 043282; Horotsuki, Aomori Pref., Jul. 23, 1956, leg. S. KAWASHIMA, SAP 034424; Asamushi, Aomori Pref., Jul. 1929, leg. S. INOH, SAP 8344; Ohma, Aomori Pref., June 30, 1976, leg. M. SAWADA, SAP 034444; Shimofuro, Aomori Pref., Mar. 28, 1956, leg. S. KAWASHIMA, SAP 028679.

SHIKOKU: Kozuchi-jima, Kagawa Pref., Oct. 31, 1962, leg. T. YAMAMOTO, SAP 034433; Ikata, Ehime Pref., May 16, 1956, leg. Y. NOMURA, SAP 034432; Misaki, Ehime Pref., Mar. 4, 1981, leg. MORI, SAP 035718; Toshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 042170; Totoshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 042171; Karitsu, Ehime Pref., May 22, 1982, leg. T. YOSHIDA, SAP 042169.

KYUSHU: Tsukumi, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 035746; Saganoseki, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 035758; Sumiyoshi, Oita Pref., June 3, 1981, leg. T. YOSHIDA, SAP 035739; Ryozaki, Oita Pref., June 3, 1981, leg. T. YOSHIDA, SAP 035743; Hime-shima, Oita Pref., June 4, 1981, leg. T. YOSHIDA, SAP 035764; Dairi, Fukuoka Pref., Mar. 15, 1930, leg. T. YOSHIOKA, SAP 021024; Iwaya, Fukuoka Pref., Apr. 5, 1978, leg. T. YOSHIDA, SAP 034408-9; Tsuyazaki, Fukuoka Pref., Oct. 15, 1977, leg. T. YOSHIDA, SAP 034407; Keya, Fukuoka Pref., Apr. 2, 1932, leg. SUGINO, SAP 034405; Chiga-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043711; Imari, Saga Pref., Aug. 2. 1979, leg. T. YOTSUI, SAP 034729; Hirado-jima, Nagasaki Pref., May 25, 1983, leg. T. YOSHIDA, SAP 043770; Nomozaki, Nagasaki Pref., Mar. 30, 1970, leg. M. MASUDA, SAP 041986; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 043602; Tomioka, Kumamoto Pref.,

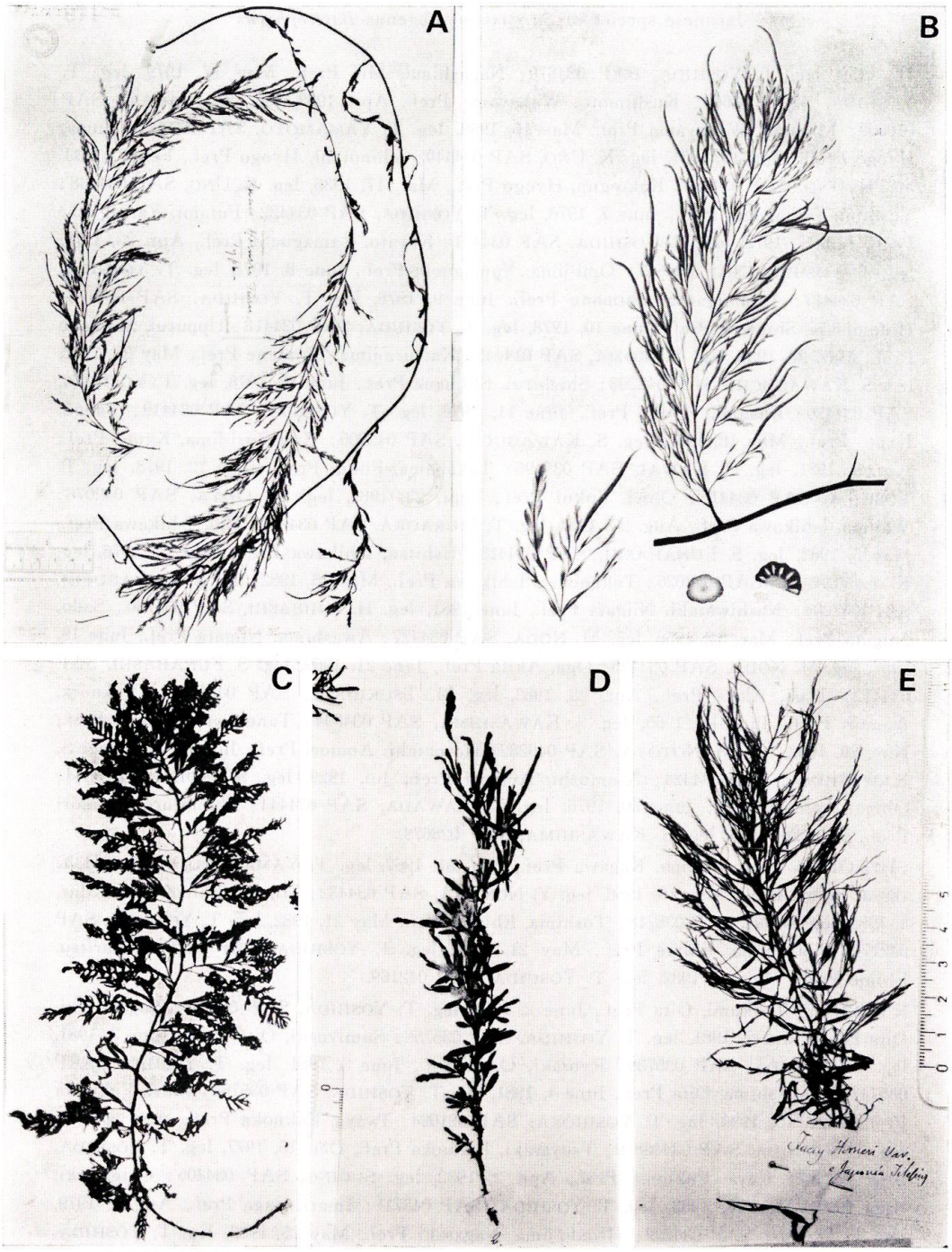

Fig. 7. A. Lectotype of *Fucus horneri* TURNER. "In the straits of Corea, Dr. HORNER" BM(K). B. Illustration of *Fucus horneri* TURNER, Hist. Fuc. Pl. 17. C. Lectotype of *Sargassum polyodonthum* J. AGARDH. "Goto, Japan, PETERSEN". LD, Herb. Agardh No. 2880. D. Lectotype of *Sargassum spathulatum* J. AGARDH. "Japan, C. WRIGHT" LD, Herb. Agardh No. 2877. E. Lectotype of *Sargassum horneri* var. *densum* C. AGARDH. "e mari Japoniae, TILESIUS" LD, Herb. Agardh No. 2867.

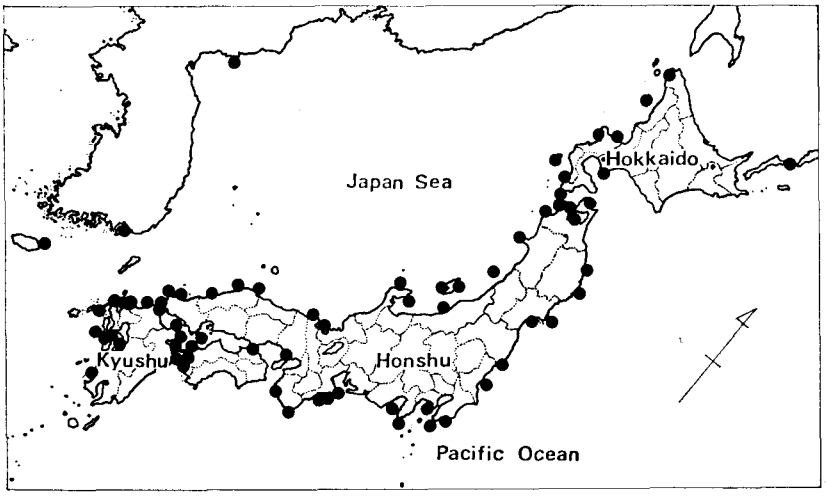

Fig. 8. Distribution of *Sargassum horneri* compiled from the specimens in SAP.

May 11, 1940, leg. S. INOH, SAP 021795; Misumi, Kumamoto Pref., Feb. 27, 1959, leg. M. ICHIKI, SAP 034843; Ushinohama, Kagoshima Pref., June 13, 1980, leg. T. YOSHIDA, SAP 034791.

KURILE ISLANDS: Kunashiri, Aug. 1, 1929, leg. M. NAGAI, SAP 022002.

KOREA: Cheju Island, Apr. 25, 1974, leg. I. K. LEE, SAP 034606; Pusan, Mar. 12, 1935, leg. M. NODA, SAP 043896; Shimpo, Jan. 1901, leg. H. KATO, SAP Herb. OKAMURA.

This species is one of the most common species around Japan. Although dioecism is usually confirmed for this species, OKUDA (1979) reported monoecious individuals collected at Tsuyazaki, Fukuoka Pref. Male conceptacles occupied proximal part of a receptacle. Hermaphrodite conceptacles were also observed.

The lectotype (Fig. 7 A) is a fragment of male individual, now deposited in BM (K). TURNER's illustration (Fig. 7 B), somewhat different from the type specimen, is sufficient to identify our plant to this species. Its elongated stem, pinnatisected leaf, cylindrical vesicle and big receptacles are quite distinct in the genus. An only resembling species is *S. filicinum* HARVEY, which is easily discriminated by its spherical to elliptical vesicle and monoecism. Size and form of leaf are very variable. Even when compared the basal leaves of young stem, one extreme is that the leaf pinnatisected deeply to midrib throughout the whole length, and the pinnae are narrowly linear, once or twice dichotomously or digitately divided. This type of leaf is clearly seen in the lectotype of *S. polyodonthum* J. AGARDH (Fig. 7 C) and *S. horneri* f. *furcatodentatum* KUNTZE (1880, pl. 2, f. 25). Other extreme is those

with shallowly pinnatisected leaf often encountered in the population from Pacific coast of Honshu. This state is represented by the lectotype of *S. spathulatum* J. AGARDH (Fig. 7 D) and figures given by YENDO (1907, pl. 10, f. 1) and OKAMURA (1923, pl. 202, f. 1). Subspecific distinction basing on the leaf form needs further study.

S. horneri var. *densum* C. AGARDH is lectotypified by a specimen (Fig. 7 E), which is a terminal part of an individual with very narrow leaves. As for *S. horneri* f. *minus-dentata* of GRUNOW, I cannot make any comment until the specimen is examined.

2. *Sargassum filicinum* HARVEY 1859 : 327. (Figs. 9–10)

J. AGARDH 1889 : 58. DE TONI 1895 : 21. OKAMURA 1902 : 145 ; 1916 : 199 ; 1936 : 329. YENDO 1907 : 80, *pl. 12, f. 9*. GRUNOW 1915 : 341. SAWADA 1955 : 71, *f. 1–2* ; 1956 : 541, *f. 1–2*. SEGAWA 1956 : 49, *pl. 28*, No. 217. DAWSON 1959 : 5, *pl. 1*. OKUDA 1977 : 265, *f. 1*. Lectotype : TCD "East coast of Japan, C. WRIGHT" (Fig. 9 A). Iso(?) types : LD (Herb. Agardh No. 2878), BM (K), PC.

Sargassum fengeri J. AGARDH 1889 : 58. DE TONI 1895 : 21. Lectotype : LD (Herb. Agardh No. 2874 "Ad insulam extra ostia Amuris, leg. Navarsha FENGER 1868") (Fig. 9 C).

Japanese name : Shida-moku (YENDO)

Thallus usually attaining several meters high. Holdfast scutellate, up to 2 cm in diameter, constructed by radiating finger-like protuberances growing out from the basal part of the stem. Stem simple, upright, 5 mm wide, angular with shallow longitudinal furrows, ornamented with spinal processes, simple or once forked, about 1 mm long. Spines deciduous. Lateral branches always arising in axil of subtending leaves, shorter in length than the stem. Leaf spirally disposed with 2/5 divergence of phyllotaxis, slightly retroflexed at the base, linear lanceolate in outline with obtuse apex, 7 cm long and 1 cm wide, alternately pinnately dissected, with the sini being round and deep to the midrib. Segments of pinnatisected leaf ascending, sometimes shallowly dentate at apices. Midrib slightly elevated and sharply defined, vanishing near the apex. Cryptostome absent. Vesicle spherical to fusiform in shape, 3–4 mm in diameter, shortly stipitate, with coronal leaf similar to leaves on the stem.

Plant monoecious. Receptacle terete, 2–4 cm long and 2–4 mm in diameter according to sexual condition. Receptacle thicker when female conceptacles predominated and in slender part only male conceptacles observed. Male conceptacles located in proximal part and female ones in more distal part of the androgynous receptacle. Hermaphrodite conceptacle often mixed. Proportion of male and female regions variable even in the same individual. Receptacle formed at first terminal to small branchlet axil to subtending leaf,

and later smaller receptacles often produced basipetally assuming racemose disposition. Maturation period late spring to summer.

This species grows in the subtidal zone down to 20 m deep. An annual species.

Specimens examined: HONSHU: Nabeta, Shizuoka Pref., Sept. 12, 1954, leg. M. CHIHARA, SAP 027495; Shirahama, Wakayama Pref., June 18, 19—, leg. T. YAMAMOTO, SAP 034403; Kada, Wakayama Pref., May 1937, leg. K. SAKAGUCHI, SAP 025450; Tarumi, Hyogo Pref., May 29, 1961, leg. T. YAMAMOTO, SAP 034402; Kako-gun, Hyogo Pref., Mar. 1936, leg. S. UNO, SAP 034400; Mishima, Yamaguchi Pref., Aug. 8, 1969, leg. N. KAKUDA, SAP 034586; Tatekabe, Ishikawa Pref., Aug.1, 1962, leg. S. FUNAHASHI, SAP 034399.
SHIKOKU: Uwajima, Ehime Pref., Apr. 13, 1981, leg. S. OUCHI, SAP 035715; Toshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 042177.
KYUSHU: Tsuyazaki, Fukuoka Pref., May 27, 1958, leg. S. SAWADA, SAP 031110; Hariojima, Nagasaki Pref., May 24, 1983, leg. T. YOSHIDA, SAP 043714.

After the original description by HARVEY (1859), this species was rather ambiguously known, until SAWADA (1955, 1956, 1958) and OKUDA (1977) added precise knowledge concerning the basal morphology and sexuality. According to him, sexual expression is somewhat variable in this species.

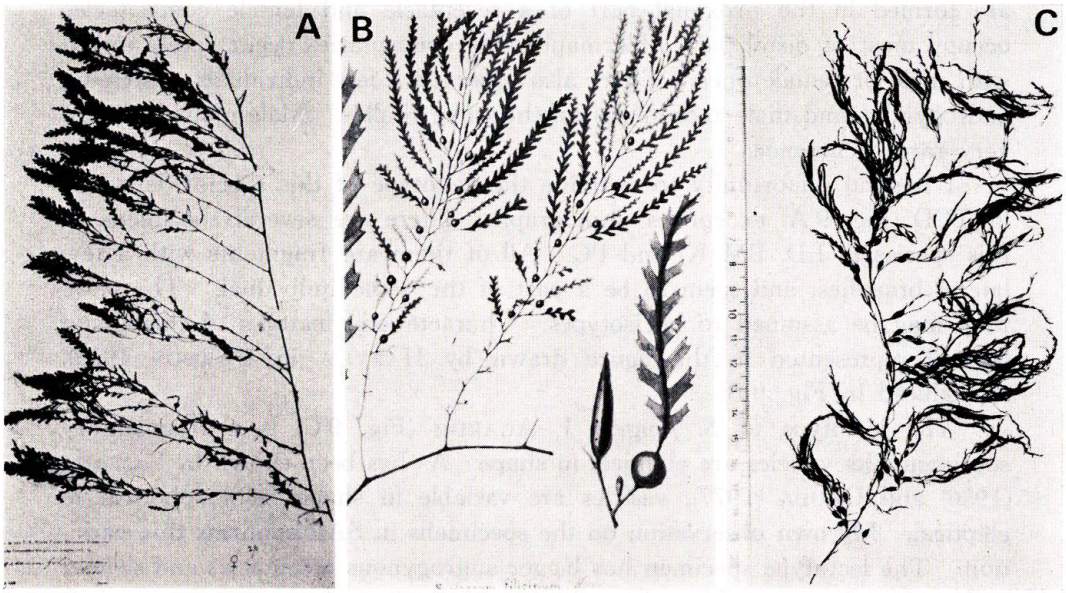

Fig. 9. A. Lectotype of *Sargassum filicinum* HARVEY. "East coast of Japan, C. WRIGHT" TCD. Reproduced from a photograph deposited in BM. B. Illustration of *Sargassum filicinum* HARVEY, taken from DAWSON (1959). C. Lectotype of *Sargassum fengeri* J. AGARDH. "ad insulam extra ostia Amuris, leg. Navarsha FENGER 1868" LD, Herb. Agardh No. 2874.

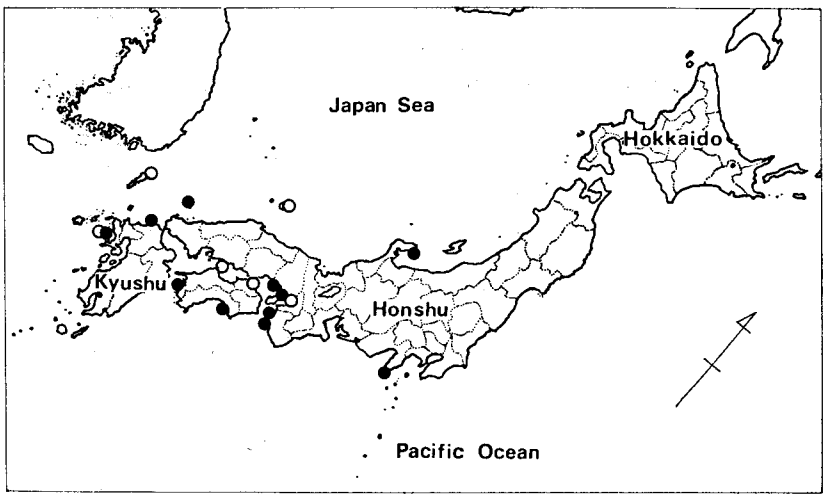

Fig. 10. Distribution of *Sargassum filicinum*. Solid circles represent specimens in SAP, and open circles from OKUDA (1977).

Most common individuals are said to be androgynous, *i. e.*, male conceptacles are formed in the proximal part of a receptacle and female conceptacles occupy most of distal part. Hermaphrodite conceptacles occur rarely mixed with male or female ones. There also observed a few individuals possessing androgynous and male receptacles on the same thallus. Male individuals are very rare occurrence.

I had no opportunity to examine the lectotype of this species deposited in TCD (Fig. 9 A) except its photograph. There are several specimens of this species in LD, BM (K) and PC. All of them are fragments with a few lateral branches, and seem to be a part of the same individual. Therefore they may be assumed to be isotypes. Characteristic features of this taxon is well represented in the figure drawn by HARVEY (in DAWSON 1959), reproduced in Fig. 9 B.

The lectotype of *S. fengeri* J. AGARDH (Fig. 9 C) is a fragmentary specimen. Its vesicles are elliptical in shape. As has been shown by SAWADA (1956) and OKUDA (1977), vesicles are variable in shape from spherical to elliptical. My own observation on the specimens in SAP confirms this variation. The lectotype specimen has bigger angrogynous receptacles and slender male ones. In spite of usual attribution of *S. fengeri* as a synonym of *S. horneri*, I propose here to treat *S. fengeri* as synonymous with *S. filicinum*.

Section ***Teretia*** YOSHIDA, sect. nov.

Caulis erectus, plus minusve abbreviatus, ramo principali semper brevior,

ramus principalis angulatus, receptaculum teres. Species typicus: *S. confusum* C. AGARDH.

Stem erect, more or less abbreviated, always shorter than main branches, main branch angulate, receptacle terete.

3. ***Sargassum microceratium*** (TURNER) C. AGARDH 1820: 35.

(Figs. 11–13)

C. AGARDH 1824: 306. J. AGARDH 1848: 295; 1896: 59. DE TONI 1895: 114. GRUNOW 1915: 352. OKAMURA 1936: 322.

Fucus microceratius TURNER 1809: 152, *pl. 130*. C. AGARDH 1815: 45. MERTENS 1828: 11. Lectotype: BM "e japonia, HORNER" (Fig. 12 A).

Myagropsis microceratia (TURNER) KÜTZING 1849: 635; 1860: 33, *pl. 94, f. 1*.

Japanese name: Fushi-ito-moku (OKAMURA)

Thallus usually less than 1 m high. Holdfast complanated discoid, up to 3 cm in diameter. Stem usually solitary, upright, becoming 20 cm long, slightly compressed, 3–4 mm wide. In the individuals several years old, scars of fallen main branches giving a knotty appearance to the stem. Main branches issued alternately in one plane, slightly compressed or angulate, 2 mm wide. Spinal processes rarely present on the main branch. Lateral branches formed abundantly. Leaf always filiform, 3–4 cm long and less than 0.5 mm wide. Cryptostomata conspicuous, giving a knotty appearance to the leaf. Vesicle spherical to obovoid in shape, up to 3 mm in diameter, shortly stipitate, with round apex, often numerously formed on the basal part of lateral branches.

Plant dioecious. Female and male receptacles terete, tapering towards the apex, 5 mm long and 1 mm in diameter. Receptacle disposed racemosely or paniculately on the upper part of branches, usually with linear bracteal leaf except terminal ones. Receptacle usually simple, sometimes with proliferated small receptacle on the surface. Maturation in spring to early summer.

This species grows subtidally down to 20 m deep or more.

Specimens examined: HONSHU: Ohma, Aomori Pref., June 30, 1976, leg. M. SAWADA, SAP 034398; Kawauchi, Aomori Pref., June 1, 1940, anonym., SAP 034395; Fukaura, Aomori Pref., June 22, 1978, leg. T. YOSHIDA, SAP 034393; Yanagisawa, Sado, Niigata Pref., Mar. 31, 1956, leg. M. NODA, SAP 034396; Tassha, Sado, Niigata Pref., Nov. 20, 1955, leg. M. NODA, SAP 034397; Kashiwazaki, Niigata Pref., June 1, 1981, leg. H. ISHIBASHI, SAP 035732; Amaharashi, Toyama Pref., May 1931, leg. K. OSHIMA, SAP Herb. Okamura; Ushitsu, Ishikawa Pref., June 19, 1976, leg. K. TANIGUCHI, SAP 042023; Shinpo, Ishikawa Pref., Mar. 7, 1963, leg. S. FUNAHASHI, SAP 043291; Rokugo-zaki, Ishikawa Pref., May 15, 1982, leg. S. KAWAGUCHI, SAP 042183; Shibagaki, Ishikawa Pref., Aug. 1938, leg. KUMA-

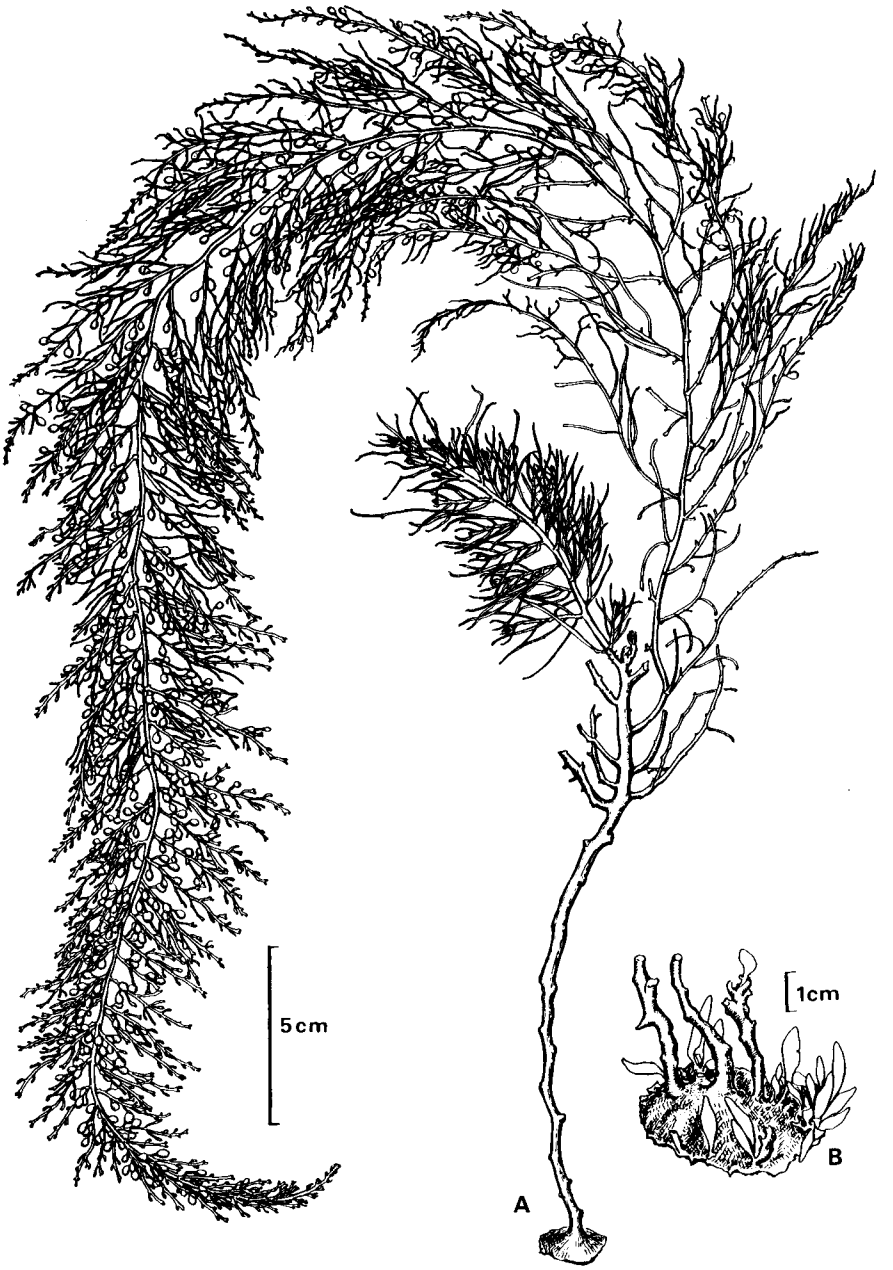

Fig. 11. *Sargassum microceratium* (TURNER) C. AGARDH. A, whole plant. B, basal part with adventitious shoots from holdfast.

ZAWA, SAP 021357; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 034394. KOREA: Genzan, Sept. 5, 1934, leg. NISHIOKA, SAP 043904.

SETCHELL (1933 a) stated that he could not locate the type of *Fucus microceratius* TURNER in the herbarium of Kew Garden (K). In BM, there are 2 sheets of specimen of this taxon. One of which indicated as Iso/Syntype seems to be used for TURNER's illustration (Fig. 12 B) and it is appropriate to designate this specimen (Fig. 12 A) as the lectotype. This is a small fragment with receptacles. The other sheet has a label 'e mari coreano' and there is a very poor fragment on it. Identity of this latter specimen is difficult to determine, as YENDO annotated that "This specimen is quite impossible to determine". There are 3 sheets of specimen of this taxon in PC, and a specimen in LD (Herb. Agardh No. 3225 "e japonia, TILESIUS"). These specimens are all fragmentary, but the identity is clear.

This species was variously treated as for the subgeneric placement in

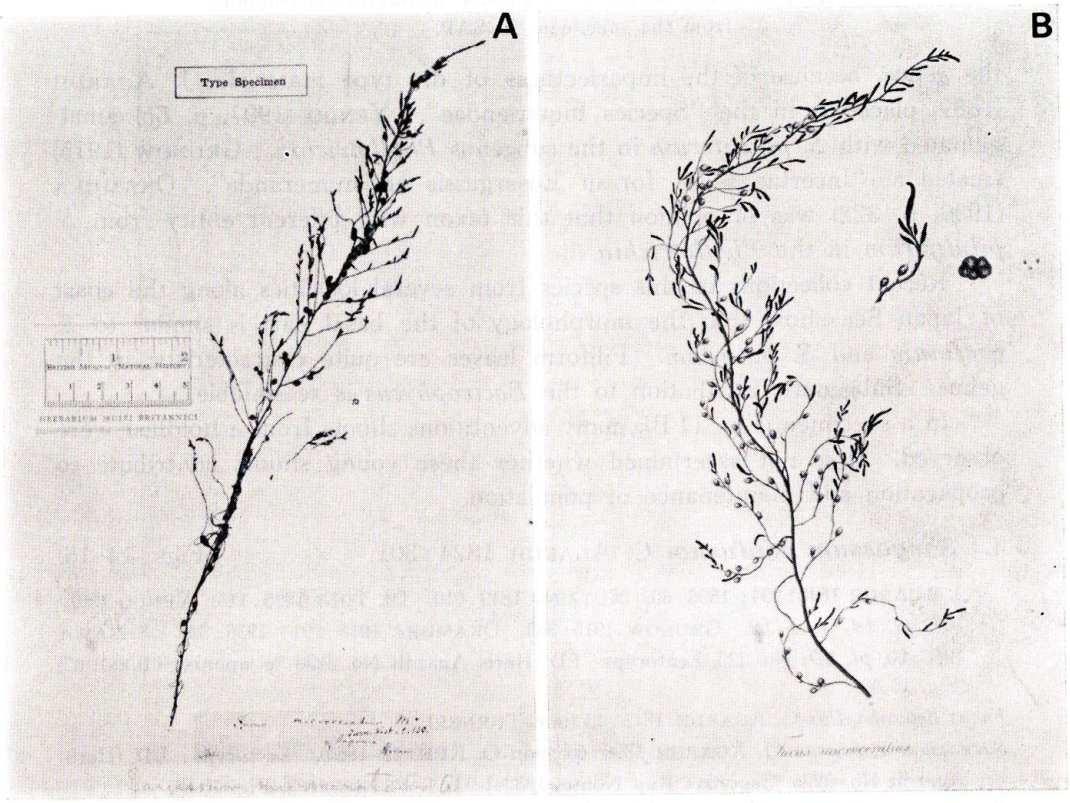

Fig. 12. A. Lectotype of *Fucus microceratius* TURNER. "e japonia, HORNER" BM.
B. Illustration of *Fucus microceratius* TURNER, Hist. Fuc. Pl. 130.

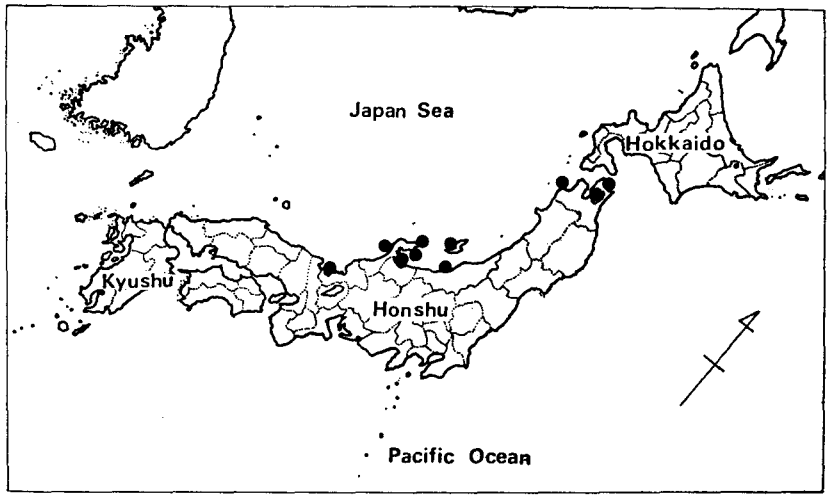

Fig. 13. Distribution of *Sargassum microceratium* compiled from the specimens in SAP.

the genus, because of the imperfectness of the type material. J. AGARDH (1889) placed it in the "Species Inquiriendae". YENDO (1907, p. 55) amalgamated with *S. piluliferum* in the subgenus *Phyllotrichia*. GRUNOW (1915) treated as "Incertae sedis, forsan Eusargassis ad numeranda". OKAMURA (1936, p. 322) was of opinion that this taxon was different entity from *S. piluliferum* in the *Phyllotrichia*.

Recent collections of this species from several localities along the coast of Japan Sea show that the morphology of the basal part is similar to *S. confusum* and *S. pallidum*. Filiform leaves are quite characteristic in the genus. Subgeneric attribution to the *Bactrophycus* is reasonable.

In a specimen (Fig. 11 B), many adventitious shoots from a holdfast were observed. It is not ascertained whether these young shoots contribute to propagation and maintenance of population.

4. *Sargassum confusum* C. AGARDH 1824 : 301. (Figs. 14-16)

J. AGARDH 1848 : 294 ; 1896 : 60. KÜTZING 1849 : 610. DE TONI 1895 : 115. YENDO 1907 : 106, *pl. 14, f. 1-12*. GRUNOW 1915 : 353. OKAMURA 1916 : 201 ; 1936 : 335. SEGAWA 1956 : 50, *pl. 29*, No. 223. Lectotype : LD (Herb. Agardh No. 3230 "e japonia, TILESIUS") (Fig. 15 A).

Fucus heterophyllus C. AGARDH 1815 : 43 (non TURNER).

Sargassum expansum J. AGARDH 1896 : 60 (non O. KUNTZE 1880). Lectotype : LD (Herb. Agardh No. 3226 "Japonia : Kap Nomo, 1882-1-11, J. PETERSEN") (Fig. 15 B).

Sargassum validum J. AGARDH 1896 : 59. Lectotype : LD (Herb. Agardh No. 3217 "Hakodate : Shirisawabe, 1881-11-8, J. PETERSEN") (Fig. 15 C).

Sargassum confusum f. *validum* (J. AGARDH) YENDO 1905 : 160 ; 1907 : 108, *pl. 14, f. 8-12.* OKAMURA 1916 : 202 ; 1936 : 335.

Sargassum confusum var. *papillata* GRUNOW 1915 : 354. Type not located "ad oras Japoniae".

Sargassum fulvellum sensu YENDO 1907 : 92, *pl. 13, f. 18-20.*

Sargassum turneri YENDO in OKAMURA 1916 : 201 (non O. KUNTZE 1880). Type not designated.

Japanese name : Fushi-suji-moku (OKAMURA)

Thallus more than 2 m high when well grown. Holdfast discoid, up to 2 cm in diameter. Stem upright, terete or slightly compressed, up to 20 cm high and 3-5 mm wide, simple usually without branching. Spinal processes about 1 mm long often formed on the stem when young, later they dropped off. Main branches issued more or less alternately in one plane, angular, 2-3 mm wide, beset with spinal processes which later dropped off. Lateral branches well developed. Leaf issued spirally with a phyllotaxis of 2/5 on the branches. Lower leaves elliptical to lanceolate up to 10 cm long and 1.5 cm wide, shortly stipitate, with round or acute apex, coriaceous in substance, usually dark brown in color in drying. Margin entire or minutely serrulate. Midrib immersed, reaching to the apex. On the distal part of the main branch and on lateral branches leaves becoming smaller and narrower to linear in shape with evanescent midrib and nearly entire margin. Cryptostomata scattered on the leaf surface. Vesicle spherical to pyriform, shortly stipitate, with round apex, up to 5 mm in diameter.

Plant dioecious. Receptacle terete, shortly stipitate, tapering upwards, disposing racemosely. Female receptacle 3-4 mm long and 1-1.1 mm in diameter. Male one longer than the female, 10-15 mm long. Maturation in spring to early summer in the southern part of its distribution, in summer in northern areas.

This species grows on rock and stones in the upper subtidal zone.

Specimens examined : HOKKAIDO : Hidaka Prov., Jul. 13, 1930, anonym., SAP 042053 ; Muroran, Iburi Prov., Apr. 2, 1935, leg. T. MURAOKA, SAP 023172 ; Date, Iburi Prov., Apr. 12, 1980, leg. S. JIN, SAP 042040 ; Esan, Oshima Prov., May 5, 1977, leg M. OHTA, SAP 034269 ; Kikonai, Oshima Prov., May 4, 1977, leg. M. OHTA, SAP 034270 ; Yamase-domari, Oshima Prov., June 22, 1931, leg. Y. YAMADA, SAP 011167-9 ; Shirakami, Oshima Prov., Apr. 25, 1978, leg. T. YOSHIDA, SAP 034266-7 ; Matsumae, Oshima Prov., May 3, 1977, leg. M. OHTA, SAP 034271 ; Esashi, Hiyama Prov., Apr. 8, 1940, leg. Y. YAMADA, SAP 021726 ; Okushiri-jima, Hiyama Prov., Jul. 2, 1943, leg. Y. HASEGAWA, SAP 025119 ; Tomari, Shiribeshi Prov., Aug. 3, 1954, leg. Y. TSUJI, SAP 034819 ; Ran-shima, Shiribeshi Prov., Jul 29, 1929, leg. S. AKIYAMA, SAP 7849 ; Oshoro, Shiribeshi Prov., June 23, 1931, leg. K. INAGAKI, SAP 014112 ; Zenibako, Shiribeshi Prov., Jul. 16, 1946, leg. Y. SAKAI, SAP 042059 ; Mashike Rumoi Prov., June 30, 1943, leg. T. TANAKA, SAP 034919 ; Reuke, Rumoi Prov., Feb. 14, 1970, leg. I. YAMADA, SAP 035416 ; Yagishiri-to, Rumoi Prov., Aug. 1960, leg. I. YAMADA,

Fig. 14. *Sargassum confusum* C. AGARDH.

SAP 035402; Teuri-jima, Rumoi Prov., Aug. 8, 1943, leg. T. TANAKA, SAP 034918; Rebunto, Soya Prov., Jul. 31, 1953, leg. I. UMEZAKI, SAP 034238; Bakkai, Soya Prov., May 19, 1978, leg. T. YOSHIDA, SAP 034264; Chishiya, Soya Prov., May 19, 1978, leg. T. YOSHIDA, SAP 034265; Nosyappu-misaki, Soya Prov., Aug. 28, 1924, leg. J. IKARI, SAP 034272; Soya-misaki, Soya Prov., May 14, 1979, leg. H. KAWAI, SAP 034737; Menashi-domari, Soya Prov., May 15, 1979, leg. H. KAWAI, SAP 034736; Saruru, Abashiri Prov., May 15, 1979, leg. H. KAWAI, SAP 034735; Notoro-misaki, Abashiri Prov., Jul. 23, 1979, leg. H. KAWAI, SAP 034738; Shiretoko-misaki, Nemuro Prov., Sept. 15, 1933, leg. Y. YAMADA, SAP 024415; Rausu, Nemuro Prov., Jul. 1936, leg. T. TANAKA, SAP 034263.

HONSHU: Shobuta, Miyagi Pref., May 2, 1965, leg. T. YOSHIDA, SAP 035264; Shiogama, Miyagi Pref., Apr. 1929, leg. S. INOH, SAP 8532-4; Matsushima, Miyagi Pref., Jul. 29, 1977, leg. T. YOSHIDA, SAP 034711; Hirota, Iwate, Pref., June 2, 1954, leg. S. KAWASHIMA, SAP 027891; Ofunato, Iwate Pref., May 20, 1951, leg. S. KAWASHIMA, SAP 026893; Otsuchi-wan, Iwate Pref., Jul. 24, 1979, leg. T. YOSHIDA, SAP 034712; Miyako, Iwate Pref., Apr. 12, 1951, leg. S. KAWASHIMA, SAP 026892; Kuji, Iwate Pref., Jul. 22, 1952, leg. S. KAWASHIMA, SAP 026894; Same, Aomori Pref., Oct. 4, 1955, leg. M. ICHIKI, SAP 034852; Shimofuro, Aomori Pref., Aug. 4, 1955, leg. S. KAWASHIMA, SAP 034887; Oma, Aomori Pref., June 30, 1976, leg. M. SAWADA, SAP 034245; Asamushi, Aomori Pref., Oct. 5, 1955, leg. M. ICHIKI, SAP 034848; Tanosawa, Aomori Pref., May 27, 1982, leg. M. NOTOYA, SAP 043287; Odose, Aomori Pref., June 18, 1955, leg. S. KAWASHIMA, SAP 034885; Fukaura, Aomori Pref., June 21, 1978, leg. T. YOSHIDA, SAP 034253; Toga, Akita Pref., Apr. 23, 1982, leg. M. TSUKIDATE, SAP 042138; Funakawa, Akita Pref., Apr. 22, 1982, leg. M. TSUKIDATE, SAP 042136; Fukura, Yamagata Pref., Aug. 1951, leg. T. KANAMORI, SAP 034240; Tobi-shima, Yamagata Pref., Aug. 22, 1966, leg. S. KIKUCHI, SAP 034261; Awashima, Niigata Pref., June 19, 1957, leg. M. NODA, SAP 034243; Sado, Niigata Pref., Nov. 21, 1955, leg. M. NODA, SAP 034242; Iwagasaki, Niigata Pref., May 13, 1982, leg. S. KAWAGUCHI, SAP 042226; Kashiwazaki, Niigata Pref., June 3, 1981, leg. H. ISHIBASHI, SAP 035731; Nou, Niigaat Pref., June 1923, leg. Y. YAMADA, SAP 028289; Ushitsu, Ishikawa Pref., June 19, 1976, leg. K. TANIGUCHI, SAP 042033; Ogi, Ishikawa Pref., Aug. 23, 1967, leg. Y. NAKAMURA, SAP 034233; Shinpo, Ishikawa Pref., Mar. 7, 1963, leg. S. FUNAHASHI, SAP 028716; Rokugo-zaki, Ishikawa Pref., May 15, 1982, leg. S. KAWAGUCHI, SAP 042201; Hakui, Ishikawa Pref., no date, leg. T. KANAMORI, SAP 021386-8; Nagahashi, Fukui Pref., Aug. 8, 1942, leg. Y. NAKAMURA, SAP 034917; Obama, Fukui Pref., Aug. 24, 1961, leg. T. YAMAMOTO, SAP 034235; Ohwi, Fukui Pref., Sept. 23, 1981, leg. M. OHTA, SAP 042074; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 034254; Kammuri-jima, Kyoto Pref., Apr. 9, 1981, leg. H. KAWAI, SAP 035489; Kinosaki, Hyogo Pref., Nov. 3, 1962, leg. T. YAMAMOTO, SAP 034236; Kasumi, Hyogo Pref., June 11, 1978, leg. T. YOSHIDA, SAP 034258; Shichirui, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 034255; Etomo, Shimane Pref., May 22, 1982, leg. S. KAWAGUCHI, SAP 042200; Tatamigaura, Shimane Pref., June 9, 1978, leg. T. YOSHIDA, SAP 034257; Hagi, Yamaguchi Pref., Mar. 17, 1919, leg. S. NIKAI, SAP 2939; Omi-jima, Yamaguchi Pref., June 8, 1978, leg. T. YOSHIDA, SAP 034256; Yuya-wan, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034259; Mukai-shima, Hiroshima Pref., Aug. 1933, leg. T. TANAKA, SAP 034866; Shimotsui, Okayama Pref., Oct. 22, 1960, leg. S. INUMARU, SAP 028812; Kada, Wakayama Pref., Apr. 3, 1957, leg. T. YAMAMOTO, SAP 041944.

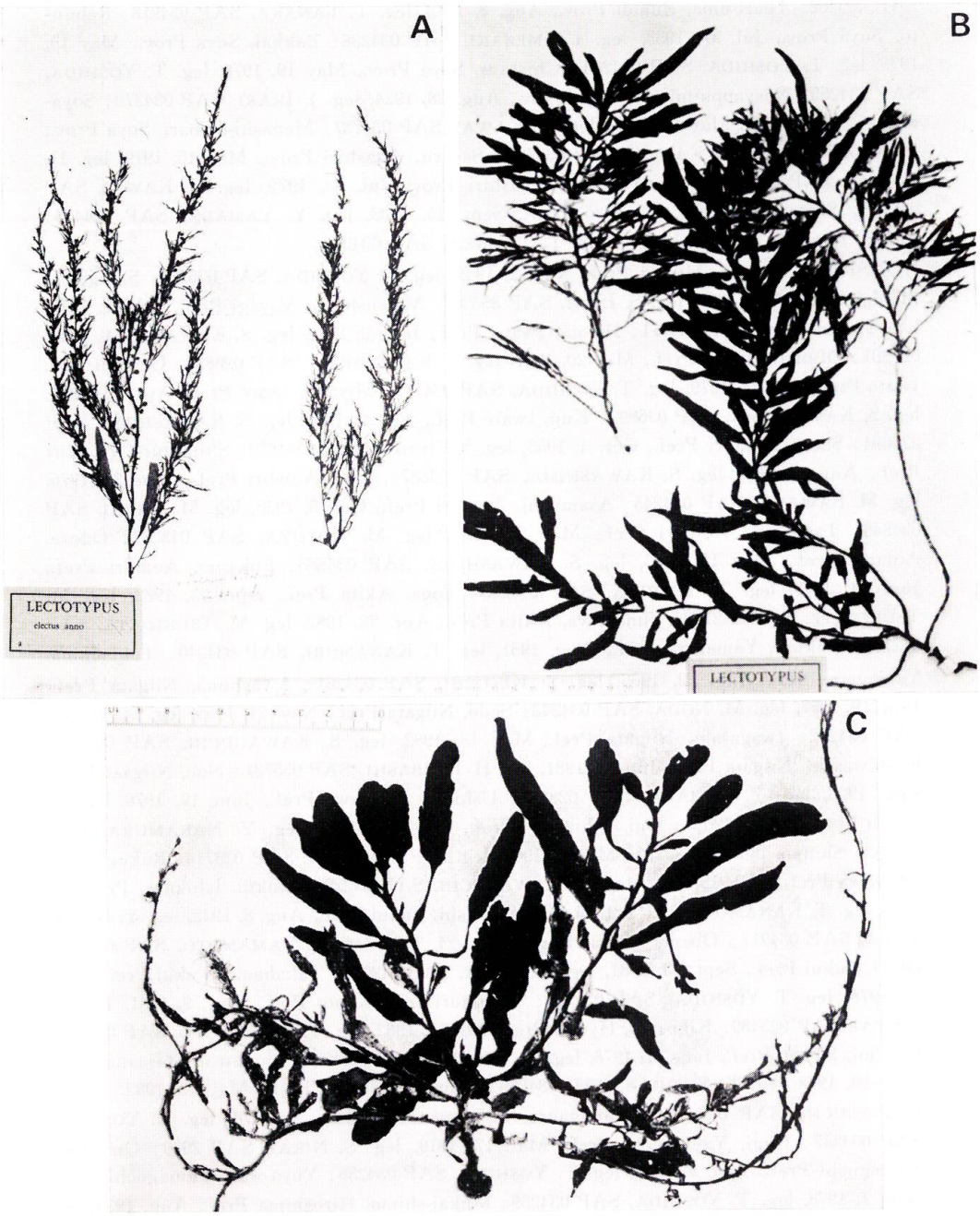

Fig. 15. A. Lectotype of *Sargassum confusum* C. AGARDH. "e Japonia, TILESIUS" LD, Herb. Agardh No. 3230. B. Lectotype of *Sargassum expansum* J. AGARDH. "Japonia: Kap Nomo, 1882-1-11, J. PETERSEN" LD, Herb. Agardh No. 3226. C. Lectotype of *Sargassum validum* J. AGARDH. "Hakodate, Shirisawabe, 1881-11-8, J. PETERSEN" LD, Herb. Agardh No. 3217.

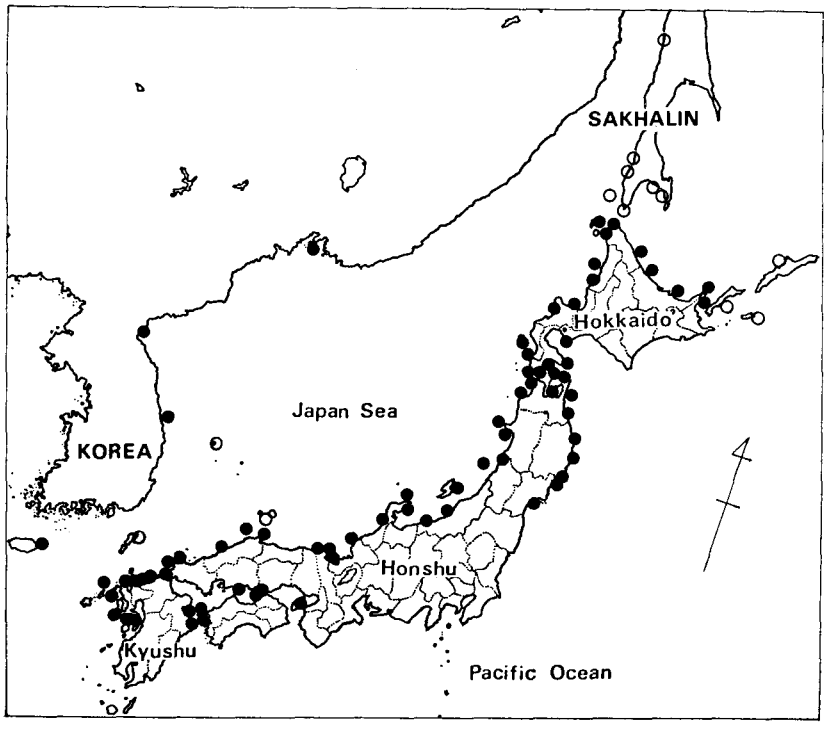

Fig. 16. Distribution of *Sargassum confusum*. Solid circles compiled from the specimens in SAP, and open circles from CHIHARA & YOSHIZAKI (1970), KANG (1965), KAJIMURA (1975), TOKIDA (1954) and NAGAI (1940).

SHIKOKU: Marugame, Kagawa Pref., Apr. 9, 1959, leg. S. INUMARU, SAP 028815; Ochi-gun, Ehime Pref., Feb. 16, 1960, leg. S. INUMARU, SAP 028814; Tsuwaji-shima Ehime Pref., Dec. 4, 1959, leg. S. INUMARU, SAP 028813; Ikata, Ehime Pref., May 4, 1954, leg. Y. NOMURA, SAP 034248.

KYUSHU: Misumi, Kumamoto Pref., May 4, 1958, leg. M. ICHIKI, SAP 034853; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 043646; Nomozaki, Nagasaki Pref., June 5, 1978, leg. T. YOSHIDA, SAP 034250; Ojika-jima, Nagasaki Pref., Jul. 31, 1942, leg. YAMADA and NAKAMURA, SAP 034916; Hirado-jima, Nagasaki Pref., May 25, 1983, leg. T. YOSHIDA, SAP 043686; Iki, Nagasaki Pref., Aug. 1925, leg. K. OHKI, SAP 043679; Imari, Saga Pref., Aug. 1979, leg. T. YOTSUI, SAP 034727; Hado-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043720; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043655; Fukuyoshi, Fukuoka Pref., June 2, 1954, leg. M. ICHIKI, SAP 034842; Tsuyazaki, Fukuoka Pref., Sept. 20, 1956, leg. T. SAWADA, SAP 031104; Iwaya, Fukuoka Pref., Apr. 5, 1977, leg. T. YOSHIDA, SAP 034252; Usuki, Oita Pref., May 10, 1924, leg. SUZUKI, SAP 034247; Tsukumi, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 035752.

KOREA: Cheju Island, Apr. 24, 1974, leg. I. K. LEE, SAP 034604; Kannun, Mar. 28, 1974, leg. Y. H. KIM, SAP 034613; Genzan, Sept. 5, 1934, leg. NISHIOKA, SAP 043902.

CHINA: Tsingtao, Apr. 7, 1935, leg. M. NODA, SAP 043670-1.
USSR: Petrocre Bay, Aug. 3, 1926, leg. KUZNETSOV, SAP 032478.

C. AGARDH (1824) gave no figure at the time of original description of this taxon. Although the lectotype is fragments of terminal part of an immature thallus (Fig. 15 A), it clearly shows characters that accord the current usage of the name by Japanese authors.

Later, J. AGARDH (1896) described 2 new species relating to *S. confusum*, *S. expansum* and *S. validum*, basing on the specimens collected by PETERSEN from Cape Nomo, Nagasaki Pref., and Shirisawabe, Hokkaido, respectively. The lectotype of both taxa (LD, Herb. Agardh Nos. 3226, 3217) are immature specimens (Fig. 15 B,C). Conspecificity of both taxa with *S. confusum* is undiscutable. The type of *S. expansum* is devoid of spinous processes on the stem and branches. This state, combined with lanceolate leaf with acute apex, seems to be identical with that of *S. turneri* YENDO. Frequency of spinal processes changes clinally, decreasing in southern population, and it is difficult to distinguish subspecific taxa basing on this character.

J. AGARDH placed his *S. expansum* and *S. validum* in his subgenus *Eusargassum* together with *S. confusum*. Characters of receptacle as well as horizontally expanded lower leaves warrant the placement in the *Bactrophycus*.

SETCHELL (1933) thought that *S. confusum* was synonymous with *S. pallidum*. This was followed by Chinese authors (TSENG & CHANG 1954). They distinguished several forms in *S. pallidum*. From the description and figures given by them, it seems to me that these forms belong to *S. confusum*. Comparison of specimens is needed before any further comments on these chinese forms.

As shown in the treatment under *S. pallidum*, I came to the conclusion that *S. confusum* is distinct enough at specific level from *S. pallidum*.

5. *Sargassum pallidum* (TURNER) C. AGARDH 1820: 39. (Figs. 17–19)

GRUNOW 1915: 350. SETCHELL 1933 a: 207, *pl. 43–44* (excl. synonym).
Fucus pallidus TURNER 1808: 149, *pl. 67*. Lectotype: BM (K) "e mari Coreano" (Fig. 18 A).
Halochloa pallida (TURNER) KÜTZING 1849: 634; 1860: 33, *pl. 94, f. 2*.

Japanese name: Usu-iro-moku (nov.)

Thallus usually less than 1 m high. Holdfast complanate discoid, up to 3 cm in diameter. Stem usually solitary, upright, terete or slightly compressed, attaining 20 cm long or more and 3–4 mm wide in several years. Main branches issued alternately in one plane. After falling off of the branches, scars giving alternate succession of knots on the stem. Main

Fig. 17. *Sargassum pallidum* (TURNER) C. AGARDH.

branches slightly compressed. Leaves formed in early season long elliptical to lanceolate, reaching more than 10 cm long and 2 cm wide, with cuneate base and round or acute apex. Margin of the leaf minutely serrulate. Midrib diminishing to the apex. Lower leaves arising alternately in one plane. Leaves thin papyraceous in texture, rather pale in color and turned greenish when treated with formalin. Cryptostomata small, numerous, scattered on the leaf surface. Leaves formed in later season or on distal part of the branch diminishing in size, narrow lanceolate to linear with entire margin, midrib becoming inconspicuous. Vesicles spherical, shortly stipitate with round or mucronate apex, up to 10 mm in diameter, usually formed singly in axil of the leaf. Vesicles formed on the upper part of the branch obovoid in shape with diminishing size.

Plant dioecious. Receptacle terete, tapering towards the apex, 3–4 mm long and 1 mm in diameter, disposing racemosely or paniculately on distal part of the ultimate branches.

This species grows in subtidal zone.

Specimens examined: HONSHU: Kashiwa-zaki, Niigata Pref., May 28, 1981, leg. H. ISHIBASHI, SAP 043290; Hiyori-yama, Niigata Pref., Jan. 18, 1982, leg. K. IKEHARA, SAP 043218; Maehama, Sado, Niigata Pref., Sept. 21, 1981, leg. K. IKEHARA, SAP 043219; Funakawa, Akita Pref., Jul. 8, 1982, leg. M. TSUKIDATE, SAP 042178.

The holotype of *Fucus pallidus* TURNER is a fertile fragment deposited in BM (K), as shown in Fig. 18 A. I could not locate any other specimen referable to this species in several european herbaria (L, LD, BM, PC). The holotype is well illustrated by TURNER (Fig. 18 B). Although the type is fragmentary, it has characteristic spherical vesicles and thinner papyraceous leaves. SETCHELL (1933 a, p. 207), after examined this specimen, considered that "*F. pallidus* TURNER, *F. microceratius* TURNER and *Sargassum confusum* C. AGARDH are names for one and the same species of the Japanese coasts" and chose the designation of *S. pallidum*. TSENG & CHANG (1954) followed the opinion of SETCHELL, whereas the Japanese authors did not pay attention to this treatment.

In SAP, we have several collections from Akita and Niigata Prefectures referable to this taxon. Basal part of the thallus resembles to that of *S. confusum* and *S. microceratium*, while leaves are thinner in texture and paler in color. Spherical vesicles are bigger than those of *S. confusum* or *S. microceratium*. Distal part of fertile specimens is quite similar to the type of *S. pallidum*. Therefore, I am certain to identify our specimens as *S. pallidum*. More collection is needed to obtain informations on reproductive structure. This species is one of deep water habitants.

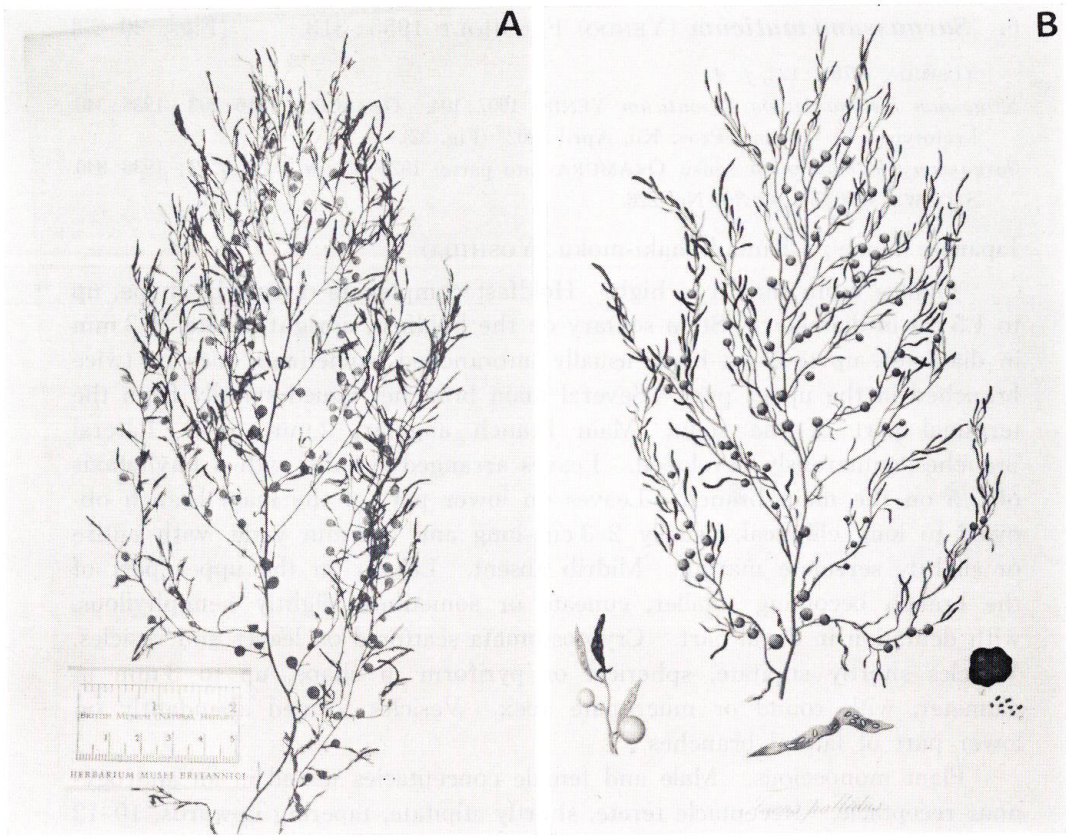

Fig. 18. A. Lectotype of *Fucus pallidus* TURNER. "e mari Coreano" BM(K).
B. Illustration of *Fucus pallidus* TURNER, Hist. Fuc. Pl. 67.

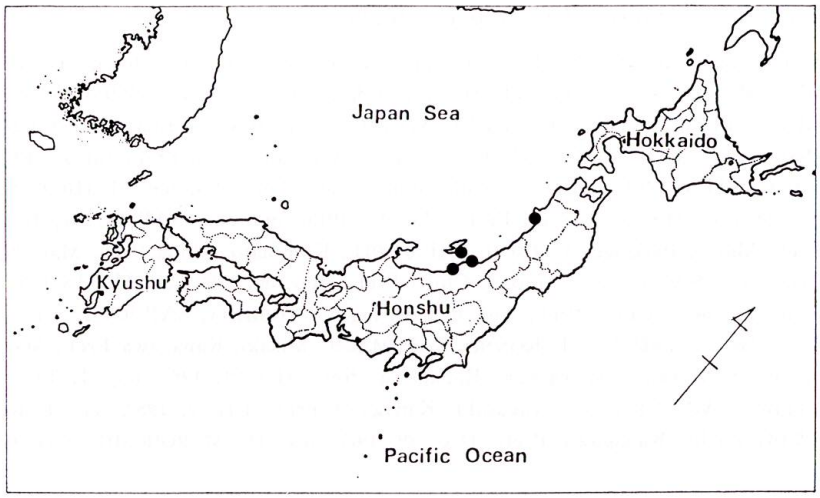

Fig. 19. Distribution of *Sargassum pallidum*, compiled from the specimens in SAP.

6. *Sargassum muticum* (YENDO) FENSHOLT 1955 : 313. (Figs. 20–23)

YOSHIDA 1978 a : 122, *f. 4.*

Sargassum kjellmanianum f. *muticum* YENDO 1907 : 104. OKAMURA 1916 : 203 ; 1936 : 340. Lectotype : TI "Itsumo, Prov. Kii, April 1902" (Fig. 22).

Sargassum kjellmanianum sensu OKAMURA (pro parte) 1924 : 45, *pl. 212, f. 2* ; 1936 : 340. SEGAWA 1956 : 51, *pl. 30*, No. 226.

Japanese name : Tama-hahaki-moku (YOSHIDA)

Thallus more than 1 m high. Holdfast complanate discoid in shape, up to 1.5 cm in diameter. Stem solitary on the holdfast, upright, terete, 2–3 mm in diameter, up to 2 cm high, usually unbranched, sometimes once or twice branched in the upper part. Several main branches issued spirally from the terminal part of the stem. Main branch angular, 2 mm wide. Lateral branches numerously developed. Leaves arranged spirally with a phyllotaxis of 2/5 on the main branch. Leaves on lower part of the main branch obovoid to long elliptical, usually 2–3 cm long and 3–4 mm wide, with entire or slightly serrulate margin. Midrib absent. Leaves on the upper part of the branch becoming smaller, cuneate or sometimes slightly hemiphyllous, with dentation in distal part. Cryptostomata scattered on leaves and vesicles. Vesicles shortly stipitate, spherical or pyriform in shape, up to 3 mm in diameter, with round or mucronate apex. Vesicles formed abundantly on lower part of lateral branches.

Plant monoecious. Male and female conceptacles mixed in an androgynous receptacle. Receptacle terete, shortly stipitate, tapering upwards, 10–12 mm long and 1 mm in diameter. Maturation period in winter to early summer.

This species grows on rocks rather protected from wave action, in a zone from lower intertidal to upper subtidal.

Specimens examined : HONSHU : Ohzuchi, Iwate Pref., Mar. 29, 1979, leg. T. YOSHIDA, SAP 034719 ; Matsushima, Miyagi Pref., Mar. 27, 1978, leg. T. YOSHIDA, SAP 034215 ; Matsugahama, Miyagi Pref., Mar 28, 1978, leg. T. YOSHIDA, SAP 034214 ; Ena, Fukushima Pref., Jul. 1, 1981, leg. K. TANIGUCHI, SAP 035714 ; Nagasaki, Fukushima Pref., Jul. 12, 1976, leg. T. YOSHIDA, SAP 034219 ; Onahama, Fukushima Pref., Apr. 1924, leg. M. HIGASHI, SAP Herb. OKAMURA ; Minato, Ibaraki Pref., May 17, 1913, anonym., SAP 034226 ; Katsuura, Chiba Pref., May 6, 1955, leg. Y. TSUJI, SAP 042011 ; Kominato, Chiba Pref., Mar. 29, 1978, leg. T. YOSHIDA, SAP 034213 ; Futomi, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 042008 ; Nishi-nemoto, Chiba Pref., Apr. 6, 1969, leg. T. YOSHIDA, SAP 034212 ; Tateyama, Chiba Pref., Dec. 4, 1982, leg. T. KONNO, SAP 042325 ; Misaki, Kanagawa Pref., Mar. 1929, leg. S. INOH, SAP 8561 ; Odawa-wan, Kanagawa Pref., May 21, 1981, leg. T. TERAWAKI and TATEDA, SAP 041921 ; Chojyagasaki, Kanagawa Pref., Dec. 3, 1982, leg. T. KONNO, SAP 042316 ; Zushi, Kanagawa Pref., Dec. 29, 1977, leg. H. MOROHOSHI, SAP 034224 ;

Fig. 20. *Sargassum muticum* (YENDO) FENSHOLT.

Shimoda, Shizuoka Pref., Mar. 31, 1976, leg. T. YOSHIDA, SAP 034220; Omaezaki, Shizuoka Pref., Apr. 13, 1982, leg. F. HAYASHIDA, SAP 042317; Sugashima, Mie Pref., Apr. 1955, leg. Y. TSUJI, SAP 034822; Wagu, Mie Pref., Apr. 25, 1955, leg. Y. TSUJI, SAP 042007; Agowan, Mie Pref., May 11, 1979, leg. T. YOSHIDA, SAP 034607; Nagashima, Mie Pref., May 13, 1979, leg. T. YOSHIDA, SAP 034609; Kushimoto, Wakayama Pref., Nov. 22, 1959, leg. T. YAMAMOTO, SAP 034232; Kada, Wakayama Pref., Oct. 30, 1981, leg. YOSHIDA and KONNO, SAP 041872; Suma, Hyogo Pref., Feb. 7, 1933, leg. K. UNO, SAP 034222; Mukai-shima, Hiroshima Pref., Dec. 13, 1961, leg. S. INUMARU, SAP 028729; Hiko-shima, Yamaguchi Pref., Feb. 16, 1930, leg. SUGINO, SAP 034230; Yoshimi, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034211; Futami, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034210; Senzaki, Yamaguchi Pref., June 8, 1978, leg. T. YOSHIDA, SAP 034209; Torii, Shimane Pref., Feb. 19, 1933, leg. S. TAKAKI, SAP 034227; Kasumi, Hyogo Pref., June 11, 1978, leg. T. YOSHIDA, SAP 034206; Kashiwazaki, Niigata Pref., Mar. 31, 1983, leg. NAKAMURA and UEDA, SAP 043664; Hiyoriyama, Niigata Pref., June 13, 1982, leg. K. IKEHARA, SAP 043220.

SHIKOKU: Hane, Kochi Pref., May 27, 1979, leg. T. YOSHIDA, SAP 034610; Ikata, Ehime Pref., May 4, 1954, leg. Y. NOMURA, SPA 034223.

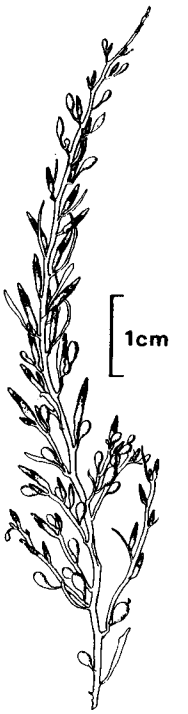

Fig. 21. *Sargassum muticum* (YENDO) FENSHOLT. Terminal fertile part with receptacle.

KYUSHU: Hime-shima, Oita Pref., June 4, 1981, leg. T. YOSHIDA, SAP 035762; Sumiyoshi, Oita Pref., June 3, 1981, leg. T. YOSHIDA, SAP 035737; Mekari, Fukuoka Pref., Apr. 1, 1953, leg. T. YOSHIDA, SAP 035068; Dairi, Fukuoka Pref., Jan. 12, 1930, anonym., SAP 034226; Iwaya, Fukuoka Pref., June 5, 1981, leg. T. YOSHIDA, SAP 035699; Tsuyazaki, Fukuoka Pref., Mar. 28, 1956, leg. T. SAWADA, SAP 031106; Hakata-wan, Fukuoka Pref., Feb. 7, 1959, leg. M. ICHIKI, SAP 034846; Keya, Fukuoka Pref., Apr. 2, 1932, leg. SUGINO, SAP 021025; Hariojima, Nagasaki Pref., May 24, 1983, leg. T. YOSHIDA, SAP 043682.

KOREA: Gijing, Mar. 20, 1974, leg. I. K. LEE, SAP 034609; Kumon Island, Mar. 1935, leg. YANAGISAWA, SAP 034208.

CHINA: Dairen, Dec. 27, 1937, leg. M. NODA, SAP 034207; Chifu, Apr. 2, 1935, leg. M. NODA, SAP 043668; Tsingtao, Apr. 4, 1935, leg. M. NODA, SAP 043667.

This taxon was first described as a form of *S. kjellmanianum* by YENDO (1907). FENSHOLT (1955) raised it to the specific rank. Japanese authors customary used the name *S. kjellmanianum* for this taxon. YOSHIDA (1978 a) selected the lectotype (Fig. 22) and consented with the treatment of FENSHOLT.

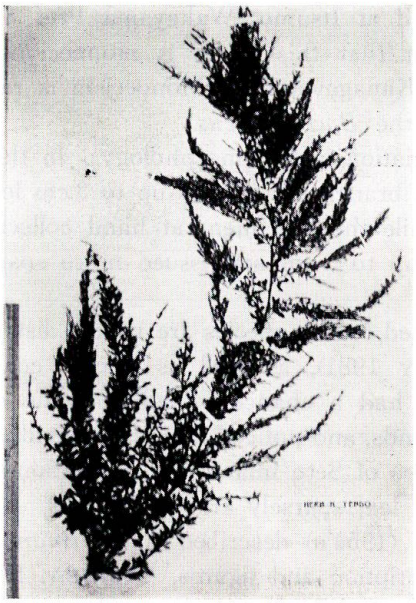

Fig. 22. Lectotype of *Sargassum kjellmanianum* f. *muticum* YENDO. "Itsumo, Prov. Kii, Honshu, April 1902" TI.

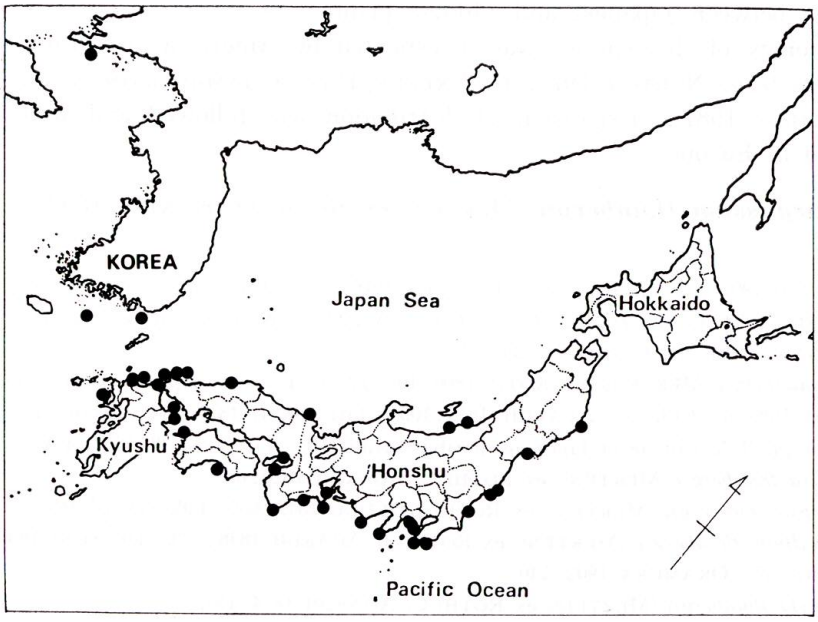

Fig. 23. Distribution of *Sargassum muticum*, compiled from the specimens in SAP.

The lectotype, collected at Itsumo, Wakayama Pref. is a sterile specimen. INOH (1930) found out that this taxon is monoecions in sexuality in the population of Misaki, Kanagawa Pref. Monoecism is rather rare occurrence among the species of the *Bactrophycus*.

There is local variation in leaf morphology. In the typical form, leaves on lower part of main branch are usually up to 3 cm long and densely cover the young shoot. While the specimens at hand collected from Seto Inland Sea have longer leaf up to 5 cm and issued more sparsely when compared with the typical form.

The plants identified to this species are widely distributed along the coast of Europe (CRITCHLEY 1981), as well as Pacific coast of North America (DEWREEDE 1978). I had a chance to collect some specimens in Zeeland district of the Netherlands, and noticed that the individuals of Zeeland population are similar to those of Seto Inland Sea population rather than to typical form in having longer leaf sparsely arising.

TSENG & CHANG (1954 a) described *S. kjellmanianum* f. *longifolium*. Judging from the description and figures, YOSHIDA (1978 a) transferred this form to *S. muticum*. This form seems to have resemblance with Seto Inland Sea population and with European population. As I have not yet examined any specimen of this form from China, I must retain to discuss the relation between Japanese and Chinese plants.

Biology of this species was investigated by American and British phycologists (*e. g.* NORTON 1977, DEWREEDE 1978, CHAMBERLAIN *et al.* 1979, CRITCHLEY 1981). Expansion of distribution was followed and well documented in Europe.

7. *Sargassum thunbergii* (MERTENS ex ROTH) O. KUNTZE 1893 : 427. (Figs. 24, 25)

YENDO 1907 : 114, *pl. 15, f. 5*. OKAMURA 1916 : 203 ; 1923 : 6, *pl. 203* ; 1936 : 337. SETCHELL 1933 : 43, *pl. 16, pl. 17, f. 1-10*. YAMADA & KINOSHITA 1948 : 11, *pl. 10*. SEGAWA 1956 : 51, *pl. 30*, No. 255.

Fucus thunbergii MERTENS ex ROTH 1806 : 104, *pl. 3* (*α simplex, β racemosa*). TURNER 1809 : 158, *pl. 133*. C. AGARDH 1815 : 103. THUNBERG 1815 : 144. Lectotype : ROTH 1806, *pl. 3* "e Chinae et Iaponiae maribus attulit Ill. THUNBERG" (Fig. 24 A).

Cystoseira thunbergii (MERTENS ex ROTH) C. AGARDH 1820 : 81.

Myagropsis thunbergii (MERTENS ex ROTH) KÜTZING 1849 : 635 ; 1860 : 33, *pl. 93, f. 2 c, d*.

Cystophyllum thunbergii (MERTENS ex ROTH) J. AGARDH 1848 : 233. DE TONI 1895 : 157 ; 1895 a : 47. OKAMURA 1902 : 140.

Rhodomela thunbergii (MERTENS ex ROTH) C. AGARDH 1824 : 199.

Turbinaria thunbergii (MERTENS ex ROTH) YENDO 1905 : 153.

Fucus swartzii C. AGARDH 1815 : 105, *pl. 4 A*. Lectotype : LD (Herb. Agardh No. 935 "in

Archipelago Japonico, TILESIUS") (Fig. 24 B).

Cystoseira swartzii (C. AGARDH) C. AGARDH 1820 : 82.

Rhodomela swartzii (C. AGARDH) C. AGARDH 1824 : 198.

Myagropsis swartzii (C. AGARDH) KÜTZING 1860 : 33, *pl. 93, f. 1.*

Myagropsis thunbergii var. *swartzii* (C. AGARDH) KÜTZING 1849 : 635.

Cystophyllum swartzii (C. AGARDH) J. AGARDH 1848 : 233. DE TONI 1895 : 157. OKAMURA 1902 : 140.

Turbinaria swartzii (C. AGARDH) YENDO 1905 : 153.

Sargassum swartzianum YENDO 1907 : 114. OKAMURA 1916 : 204.

Sargassum thunbergii f. *nipponicum* YENDO 1907 : 115, *pl. 15, f. 5.* OKAMURA 1916 : 204; 1923 : 8, *pl. 203, f. 5.* Holotype: TI "Tachimachi, Hakodate, July 27, 1899" (YOSHIDA 1980 : 104, *pl. 5, f. 10*).

Sargassum thunbergii f. *latifolium* YENDO 1907 : 115. OKAMURA 1916 : 204; 1923 : 8, *pl. 203, f. 3.* Holotype: TI "Strait Tsugaru, April 1903" (YOSHIDA 1980 : 103, *pl. 5, f. 9*).

Sargassum thunbergii f. *swartzii* (C. AGARDH) OKAMURA 1923 : 8.

Sargassum thunbergii f. *swartzianum* (YENDO) OKAMURA 1923 : 8, *pl. 203, f. 2*; 1936 : 338.

Japanese name: Umi-toranowo.

Thallus usually less than 0.5 m high, but exceeding 1 m in a calm habitat. Holdfast depressed disc shaped, 1–1.5 cm in diameter. Stem upright, less than 1 cm high, terete, about 2 mm in diameter, once or twice branched at the distal part. Main branches issued from the distal part of the stem, 1–1.5 mm in diameter, angulate. In early season, main branches simple without lateral branches and densely covered with leaves and vesicles. Later, numerous lateral branches produced. Lateral branches being longest in the middle portion of the main branch, gradually decreasing in length approaching upward and downward. Leaves disposed with 2/5 divergence of phyllotaxis on the main branch. Leaf formed near the basal part scale-like, becoming linear, cuneate to filiform in shape, up to 1 cm long and 1 mm wide with a few dentations on terminal part. Cryptostomata present on leaves. Vesicle fusiform in shape, tapering to both ends, 3–4 mm long and 1 mm in diameter, formed numerously in the upper part of the branch. Rarely 2 to 3 seriate vesicles observed.

The plant dioecious. Receptacles terete, shortly stipitate, gradually tapering upward, formed on abbreviated racemes. Female receptacle 3 mm long and 1 mm in diameter. Male one up to 10 mm long and less than 1.3 mm in diameter. Maturation in spring to early summer.

This species grows on rocks of middle to lower level in the intertidal zone, forming a conspicuous belt in places not so exposed to strong wave action.

Specimens examined: HOKKAIDO: Nemuro, Aug. 3, 1929, leg. S. AKIYAMA, SAP 7848; Erimo-misaki, Hidaka Prov., Apr. 24, 1978, leg. H. KAWAI, SAP 034346; Samani,

Hidaka Prov., Jul. 3, 1943, leg. Y. NAKAMURA, SAP 025489; Harutachi, Hidaka Prov., Aug. 1953, leg. Y. YAMADA, SAP 027211; Muroran, Iburi Prov., Jul. 2, 1935, leg. T. MURAOKA, SAP 034933; Hakodate, Oshima Prov., June 1931, leg. YAMADA, NAKAMURA and KARAKAWA, SAP 023508; Higashiura, Oshima Prov., Aug. 15, 1964, leg. I. YAMADA, SAP 035414; Yoshioka, Oshima Prov., Aug. 17, 1958, leg. N. TAZAWA, SAP 034839; Shirakami, Oshima Prov., Apr. 28, 1978, leg. T. YOSHIDA, SAP 034348; Esahi, Hiyama Prov., Apr. 26, 1978, leg. T. YOSHIDA, SAP 034349; Okushiri-jima, Hiyama Prov., Mar. 16, 1944, leg. Y. HASEGAWA, SAP 025112; Oshoro, Shiribeshi Prov., June 23, 1931, leg. K. INAGAKI, SAP 014107; Zenibako, Shiribeshi Prov., Jul. 16, 1946, leg. Y. SAKAI, SAP 042058, Yagishiri-jima, Rumoi Prov., Aug. 19, 1960, leg. I. YAMADA, SAP 035399; Bakkai, Soya Prov., May 19, 1978, leg. T. YOSHIDA, SAP 034347; Abashiri, no date, leg. S. INOH, SAP 024555; Utoro, Abashiri Prov., Sept. 17, 1943, leg. Y. YAMADA, SAP 024339; Shiretoko-misaki, Nemuro Prov., Sept. 15, 1943, leg. Y. YAMADA, SAP 024414; Rausu, Nemuro Prov., Aug. 1944, leg. Y. HASEGAWA, SAP 025429.

HONSHU: Taneichi, Iwate Pref., Apr. 14, 1952, leg. S. KAWASHIMA, SAP 026896; Shukunohe, Iwate, Pref., June 30, 1965, leg. T. YOSHIDA, SAP 035058; Kuji, Iwate Pref., Jul. 22, 1952, leg. S. KAWASHIMA, SAP 026901; Miyako, Iwate Pref., Aug. 3, 1951, leg. S. KAWASHIMA, SAP 026897; Ozuchi, Iwate Pref., Mar. 29, 1979, leg. T. YOSHIDA, SAP 034720; Kamaishi, Iwate Pref., Aug. 18, 1951, leg. YAMADA and KAWASHIMA, SAP 026898; Ofunato, Iwate Pref., May 20, 1951, leg. S. KAWASHIMA, SAP 026899; Onagawa, Miyagi Pref., June 1942, leg. S. INOH, SAP 024574; Matsushima, Miyagi Pref., Mar. 28, 1978, leg. T. YOSHIDA, SAP 034380; Matsugahama, Miyagi Pref., Mar. 28, 1978, leg. T. YOSHIDA, SAP 034378; Onahama, Fukushima Pref., Jul. 15, 1981, leg. T. YOSHIDA, SAP 035697; O-arai, Ibaraki Pref., Aug. 5, 1956, leg. Y. TSUJI, SAP 035431; Katsuura, Chiba Pref., June 20, 1976, leg. K. AOKI, SAP 035135; Kominato, Chiba Pref., Mar. 30, 1978, leg. T. YOSHIDA, SAP 034353; Futomi, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 042066; Amatsu, Chiba Pref., Nov. 1, 1927, leg. S. AKIYAMA, SAP 9478; Amatsura, Chiba Pref., Aug. 1933, leg. T. MURAOKA, SAP 019939; Nemoto, Chiba Pref., Aug. 7, 1956, leg. Y. TSUJI, SAP 042045; Chojyagasaki, Kanagawa Pref., Apr. 3, 1981, leg. T. YOSHIDA, SAP 035502; Zushi, Kanagawa Pref., Dec. 29, 1977, leg. H. MOROHOSHI, SAP 034379; Shimoda, Shizuoka Pref., June 15, 1981, leg. Y. YOKOHAMA, SAP 035707; Tabi, Shizuoka Pref., June 4, 1981, leg. F. HAYASHIDA, SAP 035725; Omaezaki, Shizuoka Pref., Mar. 28, 1982, leg. T. YOSHIDA, SAP 042002; Toshijima, Mie Pref., Aug. 1930, leg. K. INAGAKI, SAP 9625; Suga-shima, Mie Pref., Apr. 27, 1955, leg. Y. TSUJI, SAP 041966; Wagu, Mie Pref., Apr. 26, 1955, leg. Y. TSUJI, SAP 042085; Ago-wan, Mie Pref., May 11, 1979, leg. T. YOSHIDA, SAP 034649; Hamashima, Mie Pref., May 10, 1979, leg. T. YOSHIDA, SAP 034643; Katsuura Wakayama Pref., Apr. 3, 1957, leg. Y. TSUJI, SAP 041968; Taiji, Wakayama Pref., May 13, 1979, leg. T. YOSHIDA, SAP 034643; Kushimoto, Wakayama Pref., Apr. 6, 1981, leg. H. KAWAI, SAP 035503; Shionomisaki, Wakayama Pref., Apr. 2, 1957, leg. Y. TSUJI, SAP 034805; Shirahama, Wakayama Pref., Apr. 7, 1981, leg. H. KAWAI, SAP 035504; Seto, Wakayama Pref. Apr. 1, 1970, leg. M. MASUDA, SAP 041983; Tanabe, Wakayama Pref., Apr. 1, 1957, leg. Y. TSUJI, SAP 041982; Futami, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034362; Yuya, Yamaguchi Pref., June 8, 1978, leg. T. YOSHIDA, SAP 034360; Omi-jima, Yamaguchi Pref., Apr. 25, 1979, leg. T. YOSHIDA, SAP 034644; Tatamigaura, Shimane Pref., June 9, 1978, leg.

T. YOSHIDA, SAP 034367; Hinomisaki, Shimane Pref., Aug. 2, 1942, leg. Y. NAKAMURA, SAP 023780; Fuse, Shimane Pref., Mar. 26, 1933, leg. Y. IKOMA, SAP 014442; Katsura-jima, Shimane Pref., May 21, 1982, leg. S. KAWAGUCHI, SAP 042193; Shichirui, Shimane Pref, June 10, 1978, leg. T. YOSHIDA, SAP 034369; Tango, Hyogo Pref., May 18, 1982, leg. S. KAWAGUCHI, SAP 042192; Maizuru, Kyoto Pref., Dec. 26, 1977, leg. H. KAWAI, SAP 034375; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 034363; Takanosu, Fukui Pref., Aug. 8, 1942, leg. Y. NAKAMURA, SAP 023781; Nagahashi, Fukui Pref., Aug. 8, 1942, leg. Y. NAKAMURA, SAP 034932; Hakui, Ishikawa Pref., no date, leg. T. KANAMORI, SAP 021387; Rokugo-zaki, Ishikawa Pref., May 15, 1982, leg. S. KAWAGUCHI, SAP 042190; Ogi, Ishikawa Pref., Aug. 23, 1976, leg. Y. NAKAMURA, SAP 034370; Ushitsu, Ishikawa Pref., June 19, 1976, leg. K. TANIGUCHI, SAP 042016; Maze, Niigata Pref., Jan. 7, 1982, leg. K. KOBAYASHI, SAP 042166; Iwagasaki, Niigata Pref., May 13, 1982, leg. S. KAWAGUCHI, SAP 042228; Sado, Niigata Pref., Mar. 3, 1955, leg. M. NODA, SAP 034359; Awashima, Niigata Pref., Mar. 18, 1957, leg. M. NODA, SAP 034374; Fukura, Yamagata Pref., Aug. 1951, leg. T. KANAMORI, SAP 034372; Tobishima, Yamagata Pref., Jul. 1931, leg. W. HIROHASHI, SAP 012076; Oga, Akita Pref., June 21, 1951, leg. S. FUNAHASHI, SAP 034358; Toga, Akita Pref., Apr. 23, 1982, leg. M. TSUKIDATE, SAP 042137; Fukaura, Aomori Pref., June 20, 1978. leg. T. YOSHIDA, SAP 034361; Mimmaya, Aomori Pref., Jul. 24, 1956, leg. S. KAWASHIMA, SAP 034882; Horozuki, Aomori Pref., Jul. 23, 1956, leg. S. KAWASHIMA, SAP 034901; Sai, Aomori Pref., Aug. 6, 1955, leg. S. KAWASHIMA, SAP 034883; Ohma, Aomori Pref., Aug. 5, 1955, leg. S. KAWASHIMA, SAP 034904; Shimofuro, Aomori Pref., Aug. 4, 1955, leg. S. KAWASHIMA, SAP 034903; Shiriya-zaki, Aomori Pref., Aug. 6, 1955, leg. S. KAWASHIMA, SAP 034881.

SHIKOKU: Tosa, Kochi Pref., May 26, 1979, leg. T. YOSHIDA, SAP 034646; Tatsukushi, Kochi Pref., May 29, 1979, leg. T. YOSHIDA, SAP 034647; Tsushima, Ehime Pref., May 23, 1982, leg. T. YOSHIDA, SAP 042160; Sunokawa, Ehime Pref., May 23, 1982, leg. T. YOSHIDA, SAP 042162; Karitsu, Ehime Pref., May 22, 1982, leg. T. YOSHIDA, SAP 042164; Akasaki, Ehime Pref., May 22, 1982, leg. T. YOSHIDA, SAP 042165: Toshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 042163; Ikata, Ehime Pref., May 16, 1956, leg. Y. NOMURA, SAP 027667; Misaki, Ehime Pref., May 31, 1979, leg. T. YOSHIDA, SAP 034648; Ozuchi-jima, Kagawa Pref., Oct. 31, 1962, leg. T. YAMAMOTO, SAP 034376.

KYUSHU: Hime-shima, Oita Pref., June 4, 1981, leg. T. YOSHIDA, SAP 035763; Sumiyoshi, Oita Pref., June 3, 1981, leg. T. YOSHIDA, SAP 035738; Saganoseki, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 035757; Tsukumi, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 034747; Asamui, Oita Pref., May 24, 1982, leg. T. YOSHIDA, SAP 042161; Kadokawa, Miyazaki Pref., May 24, 1982, leg. T. YOSHIDA, SAP 042194; Hiraiwa, Miyazaki Pref., May 24, 1982, leg. T. YOSHIDA, SAP 042159; Aoshima, Miyazaki Pref., Mar. 28, 1946, leg. M. KUROGI, SAP 025481; Oryuzako, Miyazaki Pref., May 25, 1982, leg. T. YOSHIDA, SAP 042189; Natsui, Kagoshima Pref., June 12, 1980, leg. T. YOSHIDA, SAP 034795; Ushinohama, Kagoshima Pref., June 13, 1980, leg. T. YOSHIDA, SAP 034793; Misumi, Kumamoto Pref., May 4, 1958, leg. M. ICHIKI, SAP 035075; Tomioka, Kumamoto Pref., Mar. 25, 1939, leg. Y. YAMADA, SAP 021517-8; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 043664; Nomo-zaki, Nagasaki Pref., Feb. 18, 1961, leg. MATSUMURA, SAP 028390; Fukue, Nagasaki Pref., Apr. 23, 1959, leg. T. YOSHIDA, SAP 034844; Katsura-jima, Nagasaki Pref., Jul. 28, 1942,

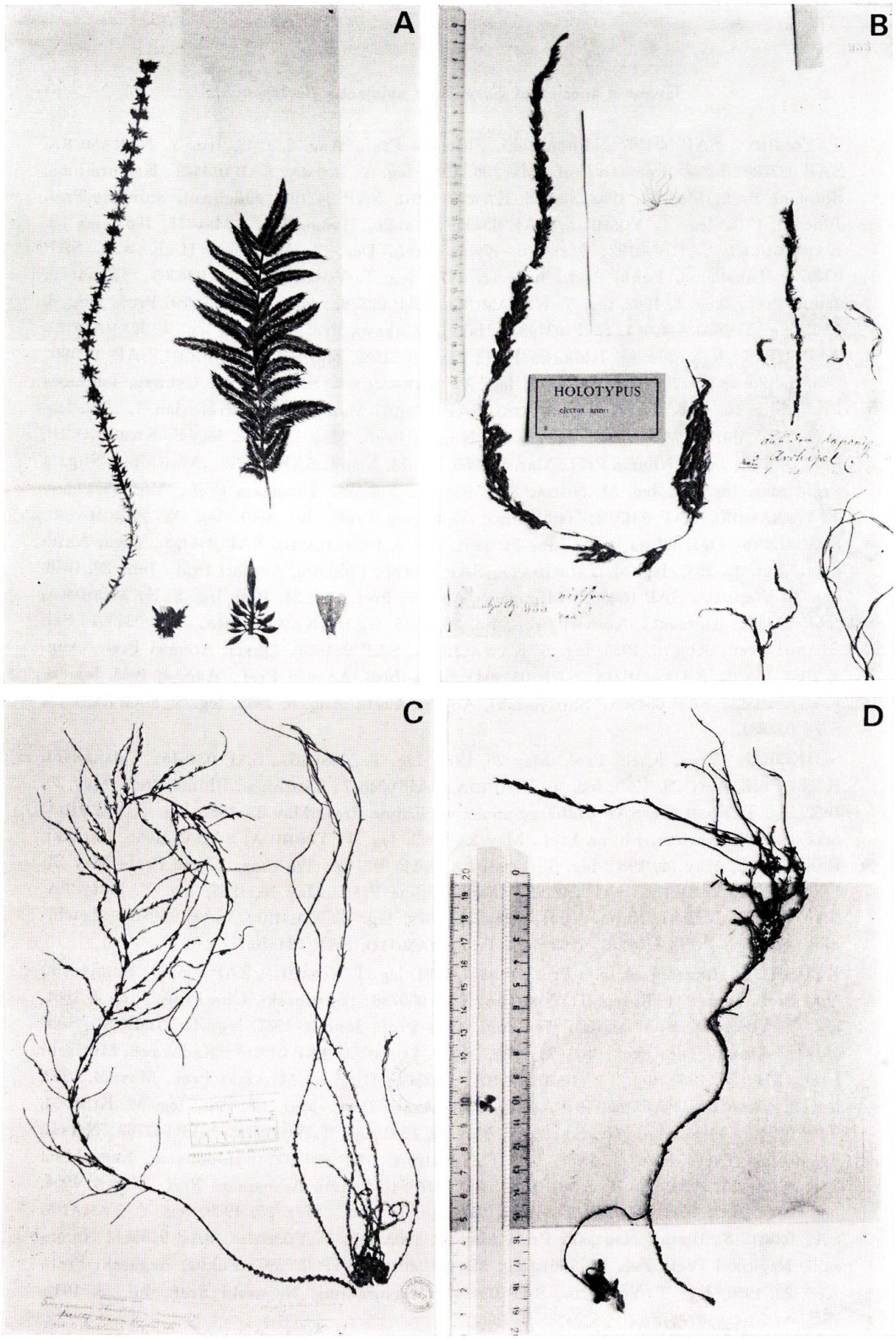

Fig. 24. A. Illustration of *Fucus thunbergii* MERTENS ex ROTH, Catal. Bot. vol. 3, pl. 3. Left, *α simplex*, right, *β racemosa*. B. Holotype of *Fucus swartzii* C. AGARDH. "in Archipelago Japonico, TILESIUS" LD, Herb. Agardh No. 935. C. A specimen used by TURNER for his Hist. Fuc. Pl. 133, BM(K). D. A specimen used by KÜTZING for his Tab. Phyc. vol. 10, Pl. 93. L 937.109.102.

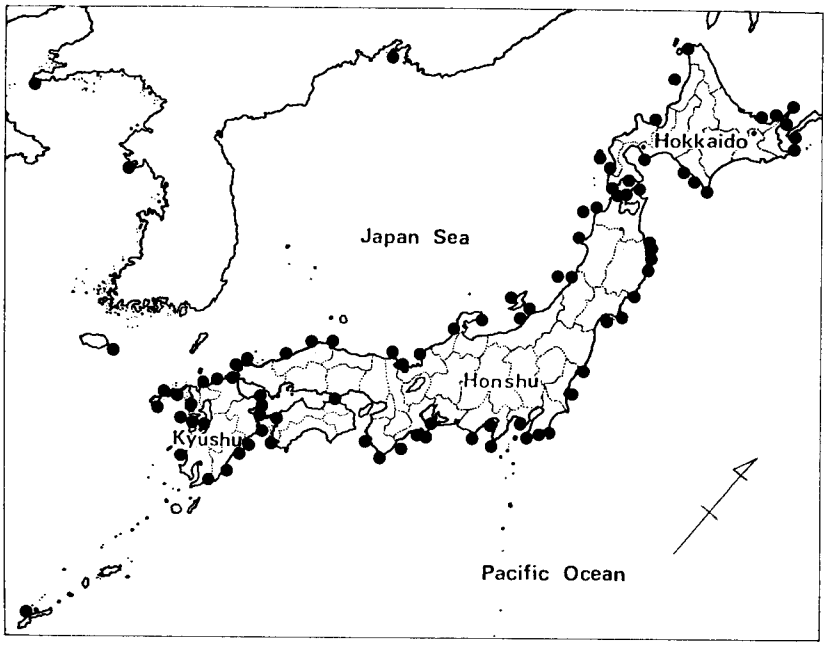

Fig. 25. Distribution of *Sargassum thunbergii*, compiled from specimens in SAP.

leg. YAMADA and NAKAMURA, SAP 023880; Sakiyama, Nagasaki Pref., Jul. 26, 1942, leg. YAMADA and NAKAMURA, SAP 023829-30; Hirado-jima, Nagasaki Pref., May 25, 1983, leg. T. YOSHIDA, SAP 043689; Tsuyazaki, Fukuoka Pref., Mar. 20, 1955, leg. M. ICHIKI, SAP 043648; Iwaya, Fukuoka Pref., June 5, 1981, leg. T. YOSHIDA, SAP 035702.
NANSEI SYOTO: Naha, Okinawa Pref., Mar. 16, 1955, leg. I. NAKATA, SAP 042060.
KURILE ISLANDS: Kunashiri-jima, Aug. 12, 1929, leg. M. NAGAI, SAP 022004.
USSR: Ussuri Bay, Mar. 23, 1928, leg. KUZNETZOV, SAP 032483.
KOREA: Cheju Island, Apr. 25, 1974, leg. I. K. LEE, SAP 034605; Daiseito, Aug. 1935, leg. LEE, SAP 043901.
CHINA: Dairen, Jul. 24, 1937, leg. M. NODA, SAP 034371; Tsingtao, Apr. 7, 1935, leg. M. NODA, SAP 043669.

According to KOSTER (1969, p. 557), the type materials of A. W. ROTH (1757-1834) were "mostly destroyed, a few specimens in Lund, Inst. Syst. Bot. (LD), London, Brit. Mus. (BM) and Munich, Bot. Staatssamml. (M)". I cound locate no specimen of this taxon examined by ROTH neither in LD nor in BM. As it cannot be located also in M (HERTEL, personal communication), the type seems to be lost, and we must designate ROTH's figure (ROTH 1806, pl. 3, f. a), reproduced here in Fig. 24 A, as the lectotype of *Fucus thunbergii*. This figure represents only a small fragment, but suffi-

ciently characteristic as for the identity. Another specimen (Fig. 24 C) also sent by MERTENS is now deposited in BM (K), and used for the illustration of TURNER. In the Herbarium KÜTZING housed in L, there is a specimen ("e mari Coreano" L. 937.109.102, Fig. 24 D), that was used by KÜTZING for his illustration in his Tabulae. These two specimens have basal part, but most of leaves fell off, indicating that the collection was made in later period of maturation.

The holotype of *Fucus swartzii* C. AGARDH (LD, Herb. Agardh No. 935, Fig. 24 B) is also a fragment collected by TILESIUS. Identity of this taxon with *Fucus thunbergii* var. *racemosus* ROTH was already pointed out by KÜTZING (1849, p. 635), and I agree to this treatment. YENDO (1907, p. 114) gave a new name *S. swartzianum* for the Agardhian species because the epithet '*swartzii*' had been preoccupied (*S. swartzii* C. AGARDH = *Fucus swartzii* TURNER 1819 : 120, nom. illeg.) in the genus *Sargassum*. At the same time, YENDO distinguished other two forms under *S. thunbergii* as f. *nipponicum* and f. *latifolium*, because of the relative development of lateral branches or size of leaves. These characters are rather variable with the age of plant, as shown by UMEZAKI (1974). I did not made any effort to discriminate taxa at subspecific level.

8. ***Sargassum fulvellum*** (TURNER) C. AGARDH 1820 : 34. (Figs. 26, 27)

C. AGARDH 1824 : 306. J. AGARDH 1848 : 293 ; 1889 : 61. DE TONI 1895 : 25. GRUNOW 1915 : 349. SEGAWA 1956 : 50, *pl. 29*, No. 224.

Fucus fulvellus TURNER 1808 : 148, *pl. 66*. Holotype : BM (K) "e mari Coreano, HORNER" (Fig. 26 A).

Spongocarpus fulvellus (TURNER) KÜTZING 1849 : 632 ; 1860 : 31, *pl. 90, f. 1*.

Fucus biserratus THUNBERG 1815 : 144. Holotype : UPS "e japonia, THUNBERG" (YAMADA 1955, f. A).

Sargassum enerve C. AGARDH 1820 : 17 ; 1824 : 299. J. AGARDH 1848 : 294 ; 1889 : 61 ; 1896 : 55. KÜTZING 1849 : 610 ; 1861 : 4, *pl. 13, f. 1*. DE TONI 1895 : 25. YENDO 1907 : 96, *pl. 13, f. 1-6*. GRUNOW 1915 : 350. OKAMURA 1916 : 202 ; 1924 : 29, *pl. 209* ; 1936 : 335. Lectotype : LD (Herb. Agardh No. 2976 "e mari Coreano, TILESIUS") (Fig. 26 C).

Spongocarpus enervis KÜTZING 1843 : 55 ; 1849 : 631 ; 1860 : 31, *pl. 89, f. 2*. Lectotype : L 937. 71.531 "China, MERTENS" (Fig. 26 D).

Sargassum mertensii ENDLICHER 1843 : 32.

Sargassum fulvellum var. *wilkesii* GRUNOW 1915 : 349. Type not located "In mari Japonico, leg. WILKES".

Japanese name : Hondawara.

Thallus usually 1-2 m high, sometimes attaining up to 5 m. Holdfast conical, scutellate, composed of finger-like outgrowths from the basal part of the stem, up to 2 cm in diameter. Distal part of radiating components

not fully coagulated with each other. A single stem arising from the holdfast, short in length, terete and unbranched, usually not exceeding 1 cm high. Several main branches issued spirally from the distal part of the stem, triangulate, 3–4 mm wide, often twisting loosely. Lateral branches numerous. Leaf of the basal part of the main branch retroflexed at the base, elliptical to lanceolate in shape, 3–4 cm long and 1 cm wide, with obtuse apex, provided with shallow serration on the margin, thick but soft in substance. Slightly elevated midrib discernible only in short distance from the petiole. Phyllotaxis of leaves on the main branch 1/3. Leaves in the middle part of the branch lanceolate to linear in shape, with slightly or acutely serrate margin, 6 cm long and 1 cm wide, with cuneate base and obtuse apex. Midrib absent. Cryptostomata small, scattered on the leaf surface. Larger vesicle elliptical or pyriform in shape, up to 1 cm long and 0.7 cm in diameter, with round or mucronate apex, rarely provided with small coronal leaf up to 1 cm long. Stipe slender, up to 5 mm long. Vesicles formed in the distal part becoming smaller and slenderer nearing to fusiform in shape.

The plant dioecious. Receptacle terete, shortly stipitate, tapering upward, racemosely or paniculately disposed on fertile branches. Female receptacle up to 1 cm long and 1 mm in diameter. Male one 3–5 cm long and 1–1.5 mm in diameter. Maturation in winter to spring.

This species grows on rocks of upper subtidal zone.

Specimens examined: HONSHU: Matsushima, Miyagi Pref., Aug. 16, 1965, leg. T. YOSHIDA, SAP 035265; Kominato, Chiba Pref., Mar. 29, 1978, leg. T. YOSHIDA, SAP 034464; Misaki, Kanagawa Pref., May 1938, leg. Y. YAMADA, SAP 021225–7; Aburatsubo, Kanagawa Pref., Apr. 3, 1981, leg. T. YOSHIDA, SAP 035491; Zushi, Kanagawa Pref., Mar. 1940, leg. T. TANAKA, SAP 021567; Kamakura, Kanagawa Pref., Oct. 1923, leg. Y. YAMADA, SAP 021288; Shimoda, Shizuoka Pref., Mar. 31, 1976, leg. T. YOSHIDA, SAP 034463; Suga-shima, Mie Pref., Apr. 21, 1955. leg. Y. TSUJI, SAP 041942; Kada, Wakayama Pref., Nov. 14, 1959, leg. T. YAMAMOTO, SAP 034465–6; Tateishi, Yamaguchi Pref., Apr. 24, 1979, leg. T. YOSHIDA, SAP 034641; Hamada, Shimane Pref., Aug. 30, 1954, leg. T. YAMAMOTO, SAP 034456; Hinomisaki, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 034454; Yura, Hyogo Pref., Nov. 4, 1962, leg. T. YAMAMOTO, SAP 034455; Ohwi, Fukui Pref., Sept. 23, 1981, leg. M. OHTA, SAP 042075; Wada, Fukui Pref., Oct. 14, 1949, leg. I. UMEZAKI, SAP 025696–7; Mitsuke-jima, Ishikawa Pref., Jul. 23, 1976, leg. K. TANIGUCHI, SAP 042027; Kashiwazaki, Niigata Pref., Jan. 6, 1932, leg. IKEGAMI, SAP 021018; Sado, Niigata Pref., Mar. 11, 1955, leg. M. NODA, SAP 034457; Awashima, Niigata Pref., Mar. 18, 1957, leg. M. NODA, SAP 034458; Funakawa, Akita Pref., Apr. 22, 1982, leg. M. TSUKIDATE, SAP 042127; Ohma, Aomori Pref., Mar. 27, 1956, leg. S. KAWASHIMA, SAP 028684.
SHIKOKU: Kurushima-kaikyo, Ehime Pref., Oct. 25, 1960, leg. S. INUMARU, SAP 028730; Hayase-seto, Ehime Pref., Apr. 16, 1960, leg. S. INUMARU, SAP 028728; Gogo-shima, Ehime Pref., Apr. 1940, leg. S. INOH, SAP 021723; Ikata, Ehime Pref., Nov. 17, 1955, leg. Y.

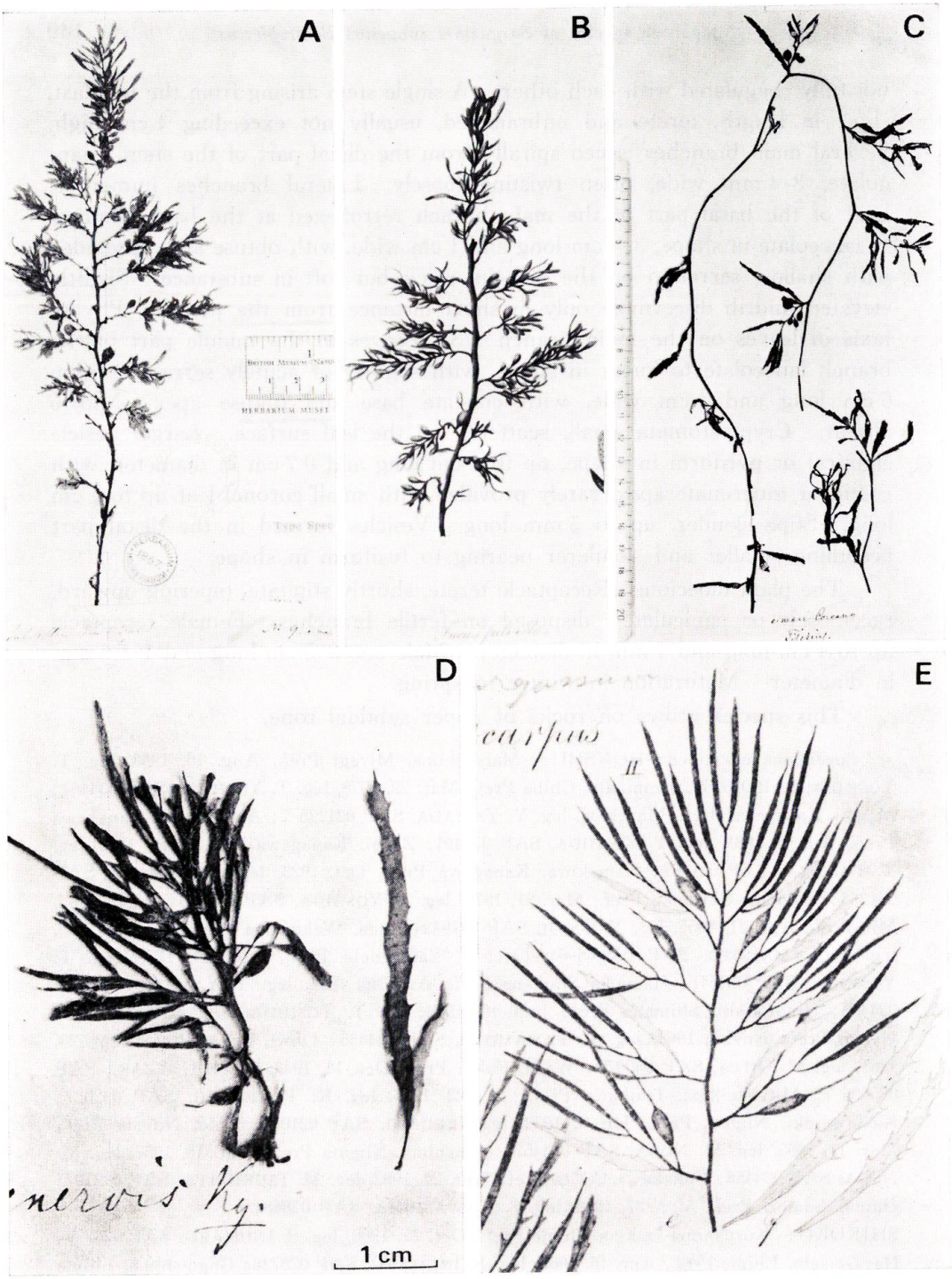

Fig. 26. A. Holotype of *Fucus fulvellus* TURNER. "e mari Coreano, HORNER" BM(K). B. Illustration of *Fucus fulvellus* TURNER, Hist. Fuc. Pl. 66. C. Lectotype of *Sargassum enerve* C. AGARDH. "e mari Coreano, TILESIUS" LD, Herb. Agardh No. 2976. D. Lectotype of *Spongocarpus enervis* KÜTZING. "China, MERTENS" L 937.71.531. E. Illustration of *Spongocarpus enervis* KÜTZING, Tab. Phyc. vol. 10, Pl. 89, f. 2.

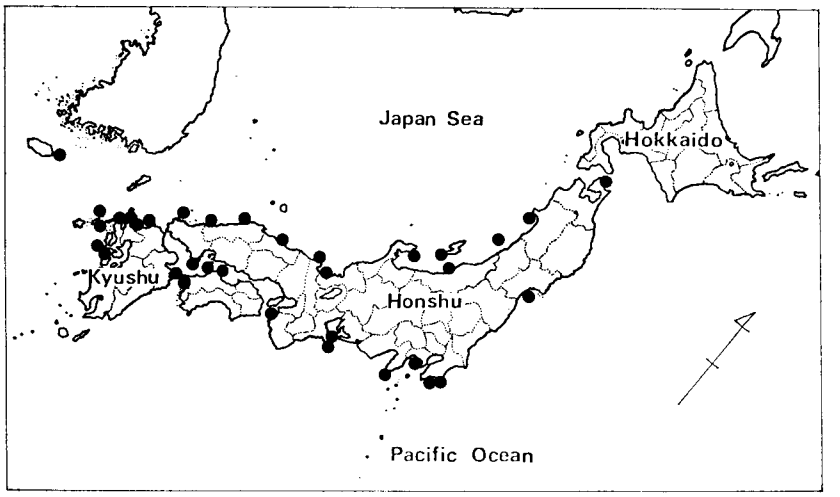

Fig. 27. Distribution of *Sargassum fulvellum*, compiled from specimens in SAP.

NOMURA, SAP 034462; Misaki, Ehime Pref., May 31, 1979, leg. T. YOSHIDA, SAP 034640.
KYUSHU: Tsuyazaki, Fukuoka Pref., Sept. 20, 1956, leg. T. SAWADA, SAP 031105; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043654; Hime-shima, Fukuoka Pref., May 20, 1983, leg. K. NANRI, SAP 043661; Hado-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043718; Imari, Saga Pref., Aug. 2, 1979, leg. T. YOTSUI, SAP 034728; Ojika-jima, Nagasaki Pref., Jul. 31, 1942, leg. YAMADA and NAKAMURA, SAP 034940; Hirado-jima, Nagasaki Pref., Jul. 30, 1981, leg. H. KITO, SAP 043594; Nomozaki, Nagasaki Pref., Mar. 30, 1970, leg. M. MASUDA, SAP 041984; Miyazuri, Nagasaki Pref., Aug. 5, 1981, leg. H. KITO, SAP 043588; Tomioka, Kumamoto Pref., Mar. 1939, leg. Y. YAMADA, SAP 021519-21.
KOREA: Cheju Island, Oct. 29, 1970, leg. I. K. LEE, SAP 034615.

The holotype of *Fucus fulvellus* TURNER (Fig. 26 A) is a fertile fragment, well represented in the illustration of TURNER (Fig. 26 B). The lectotype of *Sargassum enerve* C. AGARDH (Fig. 26 C) is a portion of sterile thallus, with leaves distantly disposed. As for the identity of these 2 taxa, SETCHELL (1933) was the first to state the opinion. Later, YAMADA (in MAKINO 1949) agreed with SETCHELL and adopted the name *S. fulvellum*, which has priority over *S. enerve*.

The holotype of *Fucus biserratus* THUNBERG was examined by YAMADA (1955), who stated that this name was synonymous with *S. fulvellum*. KÜTZING described *Spongocarpus enervis*, basing on the specimen collected in China and sent to him by HENSCHEL (Fig. 26 D). He considered that his species was similar to *Sargassum enerve* C. AGARDH, but differed in that the

vesicle was more round in shape in C. AGARDH's species. As the vesicle is often becoming slender in the distal part of a thallus, there is no need to separate KÜTZING's species. ENDLICHER (1843) gave a new name *S. mertensii* to KÜTZING's taxon in the genus *Sargassum*.

GRUNOW (1915, p. 349) described var. *wilkesii* of this species, basing on the specimen collected by WILKES "in mari Japonico". As I have not yet examined any reliable specimen, I cannot discuss the relationship of this variety.

This species is usually considered as annual in longevity. Small shoots are often observed on the periphery of holdfast. It is not clear whether these shoots establish new individuals of the next year. Perennation to second year of growth seems to occur at least in several individuals of the population, because we can collect specimens with fertile main branches and young shoots.

9. *Sargassum ammophilum* YOSHIDA et T. KONNO in KONNO et YOSHIDA 1982 : 289, *f. 1-11*. (Figs. 28, 29)

Holotype: SAP 041891 "Futomi, Chiba Pref., May 25, 1978, leg. T. KONNO" (Fig. 28). Isotype in the herbarium of Tokyo University of Fisheries.

Japanese name: Suna-biki-moku (KONNO & YOSHIDA)

Thallus more than 2 m high. Holdfast flat disc usually 5-8 cm in diameter. Growing margin of the disc composed of prostrate finger-like terete protuberances about 2 mm in diameter, which later fused with each other to form a flat disc. Many stems issued from the surface of the disc. The stem terete, 2.5-3.5 mm in diameter, up to 3-4 cm long, upright usually without branching. Several main branches formed in spiral succesion near the apex of the stem. Main branch triquetrous with rounded edges, 3-5 mm wide, twisting loosely or strongly. In the lower part of the main branch, spinal processes 1-3 mm long present on the ridges. Lateral branches longest in the middle part of the main branch, attaining 20-30 cm in length, then becoming gradually shorter above. Leaves shortly stipitate, very variable in shape according to season, age or position on the branch. Lower leaves thicker in texture and bigger, spread horizontally, obovoid, elliptical or lanceolate in shape, 3-6 cm long and 1-2 cm wide, with entire or irregularly minutely serrulate margin, with rotundate or acute apex, and obtuse or cuneate base. Phyllotaxis of the leaves 1/3 on the main branch. Midrib evanescent at a half length to the apex. Leaves on the distal part of the main branch or on lateral branches thinner in texture, obovoid, lanceolate, oblanceolate or even hemiphyllous in shape, becoming smaller in size. Small dots scattered on the leaves, but no cryptostome observed. Vesicles formed singly or in

groups in axil of leaves or on branchlets. Vesicles in the lower part of the main branch spherical or pyriform in shape, 5–7 mm long and 4–6 mm in diameter, shortly stipitate, mucronate or with round apex, rarely with small coronal leaf or wings, becoming smaller and slenderer above, pyriform to fusiform in shape.

The plant dioecious. Receptacle terete, tapering upwards, with short stipe, formed singly in axil of stipule-like leaflet, arranging in racemose or paniculate disposition. Female receptacle 9–12 mm long, 0.5–1.0 mm in diameter. Male one longer than the female, 15–18 mm long. Receptacles usually simple, but rarely smaller receptacle or vesicle proliferating laterally. Maturation period May to July.

This species grows near low water mark, on the open coast with good exchange of sea water, forming a thick coverage on rather flat rock surface. The holdfast is often covered by drift sand.

Specimens examined: HONSHU: Ena, Fukushima Pref., Jul. 1, 1981, leg. K. TANIGUCHI, SAP 041892; Onahama, Fukushima, Pref., Apr. 1924, leg. M. HIGASHI, SAP 034221; Kawarago, Ibaraki Pref., May 17, 1935, leg. S. KAWABATA, SAP 042042; Futomi, Chiba Pref., June 4, 1977, leg. T. KONNO, SAP 041895; Futomi, Chiba Pref., Dec. 24, 1978, leg. T. KONNO, SAP 041894; Shichiriga-hama, Kanagawa Pref., May. 1924, leg. Y. YAMADA, SAP 034228; Shichiriga-hama, Kanagawa Pref., Apr. 4, 1981, leg. T. YOSHIDA, SAP 041893; Enoshima, Kanagawa Pref., May 14, 1933, leg. K. OKAMURA, SAP Herb. Okamura; Omaezaki, Shizuoka Pref., Mar. 28, 1982, leg. T. YOSHIDA, SAP 041965.

The holdfast of this species is unique in the genus. A flat discoid holdfast is constructed by horizontally expanding rhizomatous filaments, which are apparent only in peripheral parts. A tangential section of the holdfast shows clearly this construction distinguishable by the disposition of brown pigment in the epidermal layer of original finger-like filaments. New growing apices differentiate on the flat disc, and by this process, vegetative multiplication is maintained. Although this type of multiplication of shoots may occur in

Fig. 28. Holotype of *Sargassum ammophilum* YOSHIDA et T. KONNO. "Futomi, Chiba Pref., May 25, 1978, leg. T. KONNO" SAP 041891.

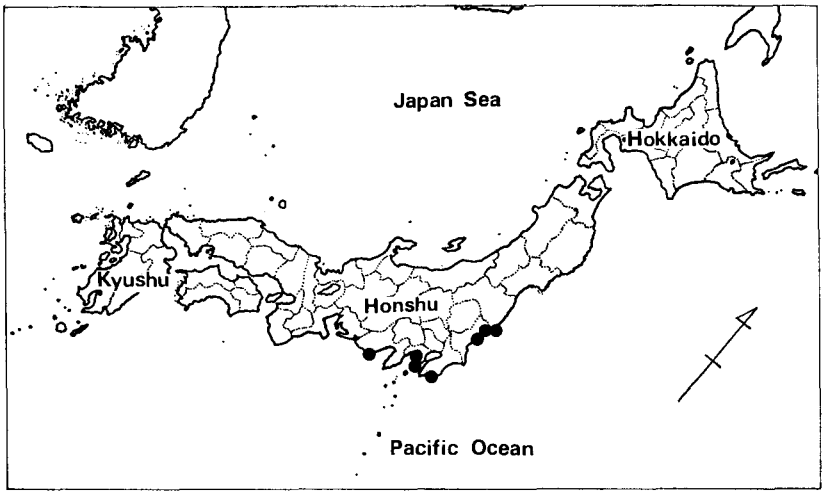

Fig. 29. Distribution of *Sargassum ammophilum*, compiled from specimens in SAP.

S. patens or *S. piluliferum*, it is exceptional in the *Bactrophycus*.

This species was sometimes confused with *S. muticum* (as *S. kjellmanianum*) by several authors. When the specimens are devoid of basal part, distinction becomes somewhat difficult. Larger leaf, spinal processes on the branch and bigger vesicle of *S. ammophilum* can be reliable in separation from *S. muticum*. Dioecism is another distinction from the latter.

10. *Sargassum hemiphyllum* (TURNER) C. AGARDH 1820 : 39.

(Figs. 30–32)

C. AGARDH 1824 : 307. J. AGARDH 1848 : 331 ; 1889 : 61 ; 1896 : 56. DE TONI 1895 : 26. YENDO 1907 : 99, *pl. 13, f. 7–17*. GRUNOW 1915 : 350. OKAMURA 1916 : 204 ; 1924 : 48, *pl. 213* ; 1936 : 342. SEGAWA 1956 : 51, *pl. 30*, No. 228.

Fucus hemiphyllus TURNER 1811 : 86, *pl. 167*. Holotype: BM(K) "In portu Nangasaki Japoniae, HORNER" (Fig. 31 A).

Spongocarpus hemiphyllus (TURNER) KÜTZING 1849 : 632 ; 1860 : 32, *pl. 90, f. 2*.

Sargassum hemiphyllum var. *micromerum* J. AGARDH 1889 : 62. DE TONI 1895 : 27. Lectotype: LD (Herb. Agardh No. 2987 "ad oras Japoniae, Kap Nomo, 1882-6-28, leg. J. PETERSEN") (Fig. 31 C).

Sargassum micromerum (J. AGARDH) J. AGARDH 1896 : 57.

Sargassum hemiphyllum var. *anisophyllum* GRUNOW 1915 : 351. Type not located "ad Lemma Island, leg. C. WRIGHT".

Sargassum hemiphyllum var. *anisophyllum* f. *edentata* GRUNOW 1915 : 351. Type not located "ad litora orientalia Japoniae, leg. C. WRIGHT".

Sargassum hemiphyllum f. *serrata* P. H. HO 1967 : 276. Type not located "Nha-Trang, Vietnam".

Sargassum henslowii GREVILLE 1848: 85, *pl. 6, f. 1.* Type not located "in mari Chinensi".

Japanese name: Iso-moku.

Thallus usually less than 1 m high. Holdfast composed of many radiating filamentous outgrowths from the basal part of the stem. These filaments up to 2-3 cm long, 0.8 mm wide, branched irregularly several times, creeping to form a mat on the substratum. Stem upright, short in length, less than 1.5 cm and 1.5-2 mm wide, terete or angulate and unbranched. Several main branches issued spirally from the terminal part of the stem. Main branch triangular in cross section with rounded ridges, 1.5-2 mm wide, sending off many lateral branches. Several leaves formed near the base of main branch spreading horizontally, and upper leaves becoming vertical in direction. Phyllotaxis of the leaf 1/3 on the main branch. Horizontally expanding lower leaves elliptical to long elliptical in shape, 1.5 cm long and 0.7 cm wide, with cuneate base and obtuse apex, having coarsely serrate margin and inconspicuous midrib near the base. Vertically expanding leaves on main and lateral branches markedly hemiphyllous in shape, 1-1.5 cm long and 0.5 cm wide, with minute serration on lower margin. Leaves on distal part becoming smaller and narrower to linear in shape. Midrib not discernible. Crysptostomata scattered on the leaf. Vesicle elliptical or pyriform to fusiform, with apex mucronate or terminated into short filiform coronal leaf or short leaf

Fig. 30. *Sargassum hemiphyllum* (TURNER) C. AGARDH. A, terminal part of the plant with receptacles. B, basal part.

running down for short distance to form wings, up to 5 mm long and 1.5 mm wide.

The plant dioecious. Receptacle terete, shortly stipitate and tapering upward. Female receptacle 2-3 mm long and 0.7 mm wide, Male one up to 7 mm long and 0.6 mm in diameter. Receptacle disposing racemosely or paniculately on the distal parts. Maturation in spring to early summer.

This species grows on rocks of lower intertidal to subtidal zones, in the area rather protected from strong wave action.

Specimens examined: HONSHU: Kominato, Chiba Pref., Mar. 29, 1978, leg. T. YOSHIDA, SAP 034511; Futomi, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 042070; Mikura-jima, Tokyo Pref., May 12, 1954, leg. S. FUNAHASHI, SAP 035188-9; Jyogashima, Kanagawa Pref., Apr. 28, 1979, leg. T. YOSHIDA, SAP 034682; Aburatsubo, Kanagawa Pref., Apr. 3, 1981, leg. T. YOSHIDA, SAP 035495; Misaki, Kanagawa Pref., May 1942, leg. Y. YAMADA, SAP 022274-5; Arasaki, Kanagawa Pref., Dec. 29, 1977, leg. H. MOROHOSHI, SAP 034509; Chojyagasaki, Kanagawa Pref., Apr. 3, 1981, leg. T. YOSHIDA, SAP 035494; Enoshima, Kanagawa Pref., Apr. 1, 1932, leg. Y. YAMADA, SAP 013020; Nabeta, Shizuoka Pref., Mar. 31, 1976, leg. T. YOSHIDA, SAP 034505; Nishiura, Shizuoka Pref., June 2, 1981, leg. F. HAYASHIDA, SAP 035722; Sugashima, Mie Pref., June 8, 1944, leg. N. TAKAMINE, SAP 043605; Wagu, Mie Pref., Apr. 26, 1955, leg. Y. TSUJI, SAP 042083; Goza, Mie Pref., May 11, 1979, leg. T. YOSHIDA, SAP 034678; Hamashima, Mie Pref., May 10, 1979, leg. T. YOSHIDA, SAP 034676; Nagashima, Mie Pref., May 13, 1979, leg. T. YOSHIDA, SAP 034679; Katsuura, Wakayama Pref., Apr. 3, 1957, leg. Y. TSUJI, SAP 041969; Taiji, Wakayama Pref., May 13, 1979, leg. T. YOSHIDA, SAP 034673; Kushimoto, Wakayama Pref., Apr. 6, 1981, leg. H. KAWAI, SAP 035493; Shionomisaki, Wakayama Pref., Apr. 2, 1954, leg. Y. TSUJI, SAP 034807; Shirahama, Wakayama, Pref., Apr. 7, 1981, leg. H. KAWAI, SAP 035492; Seto, Wakayama Pref., Apr. 1, 1970, leg. M. MASUDA, SAP 041987; Tanabe, Wakayama Pref., Apr. 1, 1957, leg. Y. TSUJI, SAP 041979; Futami, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034497; Yuya, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034499; Tateishi, Yamaguchi Pref., Apr. 24, 1979, leg. T. YOSHIDA, SAP 034672; Kiwado, Yamaguchi Pref., Apr. 23, 1979, leg. T. YOSHIDA, SAP 034671; Omi-jima, Yamaguchi Pref., June 8, 1978, leg. T. YOSHIDA, SAP 034491; Hamada, Shimane Pref., Aug. 30, 1964, leg. T. YAMAMOTO, SAP 034517; Tatamigaura, Shimane Pref., June 9, 1978, leg. T. YOSHIDA, SAP 034494; Nima, Shimane Pref., Sept. 2, 1933, leg. TAKAKI, SAP 034513; Hinomisaki, Shimane Pref., Aug. 8, 1942, leg. Y. NAKAMURA, SAP 034924; Katsura-shima, Shimane Pref., May 21, 1982, leg. S. KAWAGUCHI, SAP 042188; Shichirui, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 034492; Kasumi, Hyogo Pref., June 11, 1978, leg. T. YOSHIDA, SAP 034490; Tango, Kyoto Pref., May 18, 1982, leg. S. KAWAGUCHI, SAP 042186; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 034493; Nagahashi, Fukui Pref., Aug. 8, 1942, leg. Y. NAKAMURA, SAP 034922; Oshima, Fukui Pref., Aug. 7, 1942, leg. Y. NAKAMURA, SAP 034921; Wajima, Ishikawa Pref., Aug. 27, 1934, leg. T. TERAOKA, SAP 034923; Rokugo-zaki, Ishikawa Pref., May 15, 1982, leg. S. KAWAGUCHI, SPA 042224; Takenoura, Ishikawa Pref., May 15, 1982, leg. S. KAWAGUCHI, SAP 042187; Akasaki, Ishikawa Pref., May 28, 1976, leg. K. TANIGUCHI, SAP 042022; Ushitsu, Ishikawa Pref., Aug. 25, 1976, leg. K. TANIGUCHI, SAP

042014; Ogi, Ishikawa Pref., Aug. 23, 1976, leg. Y. NAKAMURA, SAP 034524; Kashiwazaki, Niigata Pref., June 13, 1932, leg. IKEGAMI, SAP 034513; Sado, Niigata Pref., Nov. 20, 1955, leg. M. NODA, SAP 034521; Awashima, Niigata Pref., May 12, 1956, leg. M. NODA, SAP 034520; Kamo, Yamagata Pref., Aug. 1956, leg. T. KANAMORI, SAP 034516; Fukaura, Aomori Pref., June 11, 1956, leg. S. KAWASHIMA, SAP 028687-8; Tanosawa, Aomori Pref., Oct. 2, 1982, leg. M. NOTOYA, SAP 043283.

SHIKOKU: Nomi-wan, Kochi Pref., May 25, 1979, leg. T. YOSHIDA, SAP 034681; Sukumo, Kochi Pref., May 29, 1979, leg. T. YOSHIDA, SAP 034680; Funakoshi, Ehime Pref., May 30, 1979, leg. T. YOSHIDA, SAP 034675; Sunokawa, Ehime Pref., May 23, 1982, leg. T. YOSHIDA, SAP 042155; Karitsu, Ehime Pref., May 22, 1982, leg. T. YOSHIDA, SAP 042158; Totoshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 042157; Toshima, Ehime Pref., May 21, 1982, leg. M. MARUI, SAP 042156; Ikata, Ehime Pref., Apr. 7, 1955, leg. Y. NOMURA, SAP 034502-3; Misaki, Ehime Pref., May 31, 1979, leg. T. YOSHIDA, SAP 034677; Marukami-shima, Kagawa Pref., Apr. 12, 1960, leg. S. INUMARU, SAP 028726.

KYUSHU: Tsukumi, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 035751; Usuki, Oita Pref., Feb. 4, 1924, leg. SUZUKI, SAP 034504; Kadokawa, Miyazaki Pref., May 24, 1982, leg. T. YOSHIDA, SAP 042152; Natsui, Kagoshima Pref., June 12, 1980, leg. T. YOSHIDA, SAP 034794; Ushinohama, Kagoshima Pref., June 13, 1980, leg. T. YOSHIDA, SAP 034784; Tomioka, Kumamoto Pref., Mar. 1931, leg. Y. YAMADA, SAP 021511-2; Misumi, Kumamoto Pref., Feb. 9, 1959, leg. M. ICHIKI, SAP 034849; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 034641; Nomozaki, Nagasaki Pref., June 4, 1978, leg. T. YOSHIDA, SAP 034495; Hirado-jima, Nagasaki Pref., May 26, 1983, leg. T. YOSHIDA, SAP 043690; Fukue, Nagasaki Pref., Jul. 26, 1942, leg. YAMADA and NAKAMURA, SAP 034523; Sakiyama, Nagasaki Pref., Jul. 26, 1942, leg. YAMADA and NAKAMURA, SAP 023824-5; Katsura-jima, Nagasaki Pref., Jul. 28, 1942, leg. YAMADA and NAKAMURA, SAP 023877-9; Ojika, Nagasaki Pref., Jul. 31, 1942, leg. YAMADA and NAKAMURA, SAP 034920; Hado-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043727; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043658; Tsuyazaki, Fukuoka Pref., Oct. 15, 1977, leg. T. YOSHIDA, SAP 034514; Iwaya, Fukuoka Pref., June 5, 1981, leg. T. YOSHIDA, SAP 035700.

KOREA: Cheju Island, Aug. 11, 1979, leg. S. A. YOO, SAP 034600.

The holototype of this species (Fig. 31 A) is a sterile fragment now deposited in BM (K). This is well illustrated by TURNER in his 'Hist. Fuc.' pl. 167 (Fig. 31 B), which was reproduced in KÜTZING's Tabulae vol. 10, pl. 90, f. 2.

Later, J. AGARDH (1889) described 2 varieties of this species, *i. e.*, var. *micromerum* and var. *chinense*. The lectotype of var. *micromerum* (Fig. 31 C) was collected at Cape Nomo, located about 20 km from Nagasaki Port, the type locality of *Fucus hemiphyllus*. I am of opinion that there is no need to distinguish var. *micromerum*. Hemiphyllous shape of leaves is often inconspicuous in the population growing on the coast of Japan Sea. In the population of Pacific coast, leaves are often wider and conspicuously hemiphyllous.

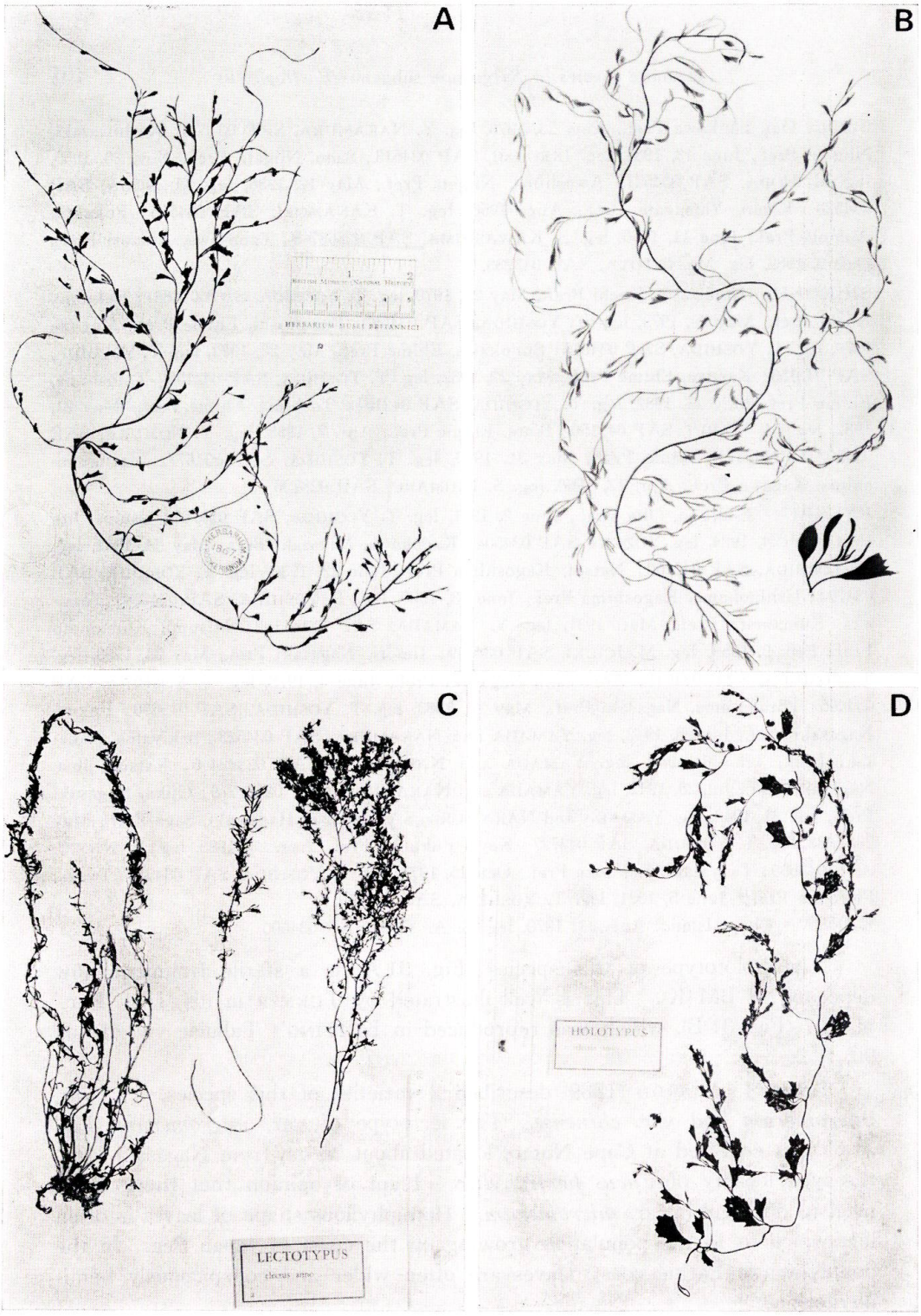

Fig. 31. A. Holotype of *Fucus hemiphyllus* TURNER. "In portu Nangasaki Japoniae, HORNER" BM. B. Illustration of *Fucus hemiphyllus* TURNER, Hist. Fuc. Pl. 167. C. Lectotype of *Sargassum hemiphyllum* var. *micromerum* J. AGARDH. "ad oras Japoniae" LD, Herb. Agardh No. 2987. D. Holotype of *Sargassum hemiphyllum* var. *chinese* J. AGARDH. "Hong Kong, ARESCHOUG" LD, Herb. Agardh No. 2983.

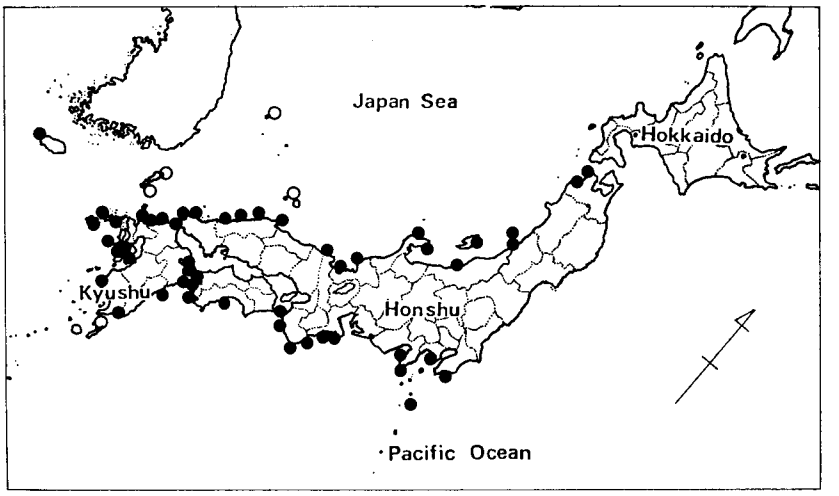

Fig. 32. Distribution of *Sargassum hemiphyllum*. Solid circles compiled from specimens in SAP, and open circles from SEGAWA & KAMURA (1960), CHIHARA & YOSHIZAKI (1970), KANG (1965) and KAJIMURA (1975).

Var. *chinense* (=*S. chinense*), with the type locality in Hong Kong (Fig. 31 D), has larger leaves when compared with Japanese population. Relations between Japanese and Chinese population need further study.

Under this species several subspecific taxa were described other than those of J. AGARDH, namely var. *anisophylla* GRUNOW (1915, p. 351), f. *edentata* GRUNOW (1915, p. 351) and f. *serrata* HO (1967, p. 276). As I have not yet examined the types of these taxa, I have no opinion as for the validity of them.

S. henslowii GREVILLE (1848, p. 85) was usually referred as a synonym under *S. hemiphyllum* (J. AGARDH 1889). His figure (pl. 6, f. 1) is too fragmentary to give enough idea as for the identity.

Earlier records of *S. nipponicum* from the coast of Japan Sea may be referable to *S. hemiphyllum*, judged from the specimens in SAP.

11. *Sargassum nipponicum* YENDO 1907 : 153, *pl. 17, f. 11-16.* (Figs. 33-35)

OKAMURA 1916 : 215 ; 1928 : 186, *pl. 249* ; 1936 : 341. SEGAWA 1956 : 51, *pl. 30*, No. 227.
Lectotype : TI "Takamatsu, Hiuga Prov., July 1900" (Fig. 34).

Japanese name : Tama-nashi-moku (YENDO)

Thallus less than 1 m long. Holdfast composed of a small disc and filamentous outgrowths about 1 mm in diameter. The filaments growing out

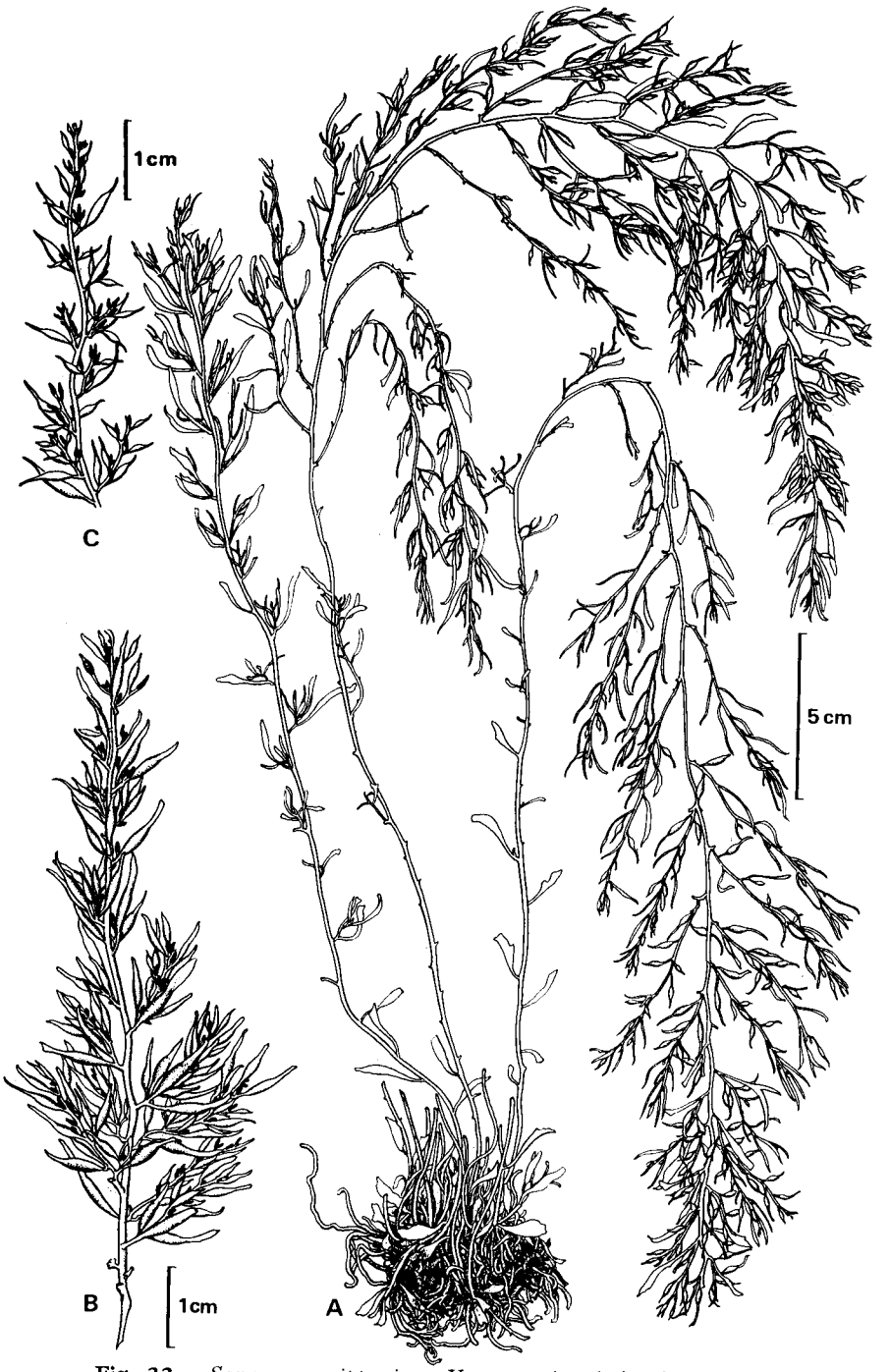

Fig. 33. *Sargassum nipponicum* YENDO. A, whole plant, B, C, terminal part with receptacles.

rather freely, branching irregularly and intricated with each other, forming a dense mat up to 10 cm in diameter, covering the substratum. Stem upright, short in length, without branching. Main branches slender and smooth, often slightly angulate, less than 1 mm wide. Leaf linear to linear oblanceolate, sometimes slightly hemiphyllous tapering toward the filiform stipe, up to 25 mm long and 4 mm wide. Midrib immersed and vaguely discernible only in the lower leaves when dried. Leaves on the lower part of the main branch expanding horizontally. Leaves on the upper part of the main branch and lateral branches narrow linear. Cryptostomata small and few in number, difficult to discern. Lateral branches much shorter in length than the main branch. Vesicles few in number especially in younger thalli, slender fusiform, tapering towards both ends, 5 mm long and 1 mm in diameter, with linear or filiform coronal leaf up to 4 mm long.

Plant dioecious. Receptacle terete, formed singly or racemosely on ramulet in axil to subtending linear leaf, usually simple, very rarely once forked. Female receptacle 2–3 mm long, 0.5 mm in diameter. Male one longer than the female, up to 5 mm long. Maturation in summer.

This species grows on steep rock surface, exposed to strong wave action, in lower intertidal and upper subtidal zones.

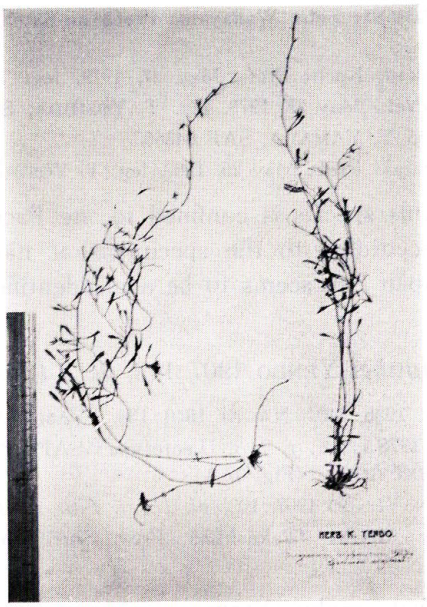

Fig. 34. Lectotype of *Sargassum nipponicum* YENDO. "Takamatsu, Prov. Hiuga, July 1900" TI.

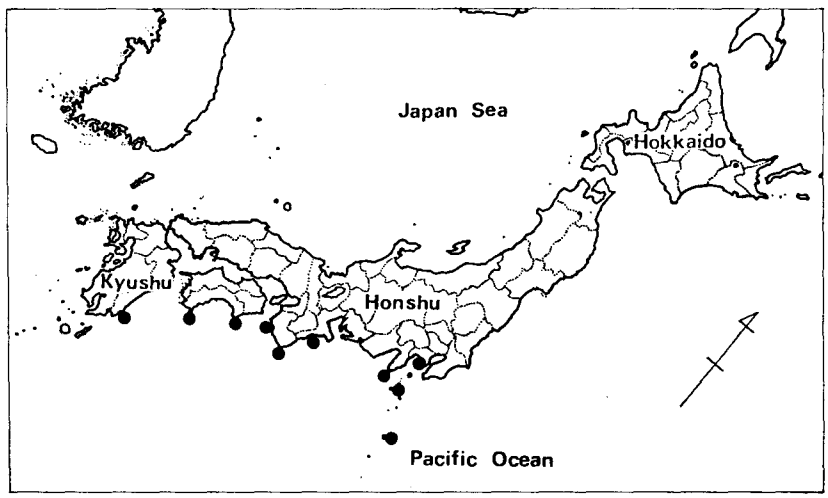

Fig. 35. Distribution of *Sargassum nipponicum*, compiled from specimens in SAP.

Specimens examined: HONSHU: Hachijo-jima, Tokyo Pref., Jul. 12, 1929, leg. H. KIKKAWA, SAP Herb. Okamura; Shikine-jima, Tokyo Pref., Aug. —, leg. S. INOH, SAP 034868; Enoshima, Kanagawa Pref., June 1925, leg. Y. YAMADA, SAP 034808; Shimoda, Shizuoka Pref., Aug. —, leg. T. TANAKA, SAP 034869; Nagashima, Mie Pref., May 13, 1979, leg. T. YOSHIDA, SAP 034685; Seto, Wakayama Pref., no date, leg. J. IKARI, SAP Herb. Okamura.
SHIKOKU: Muroto-misaki, Kochi Pref., May 27, 1979, leg. T. YOSHIDA, SAP 034683; Ashizuri-misaki, Kochi Pref., May 28, 1979, leg. T. YOSHIDA, SAP 034684; Kashiwa-jima, Kochi Pref., Jul. 1941, leg. Y. YAMADA, SAP 043665.
KYUSHU: Nango, Miyazaki Pref., May 25, 1982, leg. T. YOSHIDA, SAP 042181.

Distribution of this species is confined to the Pacific coast of Japan, as shown in Fig. 35, according to the specimens at hand. Previous records from the coast of Japan Sea seems to be a misidentification of specimens of *S. hemiphyllum*.

12. *Sargassum miyabei* YENDO 1907:112, *pl. 14, f. 13-14.* (Figs. 36-38)

OKAMURA 1916:205; 1936:340. NAGAI 1940:136. YAMADA 1944:225, *f. 1.* TOKIDA 1954:139. YOSHIDA 1978a:121, *f. 1-3.* Lectotype: SAPA "Cape Soya, Prov. Kitami, July 18, 1892, leg. FUKUSHIMA" (Fig. 37 A).

Sargassum kjellmanianum YENDO 1907:102, *pl. 15, f. 1-5.* OKAMURA 1916:202. NAGAI 1940:135. Lectotype: SAPA "Takashima, Prov. Shiribeshi, June 4, 1901, leg. K. MIYABE" (Fig. 37 B).

Japanese name: Miyabe-moku (YENDO)

Thallus less than 1 m high. Holdfast small discoid up to 1 cm in diame-

ter. Disc with smooth periphery at first, later many fibrous outgrowths about 1 mm in diameter issued from the disc. New shoot arising from the terminal part of the fibrous creeping outgrowths (Fig. 36 A). Stem erect, short in length less than 2 cm high, terete and simple, 2-3 mm in diameter. Several main branches issued spirally from the terminal part of the stem, 1.5-2 mm wide, angular. Lateral branches numerous. Leaf arranged spirally on the branch, with 1/3 to 2/5 phyllotaxis, narrow lanceolate in shape, 10-

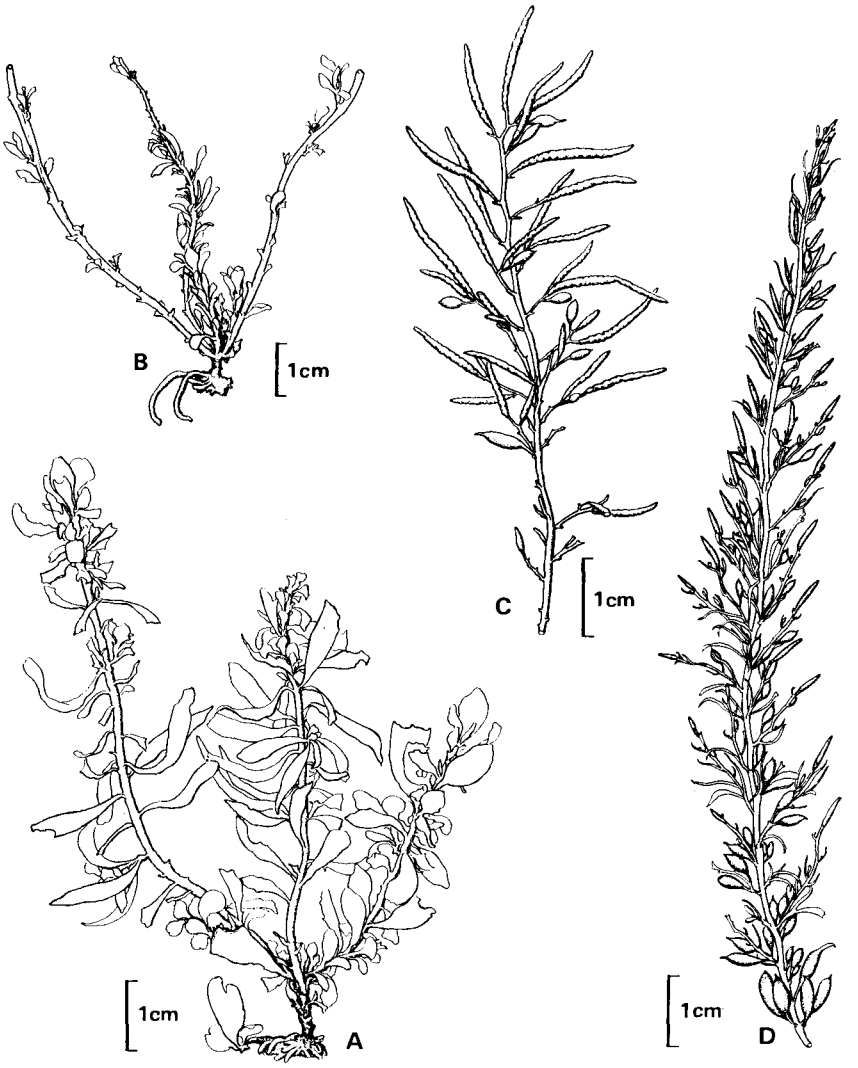

Fig. 36. *Sargassum miyabei* YENDO. A, B, basal part of young plant. C, male receptacles. D, terminal part of female plant with receptacles.

15 mm long and 1-2 mm wide, sometimes asymmetrical in outline, usually with entire margin, often dentate near the apex, gradually attenuated towards the base. Stipe short, filiform and delicate. Midrib absent. Lower leaf expanded horizontally. Upper leaf becoming vertically directed. Cryptostomata scattered on leaves and vesicles. Vesicles fusiform in shape, 5-6 mm long and 1.5 mm in diameter, mucronate or with short linear coronal leaf.

The plant dioecious. Receptacle terete, tapering towards the apex. Female receptacle up to 10 mm long and 1.2 mm in diameter. Male one 15-20 mm long, slenderer than the female. Receptacles disposed in racemose or planiculate manner. Maturation in summer.

This species grows on rocks of lower intertidal or upper subtidal levels of rather protected area, forming a zone just below that of *S. thunbergii*.

Specimens examined: HOKKAIDO: Nemuro, Aug. 3, 1929, leg. S. AKIYAMA, SAP 021027; Erimo-misaki, Hidaka Prov., Aug. 3, 1955, leg. Y. TSUJI, SAP 034817; Hakodate, Oshima Prov., Oct. 12, 1890, leg. NOZAWA, SAPA; Fukushima, Oshima Prov., June 8, 1890, leg. NOZAWA, SAPA; Yoshioka, Oshima Prov., Aug. 17, 1958, leg. N. TAZAWA, SAP 034840; Shirakami-misaki, Oshima Prov., Apr. 25, 1978, leg. T. YOSHIDA, SAP 034175; Matsumae, Oshima Prov., May 3, 1977, leg. M. OHTA, SAP 034182; Era, Oshima Prov., June 22, 1891, leg. TANAKA, SAPA; Esashi, Hiyama Prov., Apr. 26, 1978, leg. T. YOSHIDA, SAP 034174; Okushiri-jima, Hiyama Prov., Jul. 2, 1943, leg. Y. HASEGAWA, SAP 025131; Setana, Hiyama Prov., Mar. 28, 1945, leg. Y. YAMADA, SAP 025363; Tomari, Shiribeshi Prov., Aug. 3, 1954, leg. Y. TSUJI, SAP 034814; Kamoenai, Shiribeshi Prov., Aug. 1, 1954, leg. Y. TSUJI, SAP 034813; Yoichi, Shiribeshi Prov., May 10, 1891, leg. WATANABE, SAPA; Oshoro, Shiribeshi Prov., Aug. 7, 1977, leg. T. YOSHIDA, SAP 034180; Takashima, Shiribeshi Prov., June 4, 1901, leg. K. MIYABE, SAPA; Zenibako, Shiribeshi Prov., Jul. 18, 1887, leg. S. HORI, SAPA; Tomamae, Rumoi Prov., Jul. 1943, leg. T. TANAKA, SAP 034915; Teuri-jima, Rumoi Prov., Aug. 18, 1943, leg. T. TANAKA, SAP 034913; Yagishiri-jima, Rumoi Prov., Aug. 18, 1960, leg. I. YAMADA, SAP 035406; Rishiri-jima, Soya Prov., Sept. 7, 1896, leg. W. HIROSE, SAPA; Rebun-to, Soya Prov., Aug. 1, 1953, leg. I. UMEZAKI, SAP 034178; Bakkai, Soya Prov., May 19, 1978, leg. T. YOSHIDA, SAP 034171; Soya-misaki, Soya Prov., Jul. 18, 1892, leg. FUKUSHIMA, SAPA; Saroma-ko, Abashiri Prov., Aug. 16, 1960, leg. T. YAMAMOTO, SAP 034181; Abashiri, Aug. 14, 1960, leg. Y. YAMADA, SAP 034185; Shiretoko-misaki, Nemuro Prov., Sept. 15, 1943, leg. Y. YAMADA, SAP 024336; Sashirui, Nemuro Prov., Aug. 27, 1968, leg. Y. YAMADA, SAP 034179; Rausu, Nemuro Prov., Jul. 15, 1936, leg. T. TANAKA, SAP 034183.

HONSHU: Matsugahama, Miyagi Pref., Mar. 28, 1978, leg. T. YOSHIDA, SAP 034158; Yonesaki, Iwate Pref., June 3, 1954, leg. S. KAWASHIMA, SAP 026888; Miyako, Iwate Pref., Aug. 9, 1952, leg. S. KAWASHIMA, SAP 026891; Kosode, Iwate Pref., Aug. 9, 1952, leg. S. KAWASHIMA, SAP 026890; Ohma, Aomori Pref., Jul. 1929, leg. S. INOH, SAP 8563; Asamushi, Aomori Pref., Jul. 16, 1929, leg. S. INOH, SAP 8566; Fukaura, Aomori Pref., Jul. 19, 1931, leg. T. KANDA, SAP 012862-3; Toga, Akita Pref., Apr. 22, 1982, leg. M. TSUKIDATE, SAP 042123; Funakawa, Akita Pref., Apr. 22, 1982, leg. M. TSUKIDATE, SAP 042124;

Awashima, Niigata Pref., Mar. 18, 1957, leg. M. NODA, SAP 034165; Sado, Niigata Pref., Mar. 31, 1956, leg. M. NODA, SAP 034166; Iwagasaki, Niigata Pref., May 13, 1982, leg. S. KAWAGUCHI, SAP 042229; Maze, Niigata Pref., June 15, 1982, leg. K. KOBAYASHI, SAP 042172; Kashiwazaki, Niigata Pref., June 3, 1981, leg. H. ISHIBASHI, SAP 035729; Kujiranami, Niigata Pref., Jan. 7, 1932, leg. IKEGAMI, SAP 021033; Amaharashi, Toyama Pref., May 1931, leg. K. OSHIMA, SAP 034167; Ushizu, Ishikawa Pref., May 25, 1976, leg. K. TANIGUCHI, SAP 042018; Maizuru, Kyoto Pref., June 12, 1978, leg. T. YOSIHDA, SAP 034161.
KURILE ISLANDS: Shikotan-to, Jul. 1934, leg. S. KAWABATA, SAP 015619-20; Ponkotan, Kunashiri-to, Jul. 31, 1936, leg. M. NAGAI, SAP 021997; Nishi-shoro, Kunashiri-to, Jul. 13, 1893, leg. WATANABE, SAPA; Shana, Etorofu-to, Aug. 1890, leg. S. FUJIMURA, SAPA.
USSR: Ussuri Bay, June 2, 1928, leg. KUZNETZOV, SAP 032467.

YOSHIDA (1978 a) concluded that *S. miyabei* YENDO and *S. kjellmanianum* YENDO were synonymous, after examining the syntypes of both species deposited in SAPA and selecting the lectotype for each species (Fig.

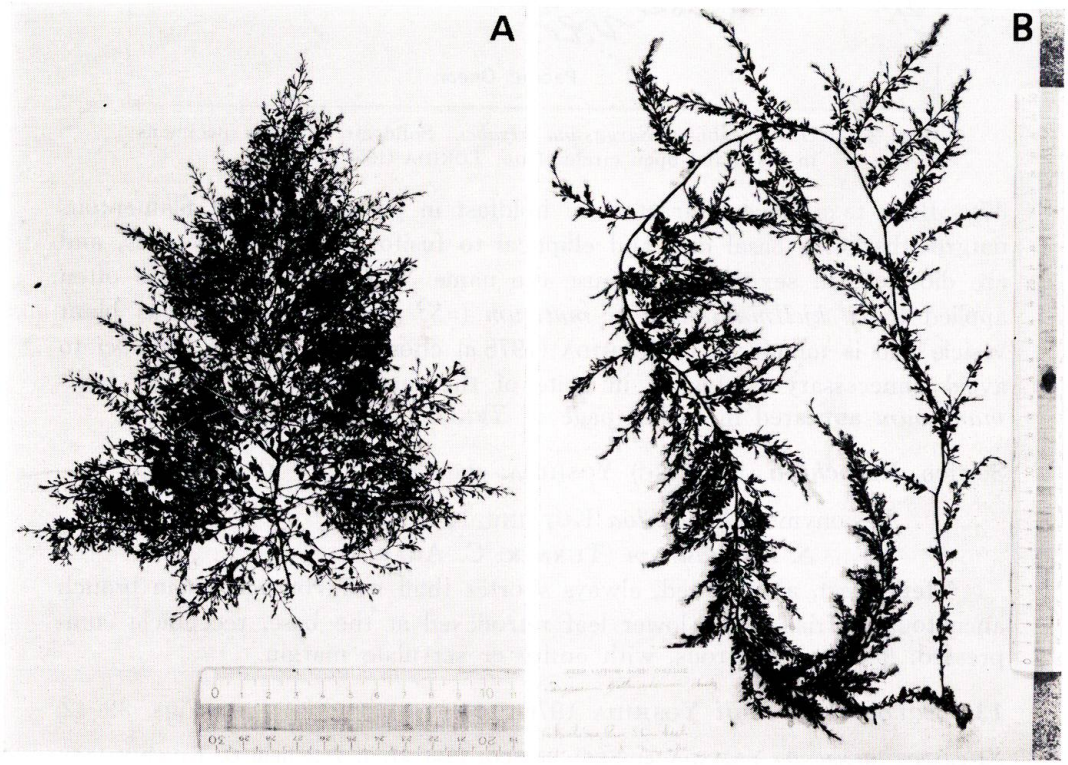

Fig. 37. A. Lectotype of *Sargassum miyabei* YENDO. "Cape Soya, Prov. Kitami, Hokkaido, July 18, 1892, leg. FUKUSHIMA" SAPA. B. Lectotype of *Sargassum kjellmanianum* YENDO. "Takashima, Prov. Shiribeshi, Hokkaido, June 4, 1901, leg. K. MIYABE" SAPA.

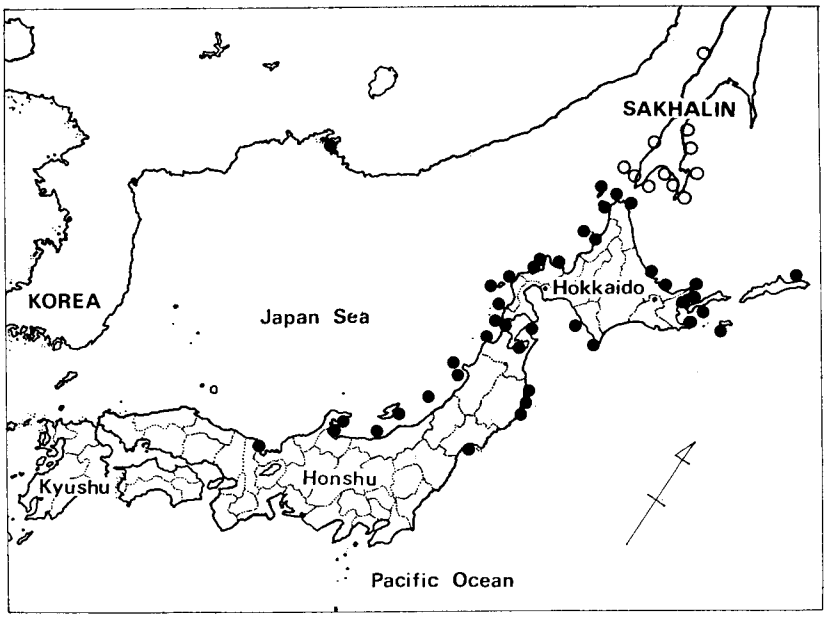

Fig. 38. Distribution of *Sargassum miyabei*. Solid circles from specimens in SAP, and open circles from TOKIDA (1954).

37). Both taxa have characteristic holdfast in possessing short filamentous outgrowths from basal disc and elliptical to fusiform apiculate vesicles, and are dioecious in sexuality. Because the name *S. kjellmanianum* was often applied to *S. kjellmanianum* f. *muticum* (=*S. muticum*), which has blunt vesicle and is monoecious, YOSHIDA (1978 a) chose the name *S. miyabei* to avoid unnecessary confusion, in spite of the fact that the name *S. kjellmanianum* appeared in earlier page of YENDO's monograph.

Section ***Halochloa*** (KÜTZING) YOSHIDA, stat. nov.

Basionym: *Halochloa* KÜTZING 1843: 55.
LT: *S. siliquastrum* (TURNER) C. AGARDH

Stem erect, abbreviated, always shorter than main branch, main branch ancipitous to triangulate, lower leaf retroflexed at the base, receptacle compressed, flat or triquetrous, with entire or serrulate margin.

13. *Sargassum segii* YOSHIDA 1976: 144. (Figs. 39–42)

Sargassum racemosum YAMADA et SEGI in SEGI 1948: 97, *f. 1–2* (non O. KUNTZE 1880). SEGAWA 1956: 52, *pl. 31*, No. 232. Holotype not located. Isotypes: SAP 024849 (Fig. 41 A), 024851 "Nagashima, Kii Prov., Aug. 1941, leg. T. SEGI".

Sargassum ringgoldianum f. *ellipticum* OKAMURA 1936: 333. Holotype: SAP (Herb. Okamura "drift at Hamashima, Mie Pref., Aug. 10, 1929" (Fig. 41 B).

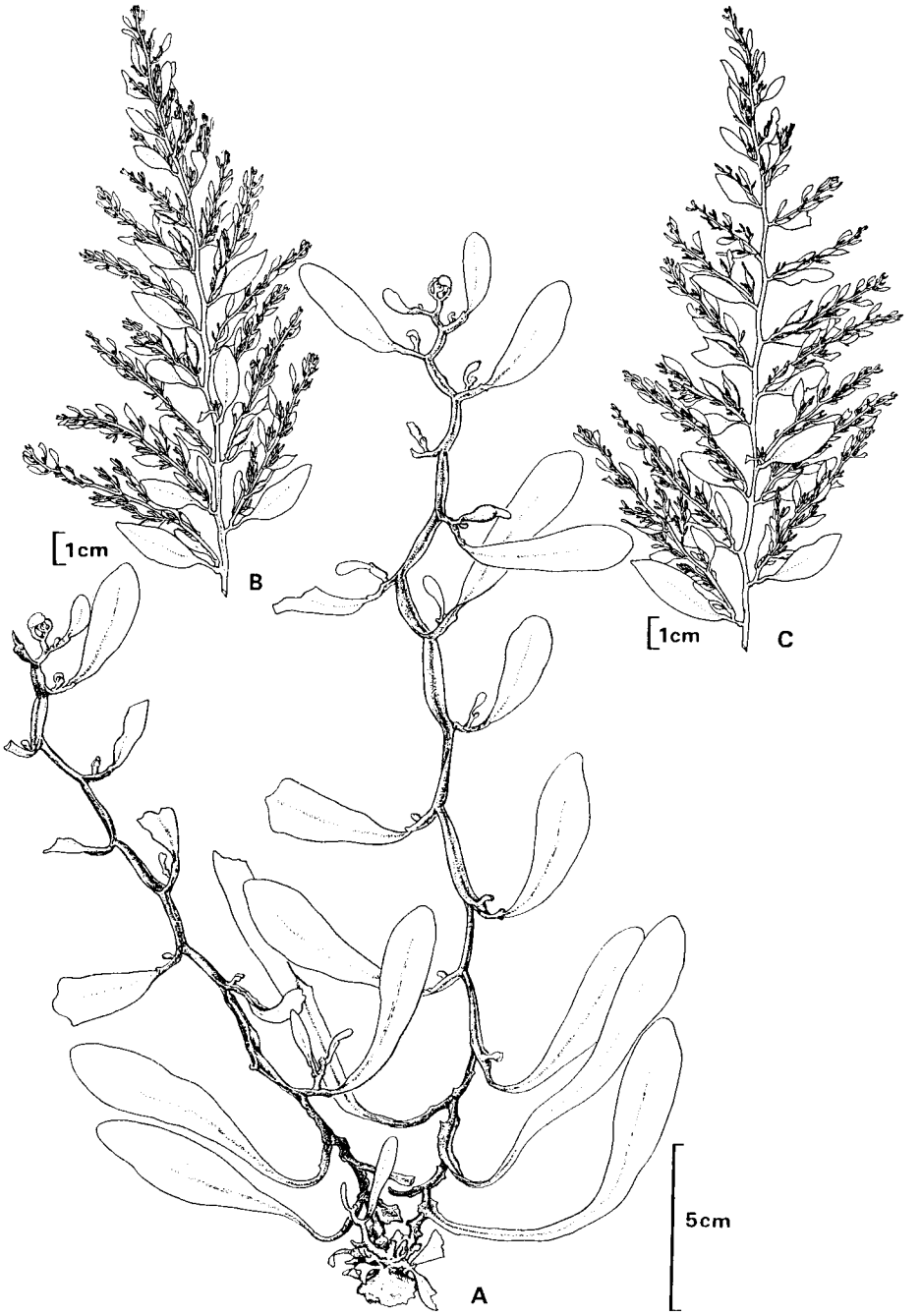

Fig. 39. *Sargassum segii* YOSHIDA. A, young plant. B, C, distal part with male and female receptacles, respectively.

Japanese name: Nagashima-moku (SEGI)

Thallus up to 1 m high. Holdfast conical, 1.5 cm in diameter, composed of several lobes formed from the stem. Stem very short, terete. Several main branches issued spirally from the upper part of the stem. Main branch

Fig. 40. *Sargassum segii* YOSHIDA.

compressed with thinner margin, 5-6 mm in width in the lower part. Margin of the main branch smooth. Phyllotaxis 1/2 at least in lower part of the main branch. Leaves on the lower part of the main branch elongate elliptical to linear lanceolate in shape with cuneate base and obtuse apex, up to 10 cm long and 1-1.5 cm wide. Leaf margin entire. Lower leaves retroflexed conspicuously at the base. First formed several leaves spread horizontally, but upper ones becoming vertical because of the tortion at the transitional part between blade and petiole. Midrib evanescent. Upper leaves oblanceolate in shape with obtuse or acute apex and with entire margin, becoming gradually smaller. Midrib not discernible in smaller leaves. Cryptostomata absent. Vesicle shortly petiolated, linear oblong to obovate in shape, 1-1.7 cm long and 0.3-0.5 cm in diameter, with coronal leaf which extending downwards to form wings. Those on upper branches gradually elongated and often crowned with a linear leaf. They usually formed singly at the base of lateral branch.

The plant dioecious. Receptacles disposed in abbreviated racemes or panicles on upper part of branches. Female receptacles linear in shape, slightly compressed, 2-3 mm long and 0.5-0.7 mm wide, usually provided with a under leaf. Male ones compressed, linear in shape, up to 7 mm long and 1 mm wide. Maturation in autumn to early winter.

This species grows on rocks rather exposed to wave action, subtidally down to 10 m or more deep.

Specimens examined: HONSHU: Nagashima, Mie Pref., Aug. 1941, leg. T. SEGI, SAP 024851, 024849; Nakiri, Mie Pref., Oct. 28, 1941, leg. Y. YAMADA, SAP 034637-9; Goza, Mie Pref., May 11, 1979, leg. T. YOSHIDA, SAP 034598; Wagu, Mie Pref., June 1942, leg. S. INOH, SAP 034687; Iwai-zaki, Mie Pref., Oct. 26, 1981, leg. YOSHIDA and KONNO, SAP 038662.

I have not yet located the specimen clearly designated as type by original authors. The specimens in SAP cited above (SAP 024849, 024851) can certainly be assumed as isotypes. Characteristic basal part with very short stem, elliptical to lanceolate leaves and slender receptacles racemosely or paniculately disposed on abbreviated branches are distinctive features of this taxon. I failed to collect this species at the type locality, Nagashima, Mie Pref. This species seems to be of more common occurrence around eastern coast of Mie Prefecture, and has very restricted area of distribution.

OKAMURA (1936, p. 337) described *S. ringgoldianum* f. *ellipticum*. After examination of the holotype (Fig. 41 B), I came to the conclusion that this is synonymous with *S. segii* in every respects.

SEGI (1948) referred this taxon to the subgenus *Arthrophycus*. Distinction of the 2 subgenera, *Bactrophycus* and *Arthrophycus*, given by J. AGARDH

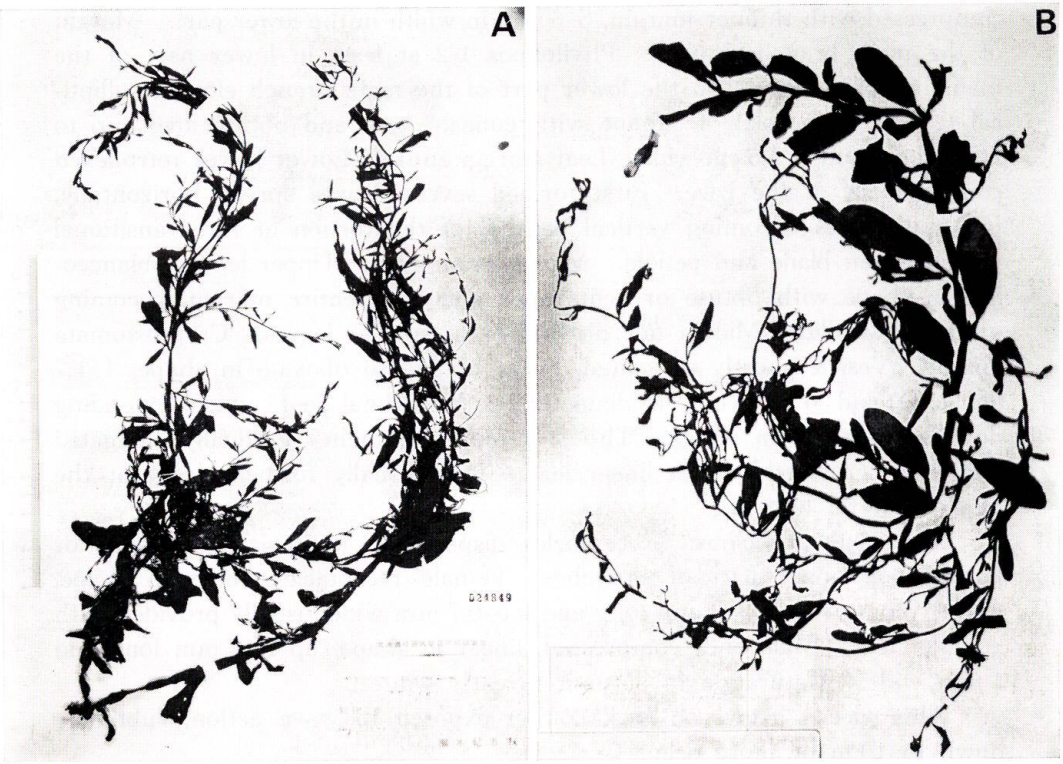

Fig. 41. A. Isotype (?) of *Sargassum racemosum* YAMADA et SEGI. "Nagashima, Kii Prov., Aug. 1941, leg. T. SEGI" SAP 024849. B. Holotype of *Sargassum ringgoldianum* f. *ellipticum* OKAMURA. "drift at Hamashima, Mie Pref., Aug. 10, 1929" SAP, Herb. Okamura.

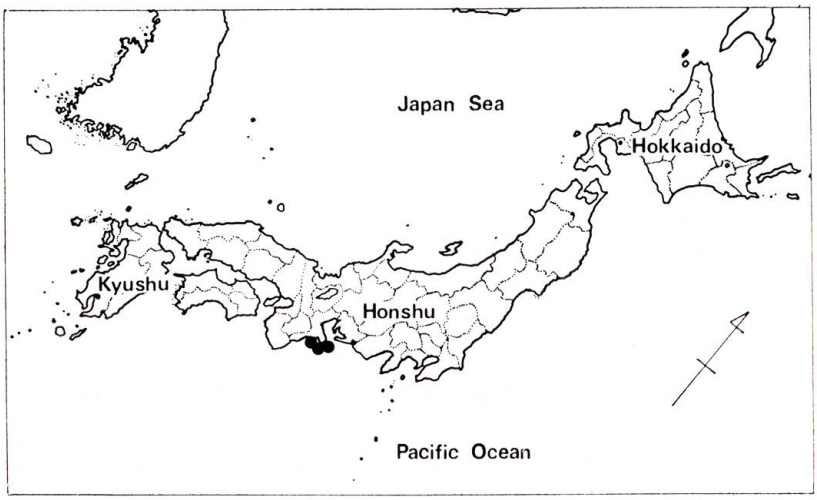

Fig. 42. Distribution of *Sargassum segii*, compiled from specimens in SAP.

(1889) is solely based on the morphology of receptacles. As shown in this enumeration of species, receptacles are not only "simplicia siliquaeformia et inermia" as seen in *S. horneri*, but also spatulate or forked in the other species. At present, as I have not examined any of species belonging to the *Arthrophycus* in living state, discussions on the subgeneric arrangement must be postponed. Here I treat *S. segii* as a species of the *Bactrophycus*, assuming that the *Arthrophycus* is a group occurring only in the southern Hemisphere.

14. *Sargassum yamamotoi* YOSHIDA, spec. nov. (Figs. 43-46)

Sargassum serratifolium sensu YENDO (pro parte) 1907, *pl. 11, f. 1-2.*

Thallus altitudinem 1 vel 2 m. Hapteron conicum vel scutatum sulco radianti, 1-1.5 cm in diametro. Caulis brevissimum, minus quam 1 cm altus, plerumque non ramosus. Aliquot rami principales ad apicem caulis enascentes. Ramus principalis planus, nervo elevato longitudinali et alis marginibus tenuioribus. Margines ramosum principalium integri vel in parte irregulariter dentati. Ramis lateralis numerosi et bene crescentes. Folia enascentia primaria prope partem basalem elliptica, 2-3 cm longa et 1-1.5 cm lata. Folia inferiora lanceolata 10 cm vel longiora et 2 cm lata, basi conspicue retroflexa. Lamina basi in petiolum complanatum abrupte transiens. Apex folii obtusus. Margines folii integri vel irregulariter dentati serrative. Textura folii crassa membranacea. Folia in parte distali versus linearia angustescentia, margine parce dentata. Cryptostomata in pagina folii dispersa. Vesicula grandis obovata vel elliptica, usque ad 2 cm longa et 1.5 cm in diametro, stipite 0.5 cm longo et folio coronae simplici. Vesicula gradatim parvescens et angustescens in parte distali.

Planta dioica. Receptacula in parte distali rami racemose disposita. Receptacula femina oblanceolata, 3-4 mm longa et 1-1.5 mm lata. Receptacula masculina linearia, compressa, 1-3 cm longa et 1-1.5 mm lata. Maturation sero verne et ineunte aestate est.

Holotypus: Nomi-wan, Kochi Pref., maio 25, 1979, leg. T. YOSHIDA, SAP 043447 (Fig. 45). Isotypi in BM, L, LD, PC, UC, US.

Japanese name: Yoremoku-modoki (nov.)

Thallus attaining 1 or 2 m long. Holdfast conical or scutate with radiating furrows, 1-1.5 cm in diameter. Stem very short in length, less than 1 cm high, usually unbranched. A few main branches arising on top of the stem. Main branch ancipitous, 5 mm or more in width, with longitudinal costal elevation and thinner marginal wing portion. Margin of main branch entire or partly irregularly dentate. Lateral branches abundant and well

developed. Lower leaf conspicuously retroflexed at the base. Leaves first formed near the basal part of the main branch elliptical, 2–3 cm long and 1–1.5 cm wide. Leaves succeeding on upper part lanceolate in shape, 10 cm

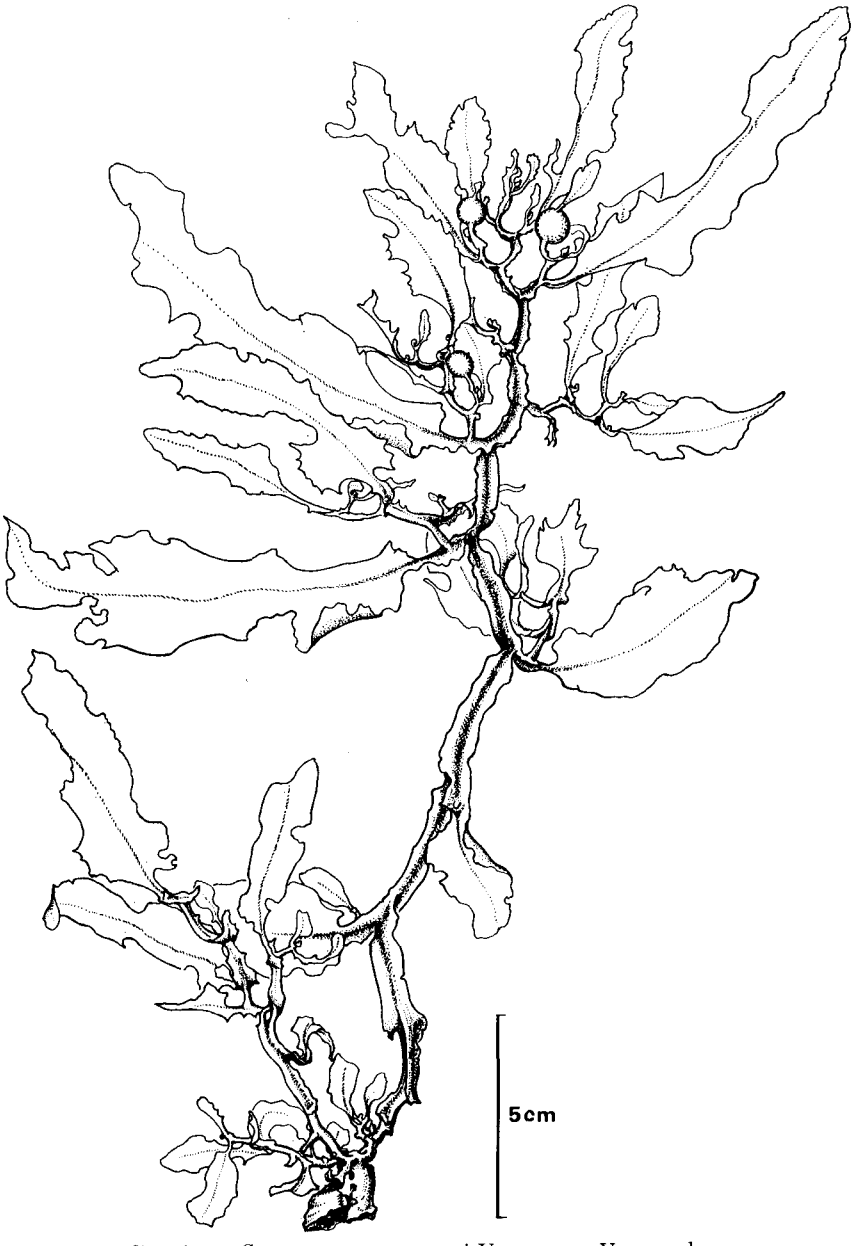

Fig. 43. *Sargassum yamamotoi* YOSHIDA. Young plant.

or more in length and 2 cm in width. Basal part abruptly passing into complanate petiole. Apex obtuse. Margin entire or irregularly dentate or serrate. Texture thick membranaceous. Leaves on distal part becoming narrower to linear in shape with sparse dentation on the margin. Cryptostomata scattered on the leaf surface, Larger vesicle obovoid or elliptical, up to 2 cm long and 1.5 cm in diameter, with stipe 0.5 cm long and simple

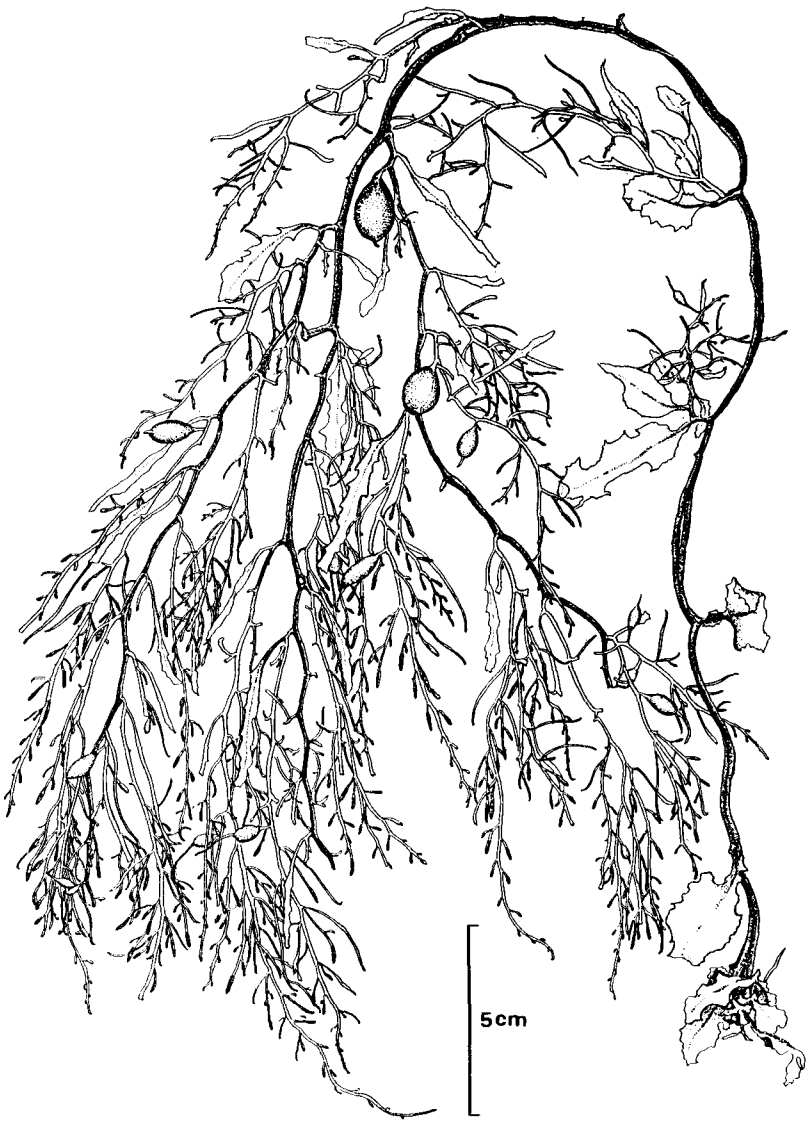

Fig. 44. *Sargassum yamamotoi* YOSHIDA. Fertile plant.

coronal leaf 3 cm long. Vesicles becoming smaller and narrower in distal part.

The plant dioecious. Receptacle disposed racemosely on the distal part of the branches. Female receptacle oblanceolate, 3-4 mm long and 1-1.5 mm wide. Male one linear, compressed, 1-3 cm long and 1-1.5 mm wide. Maturation in late spring to early summer.

This species grows on rocks in the subtidal zone down to 5 m or more deep in the area rather exposed to wave action.

Specimens examined: HONSHU: Tateyama, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 043375; Misaki, Kanagawa Pref., June 1929, leg. S. INOH, SAP 8530; Aburatsubo, Kanagawa Pref., Apr. 3, 1981, leg. T. YOSHIDA, SAP 043432; Shichirigahama, Kanagawa Pref., May 1924, leg. Y. YAMADA, SAP 043446; Shimoda, Shizuoka Pref., Jan. 24, 1961, leg. Sh. SEGAWA, SAP 028373; Nakagi, Shizuoka Pref., June 12, 1975, leg. F. HAYASHIDA, SAP 043427; Mera, Shizuoka Pref., June 11, 1975, leg. F. HAYASHIDA, SAP 043428; Koura, Shizuoka Pref., July 22, 1975, leg. F. HAYASHIDA, SAP 043425; Koshimoda, Shizuoka Pref., June 23, 1975, leg. F. HAYASHIDA, SAP 043426; Omaezaki, Shizuoka Pref., Mar. 28, 1982, leg. T. YOSHIDA, SAP 043431; Iwaizaki, Mie Pref., Oct. 26, 1981, leg. T. KONNO, SAP 043437; Goza, Mie Pref., May 10, 1979, leg. T. YOSHIDA, SAP 043441; Hamashima, Mie Pref., May 10, 1979, leg. T. YOSHIDA, SAP 043442; Nagashima, Mie Pref., May 12, 1979, leg. T. YOSHIDA, SAP 043440; Taiji, Wakayama Pref., May 13, 1979, leg. T. YOSHIDA, SAP 043443; Koza, Wakayama Pref., Oct. 29, 1981, leg. YOSHIDA and KONNO, SAP 043415; Kushimoto, Wakayama Pref., Apr. 6, 1981, leg. H. KAWAI, SAP 043424; Shionomisaki, Wakayama Pref., Apr. 2, 1957, leg. Y. TSUJI, SAP 034804; Mirotsu, Wakayama Pref., Oct. 29, 1981, leg. YOSHIDA and KONNO, SAP 043416; Seto, Wakayama Pref., May 3, 1950, leg. Y. YONEDA, SAP 043422; Shirahama, Wakayama Pref., May 19, 1957, leg. T. YAMAMOTO, SAP 043423; Tanabe, Wakayama Pref., Apr. 1, 1957, leg. Y. TSUJI, SAP 043417.
SHIKOKU: Shishikui, Tokushima Pref., Aug. 1950, leg. Y. YAMADA, SAP 043408; Hane, Kochi Pref., May 27, 1979, leg. T. YOSHIDA, SAP 043439; Nomi-wan, Kochi Pref., May 25, 1979, leg. T. YOSHIDA, SAP 043438; Suzaki, Kochi Pref., Jul. 1941, leg. Y. YAMADA, SAP 043409; Tanoura, Kochi Pref., June 1, 1981, leg. T. YOSHIDA, SAP 043414; Muroto, Kochi Pref., June 18, 1954, leg. I. UMEZAKI, SAP 043413; Kashiwajima, Kochi Pref., July 1941 leg. Y. YAMADA, SAP 043410.
KYUSHU: Kadokawa, Miyazaki Pref., May 24, 1982, leg. T. YOSHIDA, SAP 043445; Nomozaki, Nagasaki Pref., Mar. 30, 1970, leg. M. MASUDA, SAP 043419.

This taxon has usually been classed under the name *S. tortile* (=*S. siliquastrum*). Morphology of basal part with very short stem, broad main branch, thinner leaf and linear receptacle are quite distinct from branched stem, coriaceous leaf and spatulate receptacle of *S. siliquastrum*.

The specific epithet is dedicated to Mr. Torao YAMAMOTO, Wakayama Prefecture, an enthusiastic collector of algae.

Fig. 45. Holotype of *Sargassum yamamotoi* YOSHIDA. "Nomi-wan, Kochi Pref., May 25, 1979, leg. T. YOSHIDA" SAP 043447.

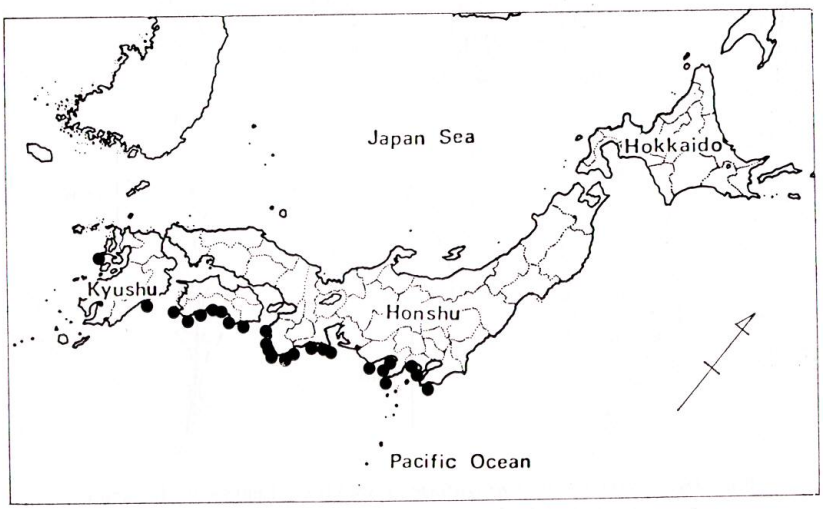

Fig. 46. Distribution of *Sargassum yamamotoi*, compiled from specimens in SAP.

15. *Sargassum tenuifolium* YAMADA 1942 : 505, *f. 10-11.* (Figs. 47-50)

YAMADA 1944 : 9. SEGAWA 1956 : 52, *pl. 31*, No. 231. Holotype: SAP 026453 "Kushimoto, Kii Prov., July 1940, leg. S. INOH" (Fig. 49).

Japanese name: Usuba-moku (YAMADA)

Thallus less than 1 m high. Holdfast small, discoid to conical, 1-1.5 cm in diameter. Stem upright, 1.5 mm in diameter, very short in length, usually 2-3 mm high, rarely attaining to 0.5 cm. A few main branches issued spirally from the distal part of the stem. Main branch terete only at basal part, compressed at distal part, 4-5 mm wide, with smooth margin, and assuming triquetrous appearance because of the ridge running down from the petiole of leaf. Lateral branches well developed. Lower leaf retroflexed at the base, shortly stipitate, lanceolate with obtuse apex in shape, irregularly incised at the margin, up to 5 cm long and 1.2 cm wide. Midrib evanescent near the apex. Cryptostomata few in number. Leaf papyraceous in substance. Leaves

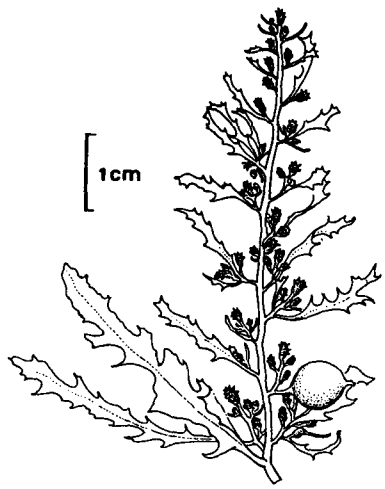

Fig. 47. *Sargassum tenuifolium* YAMADA. Terminal part of fertile plant.

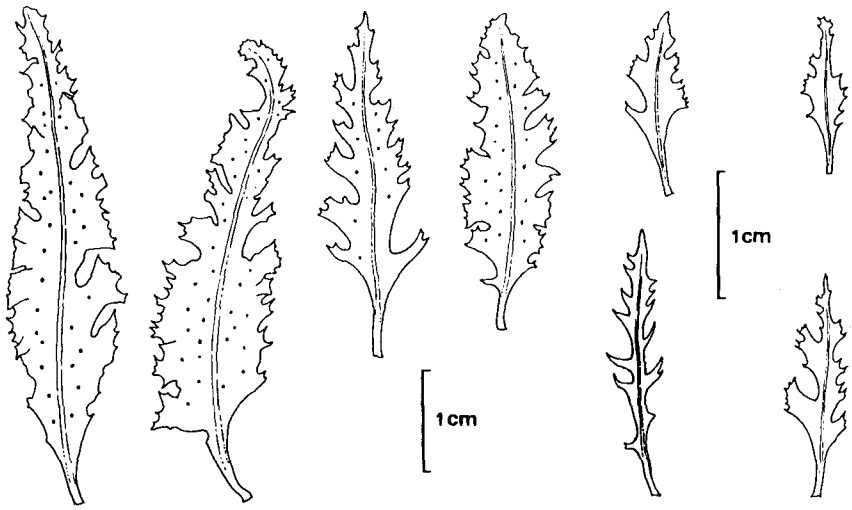

Fig. 48. *Sargassum tenuifolium* YAMADA. Leaves with various degree of incision.

on the distal part becoming narrower, with deeper serration more acute and thinner in texture. Vesicle spherical to obovoid in shape up to 8 mm in diameter, devoid of cryptostome, with mucronate apex or coronal leaflet up to 1 cm long and with serrate margin. Stipe of the vesicle short in length, terete or flattened.

Plant monoecious. Receptacle complanate, spatulate in shape, 3–4 mm long and 1.5 mm wide, with spinal processes on the margin, disposing racemosely in the distal part of the branch. Male and fermale conceptacles formed in the same receptacle. Maturation period in summer.

This species grows on rock of upper subtidal zone.

Specimens examined: HONSHU: Shikine-jima, Tokyo Pref., Aug. 1939, leg. S. INOH, SAP 034876–7; Kozu-jima, Tokyo Pref., Jul. 1937, leg. S. SEGAWA, SAP 043672–3; Kushimoto, Wakayama Pref., Jul. 1940, leg. S. INOH, SAP 026402; Seto, Wakayama Pref., June 1943, leg. K. SAKAGUCHI, SAP 025480.
SHIKOKU: Susaki, Kochi Pref., Aug. 1925, leg. Y. YAMADA, SAP 026403.

Fig. 49. Holotype of *Sargassum tenuifolium* YAMADA. "Kushimoto, Kii Prov., July 1940, leg. S. INOH" SAP 026453.

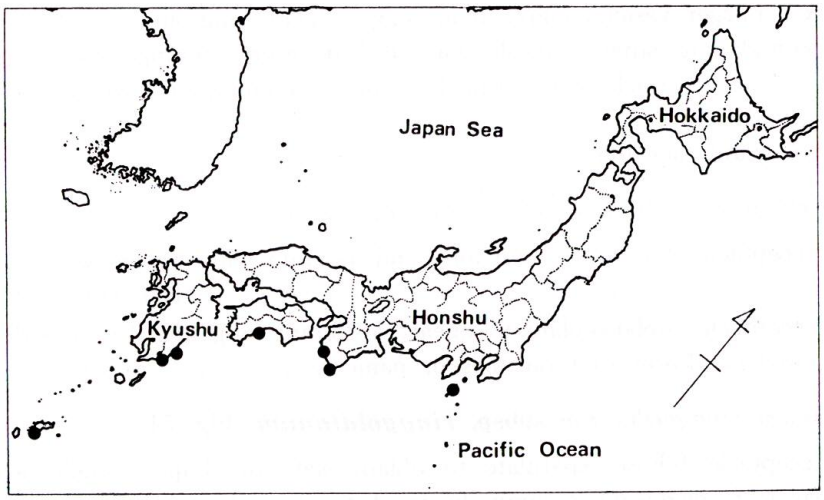

Fig. 50. Distribution of *Sargassum tenuifolium*, compiled from specimens in SAP.

KYUSHU: Aburatsu, Miyazaki Pref., Aug. 1949, leg. Y. YAMADA, SAP 026408-10; Uchinoura, Kagoshima Pref., Aug. 1940, leg. Y. NAKAMURA, SAP 026401; Koniya, Kagoshima Pref., Aug. 1927, leg. K. HAMANA, SAP 026404.

By a feature of receptacle armed with spines, YAMADA placed this species in the subgenus *Micracantha*. As discussed under *S. micracanthum*, I treat this taxon in the *Bactrophycus*. Monoecism is rather rare case in this subgenus.

16. *Sargassum ringgoldianum* HARVEY 1859: 327. (Figs. 51-54)

J. AGARDH 1896: 51. DE TONI 1895: 22. YENDO 1907: 146, *pl. 18*. GRUNOW 1915: 342. OKAMURA 1916: 215; 1924: 32, *pl. 210*; 1936: 332. SEGAWA 1956: 50, *pl. 29*, No. 221. DAWSON 1959: 5, *pl. 2*. Type: TCD "Shimoda, Charles WRIGHT".

Japanese name: Ohba-moku.

Thallus usually 1 m or more in length. Holdfast conical, up to 3-4 cm in diameter. A single stem arising from the holdfast. Stem terete, 5 mm in diameter, attaining 20 cm or more in several years, branched several times. Several main branches formed annually, leaving scars on the stem. Main branch ancipitous with a longitudinal costal elevation, with smooth margin, 5 mm wide. Lateral branches well developed. Lower leaf retroflexed at the base, lanceolate to linear in shape, base gradually passed into complanate petiole, 20 cm or more in length, up to 2 cm wide, with entire margin. Apex of leaf obtuse. Midrib immersed, evanescent near the apex. Leaf thick, coriaceous in texture. Phyllotaxis of leaves on main branch 1/2. Upper leaves becoming smaller and narrower. Cryptostomata scattered on the leaf surface. Larger vesicles elliptical in shape, 2 cm long and 1-1.3 cm wide, with complanate stipe. Simple coronal leaf often running down to form wings. Smaller vesicles formed in distal part becoming narrower to fusiform, usually with wing.

The plant dioecious.

Key to the subspecies of *S. ringgoldianum*

1. Receptacles foliose, 2-5 cm long and 4-5 mm wide, racemosely disposed . . . . . Subsp. *ringgoldianum*
1. Receptacles oblanceolate to linear, 5-10 mm long and 1 mm wide, disposed in abbreviated racemes or panicles . . . . . Subsp. *coreanum*

Sargassum ringgoldianum **subsp. *ringgoldianum*** (Fig. 51)

Receptacle foliose, spatulate to oblanceolate in shape, usually without bracteal leaf, disposing racemosely in distal branches. Female receptacle

measuring up to 2 cm long and 5 mm wide. Male one 2-5 cm long and 4 mm wide, often resembling to smaller leaf. Maturation in summer.

Fig. 51. *Sargassum ringgoldianum* ssp. *ringgoldianum*. Terminal part of female plant.

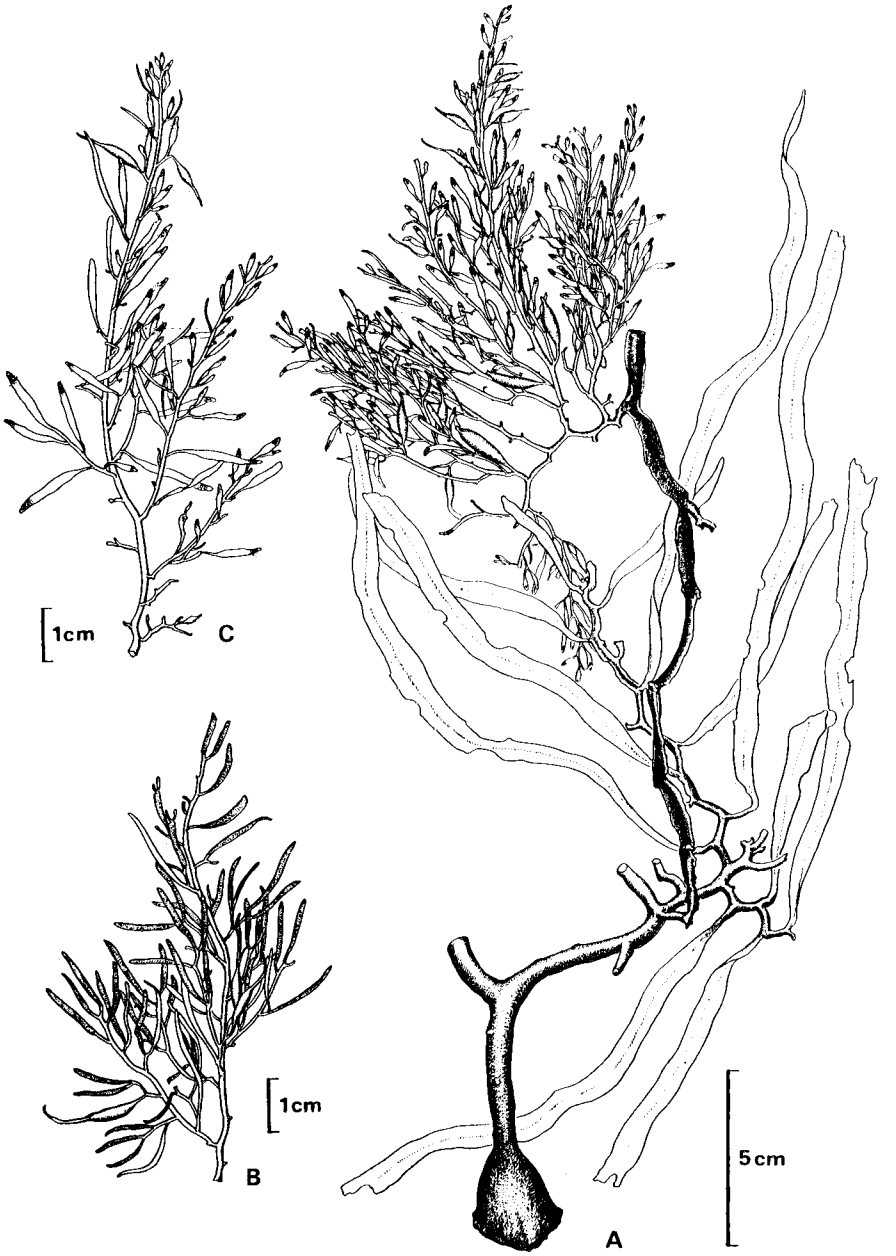

Fig. 52. *Sargassum ringgoldianum* ssp. *coreanum* (J. AGARDH) YOSHIDA. A, fertile plant. B, male receptacles. C, female receptacles.

16 a. *Sargassum ringgoldianum* **subsp. *coreanum*** (J. AGARDH) YOSHIDA, comb. nov. (Fig. 52)

Basionym: *Sargassum coreanum* J. AGARDH 1889: 58. Lectotype: LD (Herb. Agardh No. 2881 "ex insulis Corea, mis. CROUAN". Lectotypified by A. B. CRIBB, 1957-7-11) (Fig. 53 A).

Japanese name: Yanagi-moku.

Receptacles disposed racemosely or paniculately on small ramulet arising in axil of leaf. Female receptacle narrow oblanceolate, slightly compressed, 5 mm long and 1 mm wide. Male one linear, complanate, up to 10 mm long and 1 mm wide. Maturation in autumn.

Specimens examined: Subsp. *ringgoldianum*: HONSHU: Matsushima, Miyagi Pref., Jul. 29, 1979, leg. T. YOSHIDA, SAP 034708; Inubo-zaki, Chiba Pref., Mar. 27, 1982, leg. M. MASUDA, SAP 042068-9; Ohara, Chiba Pref., May 5, 1955, leg. Y. TSUJI, SAP 034821; Katsuura, Chiba Pref., June 20, 1976, leg. K. AOKI, SAP 034286; Kominato, Chiba Pref., Mar. 29, 1978, leg. T. YOSHIDA, SAP 034307; Futomi, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 041994; Amatsura, Chiba Pref., Apr. 1935, leg. Y. YAMADA, SAP 026614; Nemoto, Chiba Pref., Aug. 7, 1956, leg. Y. TSUJI, SAP 042046; Nishi-nemoto, Apr. 6, 1969, leg. T. YOSHIDA, SAP 034305; Jyogashima, Kanagawa Pref., Apr. 28, 1979, leg. T. YOSHIDA, SAP 034664; Misaki, Kanagawa Pref., Aug. 1932, leg. MACLENDON, SAP 013709; Arasaki, Kanagawa Pref., Dec. 29, 1977, leg. H. MOROHOSHI, SAP 034306; Chojyagaski, Kanagawa Pref., Apr. 3, 1981, leg. T. YOSHIDA, SAP 035488; Zushi, Kanagawa Pref., Sept. 1928, leg. S. AKIYAMA, SAP 7837-8; Kamakura, Kanagawa Pref., Apr. 5, 1969, leg. T. YOSHIDA, SAP 034304; Inamuragaski, Kanagawa Pref., Sept. 7, 1980, leg. T. YOSHIDA, SAP 034878; Enoshima, Kanagawa Pref., Apr. 1935, leg. Y. YAMADA, SAP 026609; Shimoda, Shizuoka Pref., June 5, 1981, leg. Y. YOKOHAMA, SAP 035706; Omaezaki, Shizuoka Pref., June 5, 1981, leg. F. HAYASHIDA, SAP 035709.

Subsp. *coreanum*: HONSHU: Sugashima, Mie Pref., Apr. 21, 1955, leg. Y. TSUJI, SAP 041936; Wagu, Mie Pref., Apr. 1942, leg. S. INOH, SAP 026480; Goza, Mie Pref., May 11, 1979, leg. T. YOSHIDA, SAP 034661; Hamashima, Mie Pref., May 10, 1979, leg. T. YOSHIDA, SAP 034659; Nagashima, Mie Pref., Aug. 1941, leg. T. SEGI, SAP 034308; Kinomoto, Wakayama Pref., Aug. 2, 1944, leg. T. SEGI, SAP 025329-30; Gobo, Wakayama Pref., Oct. 20, 1956, leg. Y. YAMADA, SAP 034309; Futami, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034284; Yuya, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034283; Kiwado, Yamaguchi Pref., Apr. 23, 1979, leg. T. YOSHIDA, SAP 034662; Omi-jima, Yamaguchi Pref., June 8, 1978, leg. T. YOSHIDA, SAP 034282; Tatamigaura, Shimane Pref., June 9, 1978, leg. T. YOSHIDA, SAP 034279; Hinomisaki, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 034277; Etomo, Shimane Pref., May 22, 1982, leg. S. KAWAGUCHI, SAP 042207; Katsura-jima, Shimane Pref., May 21, 1982, leg. S. KAWAGUCHI, SAP 042208; Shichirui, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 034278; Kasumi, Hyogo Pref., Aug. 19, 1964, leg. T. YAMAMOTO, SAP 034290; Kammuri-jima, Kyoto Pref., Apr. 9, 1981, leg. H. KAWAI, SAP 035487; Takahama, Fukui Pref., June 12, 1878, leg. T. YOSHIDA, SAP 034280-1; Ohwi, Fukui Pref., Sept. 23, 1981, leg. M. OHTA, SAP 042089; Hakui, Ishikawa Pref., no date,

leg. T. KANAMORI, SAP 021389; Monzen, Ishikawa Pref., Jul. 24, 1976, leg. K. TANIGUCHI, SAP 042034; Ogi, Ishikawa Pref., Aug. 23, leg. Y. NAKAMURA, SPA 034289; Karashima, Toyama Pref., Aug. 4, 1929, anonym., SAP 034288; Sado, Niigata Pref., Sept. 6, 1962, leg. Y. YAMADA, SAP 028819; Tobi-shima, Yamagata Pref., Aug. 22, 1966, leg. S. KIKUCHI, SAP 034293.

SHIKOKU: Hiwasa, Tokushima Pref., Aug. 1950, leg. Y. YAMADA, SAP 034302; Ogata, Kochi Pref., June 1, 1981, leg. T. YOSHIDA, SAP 035726; Ikata, Ehime Pref., Apr. 7, 1955, leg. Y. NOMURA, SAP 034301.

KYUSHU: Kadokawa, Miyazaki Pref., May 24, 1982, leg. T. YOSHIDA, SAP 042176; Minami-amabe, Oita Pref., Jul. 10, 1922, leg. SUZUKI, SAP 034303; Saganoseki, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 035754; Iwaya, Fukuoka Pref., Apr. 5, 1978, leg. T. YOSHIDA, SAP 034294; Tsuyazaki, Fukuoka Pref., Oct. 15, 1977, leg. T. YOSHIDA, SAP 034292; Shiganoshima, Fukuoka Pref., Mar. 31, 1930, leg. SUGINO, SAP 034287; Hado-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043725; Hirado-jima, Nagasaki Pref., Mar. 11, 1981, leg. H. KITO, SAP 043593; Nomozaki, Nagasaki Pref., Apr. 4, 1977, leg. T. YOSHIDA, SAP 034285; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 043638; Tomioka, Kumamoto Pref., Aug. 6, 1949, leg. Y. YAMADA, SAP 025680.

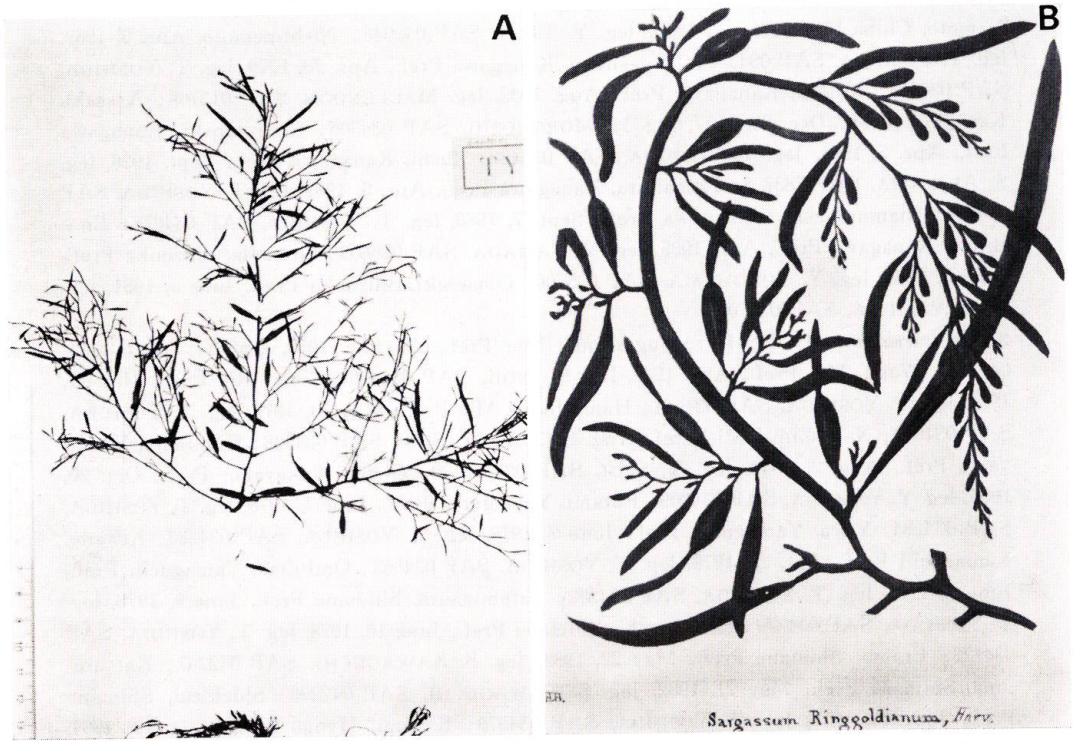

Fig 53. A. Lectotype of *Sargassum coreanum* J. AGARDH. "ex Insulis Corea, sub No. 10 mis. CROUAN" LD, Herb. Agardh No. 2881. B. Illustration of *Sargassum ringgoldianum* HARVEY, taken from DAWSON (1959).

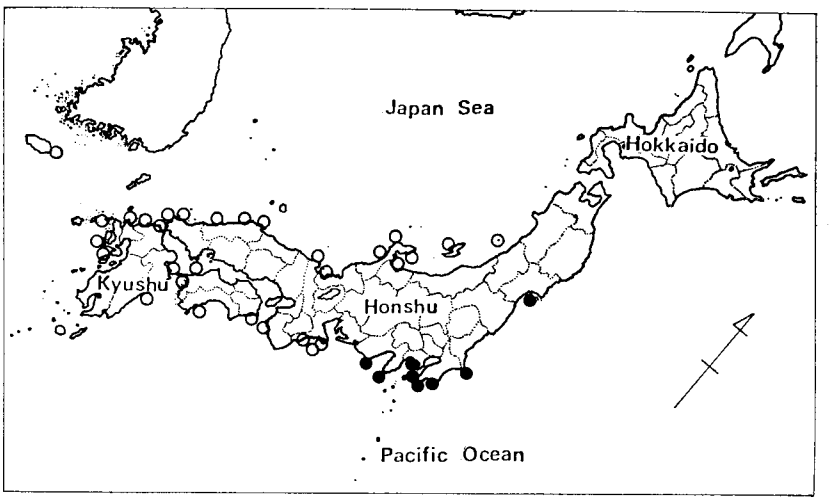

Fig. 54. Distribution of *Sargassum ringgoldainum*, compiled from specimens in SAP. Solid circles, ssp. *ringgoldianum*, open circles, ssp. *coreanum*.

KOREA: Cheju Island, Oct. 8, 1934, leg. HOSINO, SAP 043898.

S. ringgoldianum was described by HARVEY (1859), basing on the specimens collected at Shimoda, Shizuoka Pref. The type deposited in TCD is a fertile branch, which has foliar receptacles clearly depicted by HARVEY (in DAWSON 1959, pl. 2), reproduced in Fig. 53 B. This species is easily recognized by its long lanceolate leaves with entire margin.

As for *S. coreanum*, J. AGARDH (1889, p. 58) gave the locality of the taxon as "ad oras Corea (Herb. Crouan!) ad ostia Amuris Navarsha FENGER!". The specimen in Herb. Agardh No. 2881 with a label 'Ex insulis Corea, Ind. No. 10, mis. CROUAN' (Fig. 53 A) was chosen as the lectotype by CRIBB and I follow this decision. One of other specimens, No. 2883 labeled 'ad insulam Sachalin extra ostia Amuris, legit Navarsha FENGER' also corresponds to the citation by J. AGARDH. The lectotype specimen has linear receptacles, that is easily distinguishable from foliose receptacle of subsp. *ringgoldianum*.

YENDO treated this taxon as a synonym of *S. ringgoldianum*. These 2 taxa are difficult to distinguish at immature state. At maturity, size and shape of receptacles are quite different. Because of the similarity in immature state, I provisionally treat the taxon of J. AGARDH at subspecific level. Subspecies *coreanum* is distributed widely on the coast of Japan Sea and also western part of Pacific coast of Honshu to Kyushu including Shikoku. On the other hand, subsp. *ringgoldianum* is distributed on the coast from Miyagi to Shizuoka Pref. on the Pacific side of Honshu (Fig. 54).

Habitat preference shows difference between the 2 subspecies. Subsp. *ringgoldianum* grows on rocks often influenced by drift sand or unstable stones. While subsp. *coreanum* colonizes on stable substratum.

YOSHIDA (1960) showed that growth rings found in the holdfast of this species formed annually, and that the age of an individual could be determined by counting number of rings. Oldest individual examined possessed 6 rings. That means the longevity of 7 years.

17. *Sargassum trichophyllum* (KÜTZING) O. KUNTZE 1880 : 228.
(Figs. 55-58)

Carpacanthus trichophyllus KÜTZING 1843 : 57 ; 1843 a : 368 ; 1849 : 622 ; 1861 : 12, *pl. 37, f. 2.* J. AGARDH 1848 : 348. Lectotype : L 937.71.691 "Japan, TILESIUS" (Fig. 57 A, B).

Sargassum scoparium var. *trichophyllum* (KÜTZING) GRUNOW 1915 : 346.

Japanese name : Ito-yore-moku (nov.)

Thallus less than 1 m high. Holdfast conical, 1 cm in diameter. Stem terete, about 2 mm in diameter, 2-3 times branched. A few main branches arising from the distal part of the stem. Lower part of the main branch flattened caused by a conspicuous retroflexy of the leaf base. Middle part of the main branch becoming triquetrous with the phyllotaxis of the leaf 1/3. Simple spinous

Fig. 55. *Sargassum trichophyllum* (KÜTZING) O. KUNTZE. Terminal part of fertile plant.

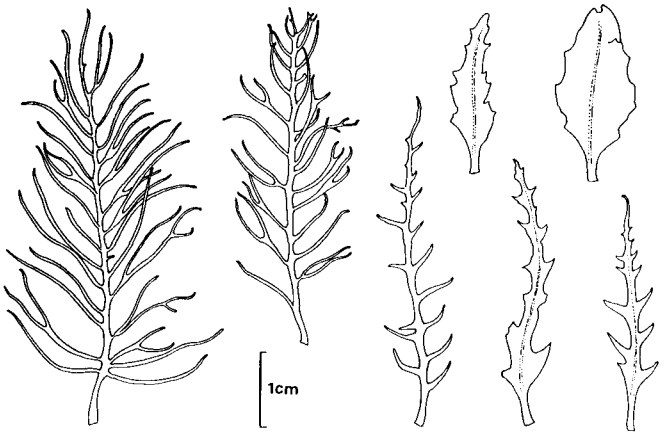

Fig. 56. *Sargassum trichophyllum* (KÜTZING) O. KUNTZE. Variation in leaf shape.

processes sparsely present on the edge of the main branch. Leaf formed on the proximal part of the main branch elliptical to lanceolate in shape, 3 cm long and 1 cm wide, with inconspicuous midrib. Margin nearly entire. Leaf changing abruptly into deeply serrate form with acute lobes. Leaf on the middle part of the branch assuming a form with midrib and alternately disposed filiform pinnules. Pinnules often once divided dichotomously. Midrib 4–5 cm long with pinnules 1–1.5 cm long. Crypstostomata nearly absent. Vesicles spherical to obovoid in shape, 7 mm long and 5 mm in diameter, in lower part of the main branch, and becoming narrower to fusiform in distal part, with mucronated apex or with coronal leaf similar to that on the branch.

Plant dioecious. Receptacle spatulate to linear spatulate, often triquetrous with minute spinal processes on the margin, 5–8 mm long and 1–1.5 mm wide,

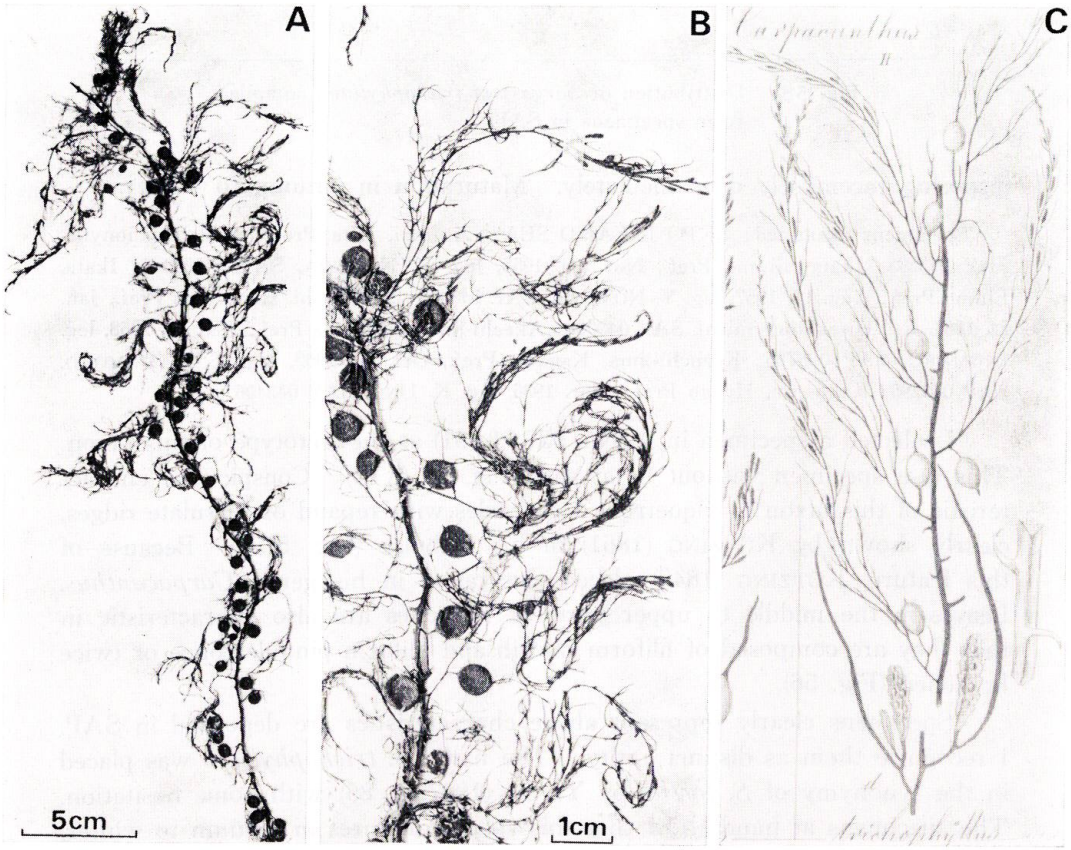

Fig. 57. A, B. Lectotype of *Carpacanthus trichophyllus* KÜTZING. "Japan, TILESIUS" L 937.71.691. C. Illustration of *Carpacanthus trichophyllus* KÜTZING, Tab. Phyc. vol. 11, pl. 37, f. 2.

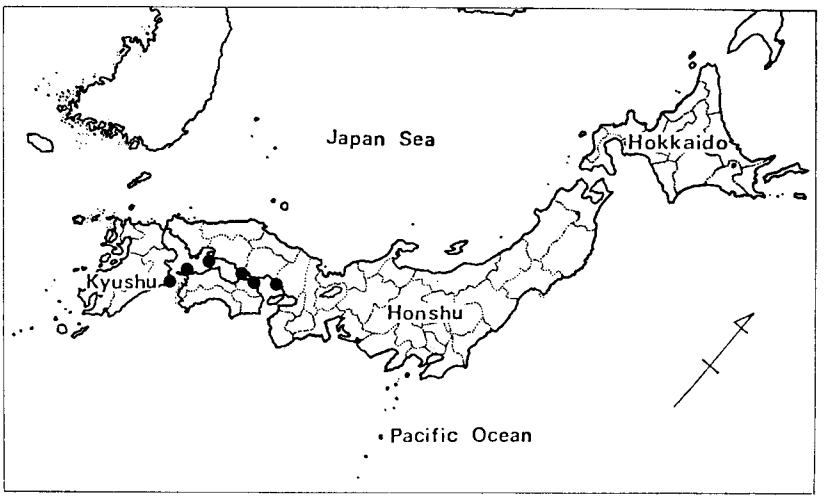

Fig. 58. Distribution of *Sargassum trichophyllum*, compiled from specimens in SAP.

disposing racemosely or paniculately. Maturation in autumn to winter.

Specimens examined: SETO INLAND SEA: Asamui, Oita Pref., no date, anonym., SAP 043298; Ikata, Ehime Pref., Nov. 28, 1955, leg. Y. NOMURA, SAP 043293-4; Ikata, Ehime Pref., Aug. 11, 1957, leg. Y. NOMURA, SAP 043403; Kurahashi, Hiroshima Pref., Jan. 22, 1981, leg. Hiroshima-Suishi, SAP 043000; Akechi-jima, Okayama Pref., Dec. 16, 1958, leg. INUMARU, SAP 028725; Kozuchi-jima, Kagawa Pref., Oct. 31, 1962, leg. T. YAMAMOTO, SAP 043295; Kako-gun, Hyogo Pref., Mar. 1936, leg. K. UNO, SAP 043406.

I selected a specimen in L (No. 937.71.691) as the lectotype of this taxon. This is a specimen without basal part (Fig. 57 A, B). Conspicuous characteristic of this taxon is triquetrous receptacles with repand or serrulate ridges, clearly shown by KÜTZING (1861) in his Tabulae (Fig. 57 C). Because of this feature, KÜTZING (1843) placed this taxon in his genus *Carpacanthus*. Leaves in the middle to upper parts of branches are also characteristic in that they are composed of filiform midrib and filiform pinnules once or twice branched (Fig. 56).

Specimens clearly represent above characteristics are deposited in SAP. I recognize them as distinct entity. The name *S. trichophyllum* was placed in the synonymy of *S. tortile* by YENDO (1907, p. 86) with some hesitation. The specimens at hand show that this species matures in autumn to winter. Difference in maturation period is another distinction from *S. siliquastrum* (=*S. tortile*).

Combination from *Carpacanthus* to *Sargassum* was made by KUNTZE

(1880, p. 228). This publication antedates the description of a name *Sargassum trichophyllum* J. AGARDH in 1889. WOMERSLEY (1954, p. 351) placed *S. trichophyllum* J. AGARDH as a synonym of *S. verruculosum* (MERTENS) C. AGARDH. Therefore, a new name is not necessary for Agardhian species.

18. *Sargassum sagamianum* YENDO 1907 : 151, *pl. 17, f. 6-9.* (Figs. 59-61)

GRUNOW 1915 : 352. OKAMURA 1916 : 216 (pro parte ?). YOSHIDA & KONNO 1983 : 146, *f. 1-4.* Lectotype : TI "Osatsu, Shima Prov., Feb. leg. K. YENDO" (Fig. 60).

Japanese name : Neji-moku (YENDO)

The plant more than 1 m long when well developed. Holdfast conical up to 5 cm or more in diameter. Stem terete, forking pseudodichotomously several times. Lower part of the stem becoming buried in the conical holdfast, giving an appearance that several stems arising from the surface of a holdfast. Several main branches issued annually from the terminal part of the stem in spiral succession. Main branch trigonous with sharp edges, twisting loosely. Leaves in the lower part of the main branch retroflexed, spread horizontally, linear lanceolate in shape, 4-7 cm long and 5 mm wide, with acute apex, decurrent at the base, with sparsely serrate margin. Midrib evanescent, not reaching to the apex. Phyllotaxis of the leaves on main branch 1/3. Leaves on upper part of the main branch and lateral branches becoming narrower to linear in shape. Cryptostomata rare or nearly absent. Vesicles elliptical or fusiform in shape, 15-18 mm long, 5-8 mm in diameter, mucronate or with linear coronal leaf. Vesicles formed rather sparsely on the basal part of lateral branches or branchlets.

The plant dioecious. Female receptacles usually triquetrous, but compressed oblanceolate ones often mixed, 12-15 mm long and 1.5 mm wide. Male one linear in shape, compressed, 20-30 mm long, 1.5 mm wide, sometimes forked or with smaller proliferation. Receptacles disposed in racemose or paniculate manner. Maturation period in autumn to winter.

This species grows on rocks rather exposed to wave action, from low water mark to 2 m deep.

Specimens examined : HONSHU : Sugashima, Mie Pref., June 8, 1944, leg. N. TAKAMINE, SAP 043604 ; Wagu Ooshima, Mie Pref., Apr. 26, 1955, leg. Y. TSUJI, SAP 042086 ; Iwaizaki, Mie Pref., Oct. 26, 1981, leg. YOSHIDA and KONNO, SAP 041904-5 ; Goza, Mie Pref., Oct. 29, 1981, leg. YOSHIDA and KONNO, SAP 041870 ; Hamashima, Mie Pref., Oct. 26, 1981, leg. YOSHIDA and KONNO, SAP 039983 ; Nagashima, Mie Pref., May 12, 1979, leg. T. YOSHIDA, SAP 041903 ; Taiji, Wakayame Pref., Apr. 4, 1957, leg. Y. TSUJI, SAP 041971.

Taxonomic history of this species was briefly given by YOSHIDA (1980)

and YOSHIDA & KONNO (1983). The lectotypification by YOSHIDA (1980) also specified the type locality of this taxon as Osatsu, Mie Pref. This is unfortunate in that Yendo approved its occurrence in Sagami Province (Kana-

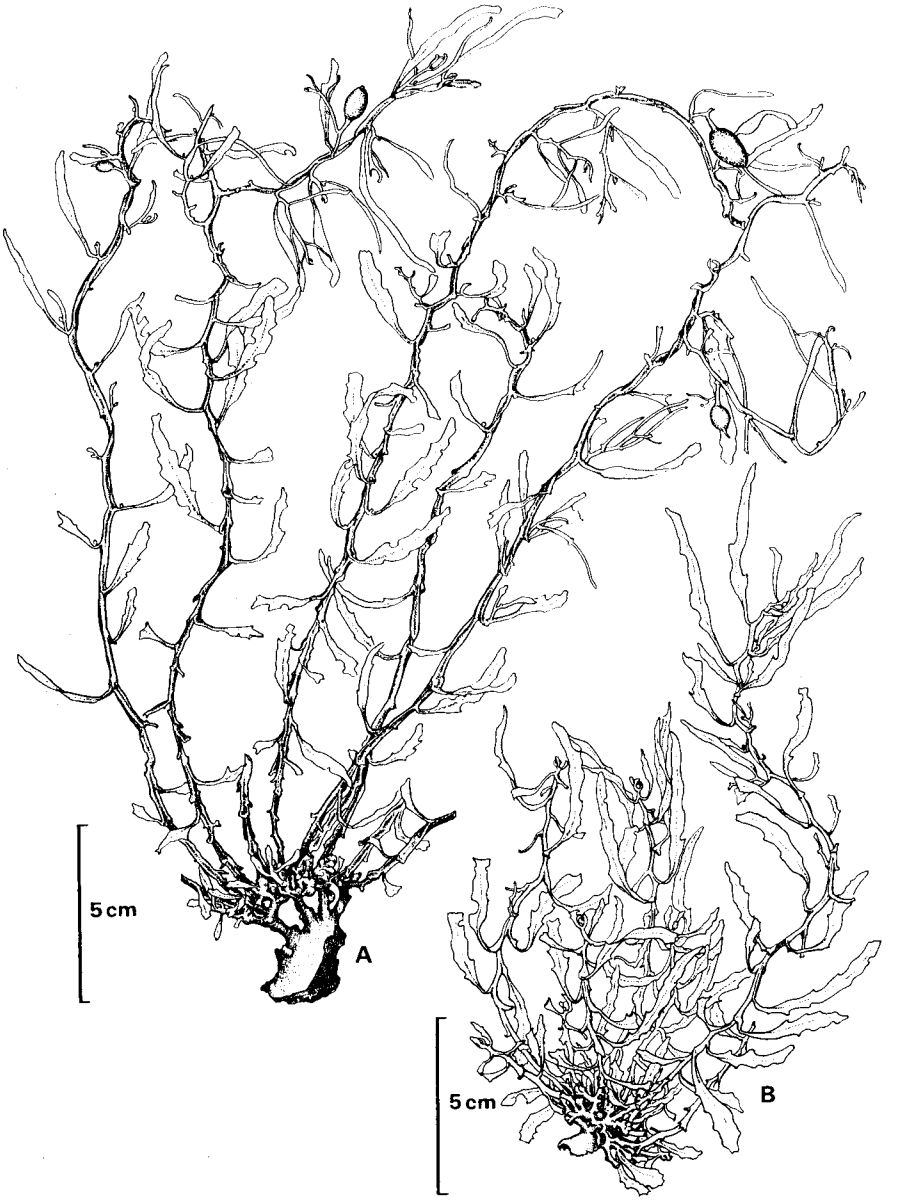

Fig. 59. *Sargassum sagamianum* YENDO.

gawa Prefecture) by the epithet '*sagamianum*', but this taxon has narrow range of distribution only in Kii Peninsula.

Fig. 60. Lectotype of *Sargassum sagamianum* YENDO. "Osatsu, Prov. Shima, Feb. 2" TI.

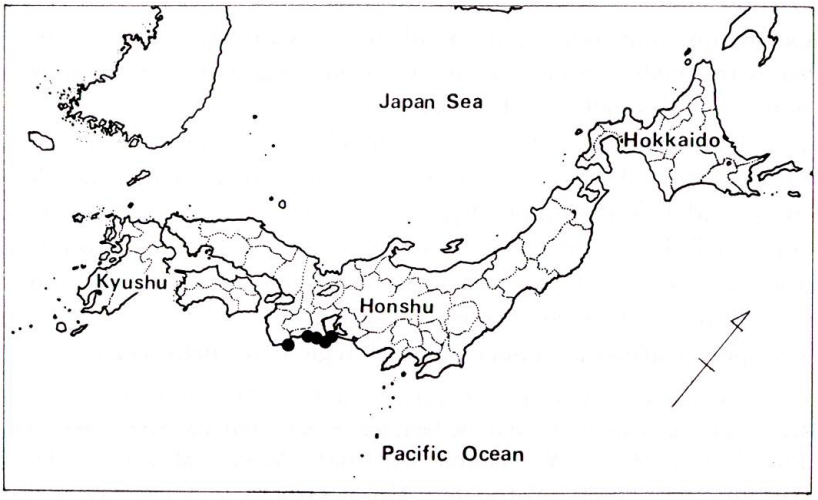

Fig. 61. Distribution of *Sargassum sagamianum*, compiled from specimens in SAP.

19. *Sargassum micracanthum* (KÜTZING) ENDLICHER 1843 : 31.
(Figs. 62–64)

J. AGARDH 1896 : 52. YENDO 1907 : 123, *pl. 15, f. 10–17*. GRUNOW 1915 : 348. OKAMURA 1916 : 206 ; 1924 : 51, *pl. 214* ; 1936 : 343, *f. 170*. SEGAWA 1956 : 51, *pl. 30*, No. 229.

Halochloa micracantha KÜTZING 1843 : 56 ; 1843 a : 367 ; 1849 : 633 ; 1860 : 34, *pl. 98, f. 2*. Holotype : L 937. 55. 8 "Japan, TILESIUS" (Fig. 63 A).

Sargassum micracanthum var. *stipulatum* YENDO 1907 : 125, *pl. 15, f. 18–21*. OKAMURA 1916 : 206 ; 1936 : 345. Holotype : LD (Herb. Agardh No. 2919 "ex Japonia, KJELLMAN") (Fig. 63 C).

Sargassum kiushianum YENDO 1907 : 121, *pl. 15, f. 6–9*. GRUNOW 1915 : 348. OKAMURA 1916 : 205. Holotype : TI "Jyono, Fukuoka Pref., leg. S. YANO" (Fig. 63D).

Japanese name : Toge-moku (YENDO)

Thallus less than 1 m high. Holdfast conical up to 5 cm in diameter. Stem terete, about 3 mm in diameter, frequently branched in short distance. Lower part of the branching stem becoming buried in the conical holdfast, assuming an appearance that many stems issued on the surface of stout holdfast. Main branches arising from the dorsal side of obliquely directed stem, triquetrous with sharp or round ridges, about 3 mm wide, loosely twisted. Lateral branches numerous, but much shorter than the main branch. Leaf lanceolate to linear lanceolate in outline, 6 cm long and 0.8 cm wide, with complanated short stipe, usually alternately pinnatisected, with the round sini often reaching to the percurrent midrib. At the insertion to the branch, stipe often expanding like a stipule. Phyllotaxis of leaves on the main branch 1/3. Cryptostomata very rare to almost absent. Vesicle obovoid to elliptical in shape, 8 mm long and 7 mm in diameter, with stipe about 5 mm long, provided with small coronal leaf up to 3 cm long with serrate margin and often with several small spinal projections.

The plant dioecious. Receptacle spatulate in shape, often with small serration on terminal or upper margin. Female receptacle 7 mm long and 3 mm wide. Male one rather slender. In early season, receptacle formed singly on small branchlet in axil of subtending leaf, and several smaller receptacles formed later in basipetal succession resulting in abbreviated racemes. Maturation in late winter to spring.

This species grows in upper subtidal region of rocky coast.

Specimens examined : HONSHU : Ozuchi, Iwate Pref., Mar. 29, 1979, leg. T. YOSHIDA, SAP 034725 ; Takada, Iwate Pref., May 19, 1951, leg. S. KAWASHIMA, SAP 026888 ; Onagawa, Miyagi Pref., Feb. 14, 1951, leg. Y. YAMADA, SAP 034335 ; Maeami, Miyagi Pref., Oct. 7, 1965, leg. T. YOSHIDA, SAP 035093 ; Matsushima, Miyagi Pref., Oct. 18, 1962, leg. T. YOSHIDA, SAP 035259 ; Kominato, Chiba Pref., Mar. 29, 1978, leg. T. YOSHIDA, SAP 034328 ; Misaki, Kanagawa Pref., June 1929, leg. S. INOH, SAP 8540–1 ; Shirahama, Shizuoka Pref., Aug. 16,

1958, leg. Y. TSUJI, SAP 042050; Utsumi, Aichi Pref., Apr. 1937, leg. T. SEGI, SAP 024695; Sugashima, Mie Pref., June 8, 1944, leg. N. TAKAMINE, SAP 043610; Wagu, Mie Pref., Apr. 25, 1955, leg. Y. TSUJI, SAP 041998; Hamashima, Mie Pref., May 10, 1979, leg.

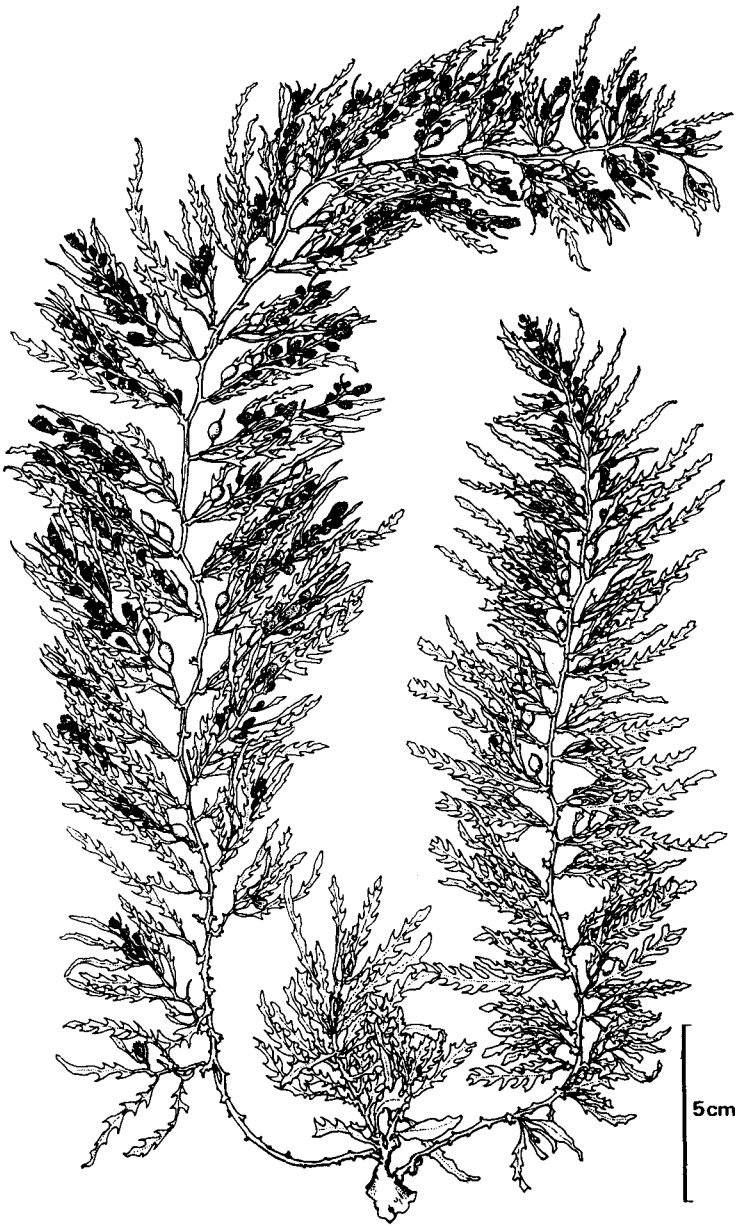

Fig. 62. *Sargassum micracanthum* (KÜTZING) ENDLICHER.

T. YOSHIDA, SAP 034599; Nagashima, Mie Pref., May 12, 1979, leg. T. YOSHIDA, SAP 034605-6; Katsuura, Wakayama Pref., 1919, anonym., SAP 034338-9; Taiji, Wakayama Pref., Apr. 4, 1957, leg. Y. TSUJI, SAP 041972; Kushimoto, Wakayama Pref., Apr. 1931, leg. Y. YAMADA, SAP 8928; Shirahama, Wakayama Pref., Apr. 7, 1981, leg. H. KAWAI, SAP 035501; Tanabe, Wakayama Pref., Jul. 1929, leg. S. INOH, SAP 8542; Futami, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034326; Yuya, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 034327; Omi-jima, Yamaguchi Pref., Apr. 25, 1979, leg. T. YOSHIDA, SAP 034603; Shichirui, Shimane Pref., Jul. 10, 1978, leg. T. YOSHIDA, SAP 034345; Kammuri-jima, Kyoto Pref., Apr. 9, 1981, leg. H. KAWAI, SAP 035500; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 034321; Aka-saki, Ishikawa Pref., Jul. 23, 1976, leg. K. TANIGUCHI, SAP 042032; Mitsuke-jima, Ishikawa Pref., Aug. 28, 1976, leg. K. TANIGUCHI, SAP 042029; Ogi, Ishikawa Pref., Nov. 8, 1960, leg. Y. YAMADA, SAP 028322; Kariha-gun, Niigata Pref., Jan. 21, 1932, leg. IKEGAMI, SAP 021026; Iwagasaki, Niigata Pref., May 13, 1982, leg. S. KAWAGUCHI, SAP 042230; Awashima, Niigata Pref., May 12, 1956, leg. M. NODA, SAP 034332; Kamo, Yamagata Pref., Jul. 1931, leg. W. HIROHASHI, SAP 012073; Tobishima, Yamagata Pref., Aug. 22, 1966, leg. S. KIKUCHI, SAP 034330; Fukaura, Aomori Pref., June 21, 1978, leg. T. YOSHIDA, SAP 034319; Tanosawa, Aomori Pref., May 27, 1982, leg. M. NOTOYA, SAP 043286; Sai, Aomori Pref., Aug. 6, 1955, leg. S. KAWASHIMA, SAP 034888; Benten-jima, Aomori Pref., Jul. 27, 1957, leg. S. KAWASHIMA, SAP 034906; Ohma, Aomori Pref., June 30, 1976, leg. M. SAWADA, SAP 034343.

SHIKOKU: Hiwasa, Tokushima Pref., Aug. 1950, leg. Y. YAMADA, SAP 027195-6; Muroto-misaki, Kochi Pref., May 27, 1979, leg. T. YOSHIDA, SAP 034604; Hane, Kochi Pref., May 27, 1979, leg. T. YOSHIDA, SAP 034601; Tosa, Kochi Pref., May 26, 1979, leg. T. YOSHIDA, SAP 034602; Nomi-wan, Kochi Pref., May 25, 1979, leg. T. YOSHIDA, SAP 034607; Saga, Kochi Pref., Jan. 19, 1954, leg. Y. YAMADA, SAP 034341; Okata, Kochi Pref., June 1, 1981, leg. T. YOSHIDA, SAP 035727; Kashiwa-jima, Kochi Pref., Jul. 1941, leg. Y. YAMADA, SAP 034344; Totoshima, Ehime Pref., May 21, 1982, leg. M. MARUI, SAP 042168; Toshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 042167; Ikata, Ehime Pref., Aug. 11, 1957, leg. Y. NOMURA, SAP 035335; Misaki, Ehime Pref., May 31, 1979, leg. T. YOSHIDA, SAP 034600.

KYUSHU: Kadokawa, Miyazaki Pref., May 24, 1982, leg. T. YOSHIDA, SAP 042182; Saganoseki, Oita Pref., Dec. 24, 1960, leg. S. INUMARU, SAP 028724; Kunimi, Oita Pref., June 4, 1981, leg. T. YOSHIDA, SAP 035741; Hime-shima, Oita Pref., June 4, 1981, leg. T. YOSHIDA, SAP 035761; Mekari, Fukuoka Pref., Apr. 1, 1953, leg. T. YOSHIDA, SAP 035086; Iwaya, Fukuoka Pref., June 5, 1981, leg. T. YOSHIDA, SAP 035704; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043652; Hime-shima, Fukuoka Pref., May 20, 1983, leg. K. NANRI, SAP 043663; Hado-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043722; Shugen-jima, Nagasaki Pref., Jul. 29, 1942, leg. YAMADA and NAKAMURA, SAP 023860; Hirado-jima, Nagasaki Pref., May 26, 1983, leg. T. YOSHIDA, SAP 043684; Nomozaki, Nagasaki Pref., June 5, 1978, leg. T. YOSHIDA, SAP 034320; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 043639; Tomioka, Kumamoto Pref., Mar. 25, 1939, leg. Y. YAMADA, SAP 021513-6.

KOREA: Cheju Island, Apr. 24, 1974, leg. I. K. LEE, SAP 034614.

The author of the name was usually cited as (KÜTZING) YENDO or

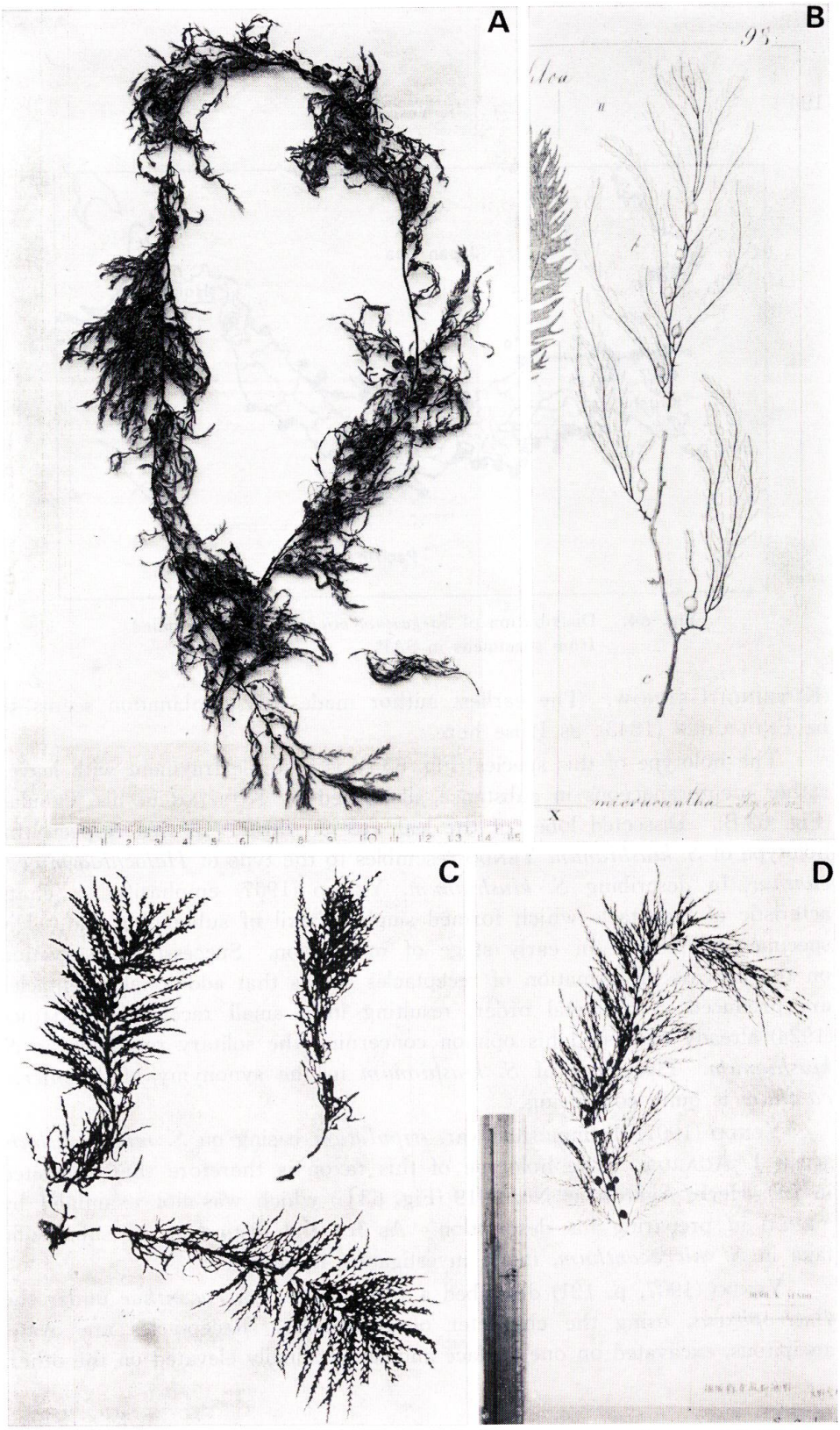

Fig. 63. A. Holotype of *Halochloa micracantha* KÜTZING. "Japan, TILESIUS" L 937. 55. 8. B. Illustration of *Halochloa micracantha* KÜTZING, Tab. Phyc. vol. 10, pl. 98, f. 2. C. Holotype of *Sargassum micracanthum* var. *stipulatum* YENDO. "ex Japonia, KJELLMAN" LD, Herb. Agardh No. 2919. D. Holotype of *Sargassum kiushianum* YENDO. "Jyono, Fukuoka Pref., leg. S. YANO" TI.

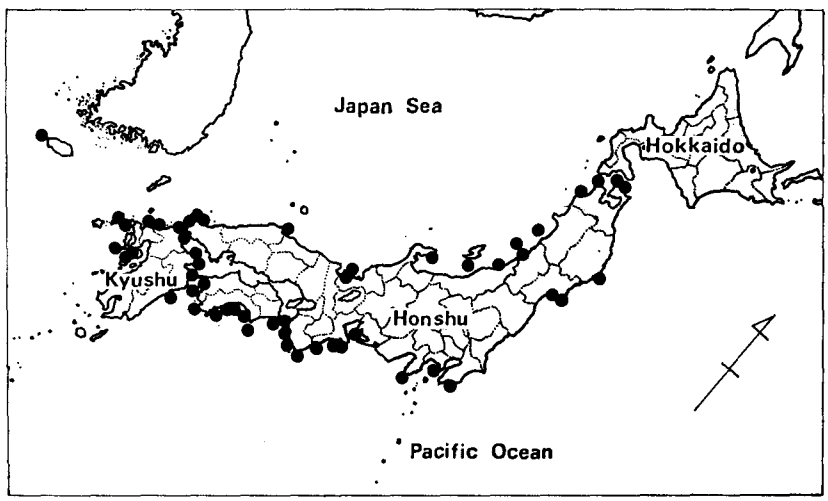

Fig. 64. Distribution of *Sargassum micracanthum*, compiled from specimens in SAP.

(KÜTZING) GRUNOW. The earliest author made this combination seems to be ENDLICHER (1843), as I use here.

The holotype of this species (Fig. 63 A) is a sterile fragment with leaves rather membranaceous in substance, illustrated by KÜTZING in his Tabulae (Fig. 63 B). Dissected lobes of the leaf are narrower. In this respect, the holotype of *S. kiushianum* YENDO resembles to the type of *Halochloa micracantha*. In describing *S. kiushianum*, YENDO (1907) emphasized a characteristic of receptacle which formed singly in axil of subtending leaf. His specimen represents an early stage of maturation. Successive observation on the process of formation of receptacles shows that additional receptacles are produced in basipetal order, resulting in a small raceme. OKAMURA (1924) already expressed his opinion concerning the solitary receptacle in *S. kiushianum*. Placement of *S. kiushianum* in the synonymy of *S. micracanthum* is quite convincing.

YENDO (1907) distinguished var. *stipulatum* basing on *S. micracanthum* sensu J. AGARDH. The holotype of this taxon is therefore that deposited in LD, Herb. Agardh as No. 2919 (Fig. 63 C) which was not examined by YENDO in preparing his description. As for the distinction of subspecific taxa in *S. micracanthum*, much investigation is needed.

YENDO (1907, p. 121) described a new section *Micracanthae* under the *Bactrophycus*, using the character of receptacles. Receptacles are ovate, ancipitous, excavated on one surface and longitudinally elevated on the other,

and minutely spinoso-dentated on the margin or at the apex, disposing on abbreviated fertile ramulets. He included in his new section following species: *S. kiushianum*, *S. micracanthum* and *S. nigrifolium*. Later, he (in OKAMURA 1916, p. 205) raised the status to subgenus. This is followed by OKAMURA (1936) and others. As a species with dentate receptacles, YAMADA (1942) described *S. tenuifolium*. *Carpacanthus trichophyllus* KÜTZING has clearly spinose, triquetrous receptacles. Morphology of basal part of those species is very different from each other. For example, *S. micracanthum* has erect branched stem, while *S. nigrifolium* has decumbent stem, and in *S. tenuifolium* stem is erect but very short in length without branching. Delimitation of subgenus by only one character is not reasonable. Therefore I am of opinion that the *Micracantha* of YENDO do not deserve to be recognized at subgeneric rank, and all the species are included here in the subgenus *Bactrophycus*.

20. *Sargassum giganteifolium* YAMADA in OKAMURA 1925 : 105, *pl. 230*. (Figs. 65-67)

OKAMURA 1936 : 332. SEGAWA 1956 : 50, *pl. 29*, No. 220. Holotype : TI "Shichirigahama, Sagami Prov., Oct. 1923, leg. Y. YAMADA". Syntype : SAP (Herb. Okamura "Enoshima, Sagami Prov., Oct. 1923") (Fig. 66).

Japanese name : Ohba-nokogiri-moku (YAMADA)

Thallus more than 1 m long. Holdfast conical or discoid, up to 4 cm in diameter. Stem upright, terete, up to 5-6 mm in diameter, branched once or twice, attaining 6 cm high or more. Main branches spirally disposed near the apices of the stem, ancipitous, up to 1 cm wide, marginal area thin, with spinal processes at irregular interval. Lateral branches well developed. Lower leaf retroflexed at the base, linear lanceolate in shape, 20 cm or more long and 3 cm wide, with rounded apex and decurrent at the base. Margin irregulary dentate. Midrib slightly elevated, evanescent near the apex. Phyllotaxis 1/2 in the lower part of main branch. Leaves becoming gradually smaller with inconspicuous midrib and acute apex on upper part of the branches. Cryptostomata scattered on the leaf. Vesicles usually solitary near the base of lateral branches, spherical to elliptical, 1.5 cm long and 1.2 cm in diameter, mucronate or coronated with a serrated leaflet at the apex, with a stipe about 1 cm long.

Plant dioecious. Receptacles disposed in abbreviated raceme or panicle on ramulets in axil of subtending leaf. Female receptacle flat, spatulate in shape with slightly emarginate apex, 3-4 mm long and 1-1.5 mm wide. Male one compressed, linear in shape, 8 mm long and 1 mm wide, usually simple,

sometimes once forked. Maturation in autumn.

This species grows in the subtidal zone down to more than 10 m deep.

Specimens examined: HONSHU: Hasunuma, Chiba Pref., Aug. 7, 1932, leg. A. KATO, SAP Herb. Okamura; Onjyuku, Chiba Pref., Nov. 17, 1981, leg. M. OHTA, SAP 041999; Chojagasaki, Kanagawa Pref., Apr. 3, 1981, leg. T. YOSHIDA, SAP 035485; Inamuragasaki,

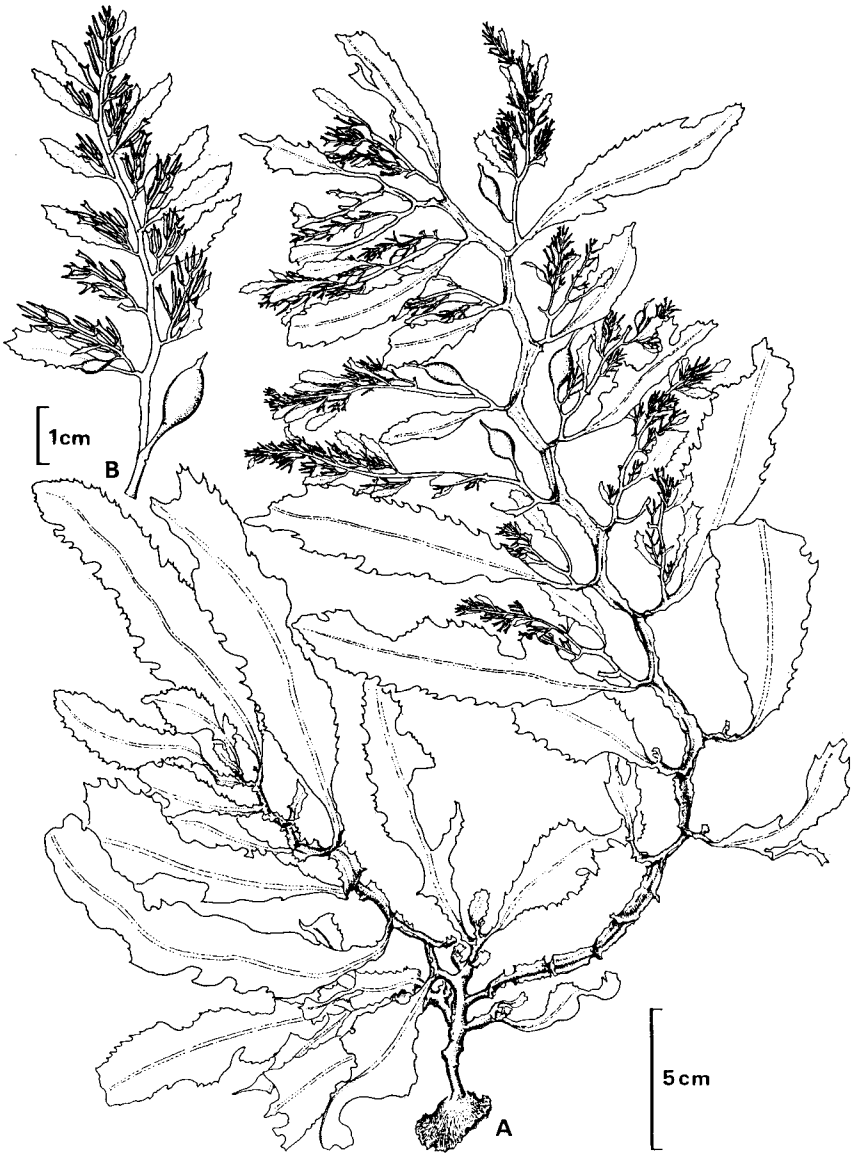

Fig. 65. *Sargassum giganteifolium* YAMADA.

Kanagawa Pref., Sept. 6, 1980, leg. T. YOSHIDA, SAP 034879; Shichirigahama, Kanagawa Pref., May 1924, leg. Y. YAMADA, SAP Herb. Okamura; Enoshima, Kanagawa Pref., Oct. 1923, leg. Y. YAMADA, SAP 012549; Okitsu, Shizuoka Pref., Sept. 27, 1982, leg. F. HAYASHIDA, SAP 042324; Yui, Shizuoka Pref., June 17, 1981, leg. F. HAYASHIDA, SAP 035724.

This species is primarily distinguishable from the species of *Siliquastrum* group in that this species has larger leaves with shallower dentation, not modified to the extremely skeletonized types as in *S. siliquastrum* or *S. macrocarpum*. Paniculately disposing slender receptacles of this species also contrast to the spatulate receptacles disposing racemosely in *S. siliquastrum* and *S. macrocarpum*.

SETCHELL (1933) assumed that this species as an extreme ecophene or possibly a gigantic mutant of a tetraploid type, without convincing data. At present we have no chromosome data for

Fig. 66. Syntype of *Sargassum giganteifolium* YAMADA. "Enoshima, Sagami Prov., Oct. 1923, leg. Y. YAMADA" SAP, Herb. Okamura.

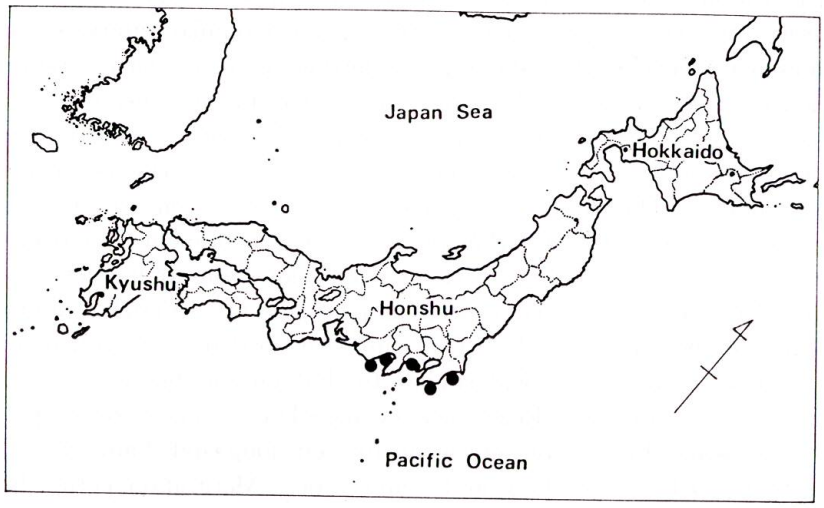

Fig. 67. Distribution of *Sargassum giganteifolium*, compiled from specimens in SAP.

this species. With its maturation period in autumn, as well as other morphological characters, this taxon is an independent entity.

This species is one of deep water inhabitants.

21. *Sargassum macrocarpum* C. AGARDH 1820 : 36. (Figs. 68–70)

C. AGARDH 1824 : 307. J. AGARDH 1848 : 293 ; 1889 : 60 ; 1896 : 52. DE TONI 1895 : 24. GRUNOW 1915 : 346. Lectotype : LD (Herb. Agardh No. 2903 "ex Japonia, TILESIUS") (Fig. 69 C).

Halochloa macrocarpa (C. AGARDH) KÜTZING 1849 : 634.

Sargassum tortile var. *macrocarpum* (C. AGARDH) YENDO 1905 : 156.

Fucus longifolius var. *angustifolius* TURNER 1809 : 88, *pl. 104, f. b–d.* Lectotype : BM (K) "e port. Nangas." (Fig. 69 B).

Sargassum tortile var. *angustifolium* (TURNER) C. AGARDH 1820 : 16.

Sargassum serratifolium auct. japon (non C. AGARDH). YENDO 1907 : 81, *pl. 11, f. 3–7* (excl. f. 1–2). OKAMURA 1916 :199 ; 1924 : 23, *pl. 207* ; 1936 : 329, *f.* 168–4. SEGAWA 1956 : 49, *pl. 28*, No. 218.

Japanese name : Nokogiri-moku.

Thallus attaining several meters long. Holdfast conical, up to 5 cm in diameter. A single stem arising from the holdfast, upright, terete, 4–5 mm in diameter, branching several times with an interval of about 1 cm or more, reaching up to more than 10 cm high. Several main branches produced annually at the distal part of the stem in spiral succession, leaving knots on the stem surface. Main branch ancipitous, 3–4 mm wide with a longitudinal costal elevation. Margin of the main branch armed by many protuberances with round or acute apex about 2 mm long in irregular intervals. Lateral branches well developed, becoming triquetrous in distal part. Lower leaf retroflexed at the base, thick coriaceous in substance, lanceolate to linear in shape, 10 cm or more long and 1.5 cm wide, with percurrent midrib. Marginal serration varying from shallow dentation to deep serration reaching to the midrib. Double serration common in leaves on lower to middle portion of the main branch. Phyllotaxis 1/2 on flat branches. Upper leaves becoming narrower to linear. Phyllotaxis on triquetrous branchlets changing to 1/3. Cryptostomata very rare to almost absent. Vesicle spherical to elliptical in shape, up to 1–1.2 cm long and 1 cm in diameter, with mucronate apex or beset with coronal leaf similar to that on the branch.

The plant dioecious. Receptacle oblanceolate to linear in shape, racemosely disposed. Female receptacle up to 1 cm long and 3 mm wide. Male one slender, up to 1.5 cm long and 2 mm wide. Maturation period in summer.

This species grows on rocks of subtidal zone down to 10 m deep or more.

Fig. 68. *Sargassum macrocarpum* C. AGARDH.

Specimens examined: HONSHU: Kominato, Chiba Pref., Mar. 29, 1978, leg. T. YOSHIDA, SAP 043225; Shikine-jima, Tokyo Pref., Aug. 1939, leg. S. INOH, SAP 021590; Jyogashima, Kanagawa Pref., Jan. 15, 1962, leg. Y. YAMADA, SAP 028776; Misaki, Kanagawa Pref., Aug. 1932, leg. Maclendon, SAP 013706-9; Shichirigahama, Kanagawa Pref., Oct. 1924, leg. Y. YAMADA, SAP 020732; Susaki, Shizuoka Pref., June 15, 1981, leg. Y. YOKAHAMA, SAP 043232; Doi, Shizuoka Pref., June 19, 1975, leg. F. HAYASHIDA, SAP 043223; Nagai, Shizuoka Pref., June 19, 1980, leg. F. HAYASHIDA, SAP 043230; Okitsu, Shizuoka Pref., May 21,

1981, leg. F. HAYASHIDA, SAP 043231; Omaezaki, Shizuoka Pref., Mar. 28, 1982, leg. T. YOSHIDA, SAP 043229; Wagu, Mie Pref., Aug. 1940, leg. T. TEGI, SAP 025001; Hamashima, Mie Pref., Oct. 27, 1981, leg. T. YOSHIDA, SAP 043228; Nagashima, Mie Pref., May 12, 1979, leg. T. YOSHIDA, SAP 043236; Koza, Wakayama Pref., Oct. 29, 1981, leg. YOSHIDA and KONNO, SAP 043227; Tsuwo, Yamaguchi Pref., Apr. 24, 1979, leg. T. YOSHIDA, SAP 043256; Tateishi, Yamaguchi Pref., Apr. 24, 1979, leg. T. YOSHIDA, SAP 043255; Kiwado, Yamaguchi Pref., Apr. 23, 1979, leg. T. YOSHIDA, SAP 043254; Misumi, Shimane Pref., Sept. 25, 1981, leg. T. TERAWAKI, SAP 043257; Setoshima, Shimane Pref., Aug. 30, 1964, leg. T. YAMAMOTO, SAP 043259; Tatamigaura, Shimane Pref., June 9, 1978, leg. T. YOSHIDA, SAP 043258; Kurauchi-wan, Shimane Pref., May 22, 1982, leg. S. KAWAGUCHI, SAP 043222; Kasumi, Hyogo Pref., June 11, 1978, leg. T. YOSHIDA, SAP 043260; Kinosaki, Hyogo Pref., Nov. 3, 1962, leg. T. YAMAMOTO, SAP 043262; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 043245; Ohwi, Fukui Pref., Sept. 23, 1981, leg. M. OHTA, SAP 043244; Wajima, Ishikawa Pref., Aug. 27, 1934, leg. T. MURAOKA, SAP 019974; Rokugo-zaki, Ishikawa Pref., May 15, 1982, leg. S. KAWAGUCHI, SAP 043221; Ogi, Ishikawa Pref., Nov. 8, 1960, leg. Y. YAMADA, SAP 028321; Ushitsu, Ishikawa Pref., May 23, 1976, leg. K. TANIGUCHI, SAP 043246; Shiiya, Niigata Pref., Nov. 19, 1981, leg. H. ISHIBASHI, SAP 043250; Sado, Niigata Pref., Aug. 26, 1971, leg. M. MASUDA, SAP 043248; Awashima, Niigata Pref., May 12, 1956, leg. M. NODA, SAP 043253; Tobishima, Yamagata Pref., May 30, 1963, leg. T. KANAMORI, SAP 035183; Funakawa, Akita Pref., Apr. 22, 1982, leg. M. TSUKIDATE, SAP 043252; Kamo, Akita Pref., May 11, 1982, leg. S. KAWAGUCHI, SAP 043272; Tanosawa, Aomori Pref., Feb. 17, 1983, leg. M. NOTOYA, SAP 043279; Asamushi, Aomori Pref., no date, leg. Y. YAMADA, SAP 7819.

SHIKOKU: Hane-zaki, Kochi Pref., Aug. 1950, leg. Y. YAMADA, SAP 026412; Onashihama, Kochi Pref., June 1, 1981, leg. T. YOSHIDA, SAP 043235; Tanoura, Kochi Pref., June 1, 1981, leg. T. YOSHIDA, SAP 043234; Totoshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 043239; Toshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 043238; Uwajima, Ehime Pref., May 22, 1982, leg. M. MARUI, SAP 043237; Ikata, Ehime Pref., May 12, 1982, leg. H. ISHIBASHI, SAP 043274.

KYUSHU: Saganoseki, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 043243; Iwaya, Fukuoka Pref., June 5, 1981, leg. T. YOSHIDA, SAP 043271; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043660; Hado-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043721; Imari, Saga Pref., Aug. 2, 1979, leg. T. YOTSUI, SAP 034733; Hirado-jima, Nagasaki Pref., Mar. 11, 1981, leg. H. KITO, SAP 043598; Katsura-shima, Nagasaki Pref., Jul. 28, 1942, leg. YAMADA and NAKAMURA, SAP 023875; Sakiyama, Nagasaki Pref., Jul. 26, 1942, leg. YAMADA and NAKAMURA, SAP 023827-8; Miiraku, Nagasaki Pref., Sept. 21, 1979, leg. T. YOTSUI, SAP 034732; Fukue, Nagasaki Pref., Jul. 26, 1942, leg. YAMADA and NAKAMURA, SAP 043267; Matsushima, Nagasaki Pref., Oct. 4, 1981, leg. T. TERAWAKI, SAP 043269; Nomozaki, Nagasaki Pref., June 5, 1978, leg. T. YOSHIDA, SAP 043265; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 043645; Ushinohama, Kagoshima Pref., June 13, 1980, leg. T. YOSHIDA, SAP 043263.

KOREA: Cheju Island, Oct. 8, 1934, leg. HOSHINO, SAP 043895.

The name *S. macrocarpum* C. AGARDH was variously treated in the

Fig. 69. A. Illustration of *Fucus longifolius* var. *angustifolius* TURNER, Hist. Fuc. Pl. 104, f. b. B. Lectotype of *Fucus longifolius* var. *angustifolius* TURNER. "e port. Nangas." BM(K), seems to be used above illustration. C. Lectotype of *Sargassum macrocarpum* C. AGARDH. "ex Japonia, TILESIUS" LD, Herb. Agardh No. 2903.

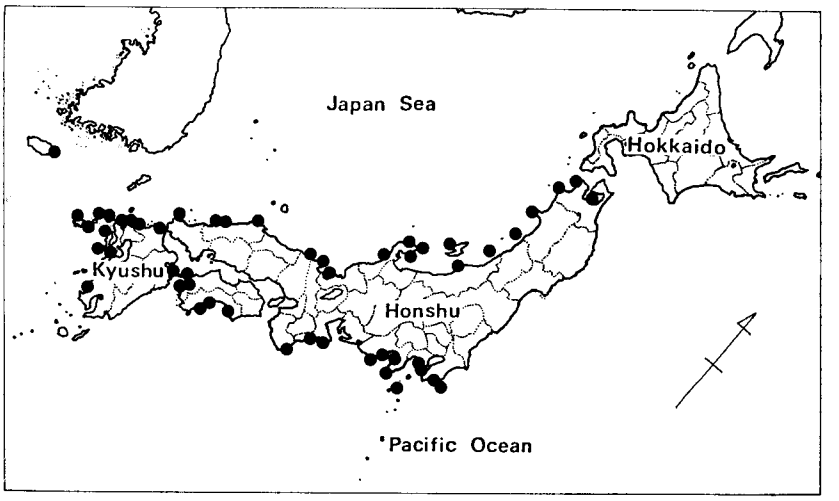

Fig. 70. Distribution of *Sargassum macrocarpum* compiled from specimens in SAP.

past. J. AGARDH (1848, 1889, 1896), DETONI (1895) and GRUNOW (1915) accepted it as a distinct species. YENDO (1905, 1907) referred this taxon as a variety under *S. tortile*. This is followed by subsequent Japanese authors.

In the Agardhian herbarium (LD), many specimens (Nos. 2895-2917) are placed in the same cover. Most of them are collection of KJELLMAN sent to J. AGARDH. Therefore I propose to select No. 2903 (Fig. 69 C) as the lectotype, because only this specimen seems to be examined by C. AGARDH. The lectotype is a small sterile fragment of about 15 cm long. Its ancipitous branch has obtuse projections on the margin. Leaf is coriaceous in texture and has coarse dentation on the margin. Double dentation is also clearly discernible. These characters are very distinct and in common with the individuals referred to *S. serratifolium* by most Japanese authors of the present day.

Fucus longifolius var. *angustifolius* TURNER was based on the specimen collected at Nagasaki and housed in BM (K) (Fig. 69 B). Illustration made by TURNER (Fig. 69 A) gives rather different impression as to the width of leaf and pinnae. Closer examination shows that this specimen represents a sterile upper part of an individual referable to *S. macrocarpum*. This taxon was later treated as a variety under *S. tortile*.

NAKAJIMA & KONNO (unpublished) and ARIYAMA (unpublished) observed that there are two different populations as for the maturation period, although they are morphologically very similar. Deep water population matures earlier

and shallow water population later in season. Taxonomic treatment of them needs further investigation.

This species is perennial in growth. YOSHIDA (unpublished) observed individuals with 7 growth rings in a population of North Kyushu.

22. *Sargassum autumnale* YOSHIDA, spec. nov. (Figs. 71–74)

Thallus plerumqe usque ad 50 cm altus. Hapteron conicum, 3–5 cm in diametro. Caulis erectus, teres, 2–3 mm in diametro, compluriens ramificans, usque ad 8 cm altus. Aliquot rami principales ex parte distali caulis enascentes. Rami principales triqueteri, margine acuti, 2 mm lati, aliquot spinis acutis circa 2 mm longis in margine exorientibus. Rami laterales multi, sed ramo principali multo breviores. Folia in parte proximali rami principalis conspicue basi retroflexa, anguste lanceolata vel linearia, 3–5 cm longa et 4–6 mm lata, margine serrata. Costa immersa et in apicem versus deminuens. Folia angustescentia in parte superiori, margine inconspicue denticulata. Folia in parte distali filiformia, 4–5 cm longa et 0.2–0.3 mm lata. Costa incognita. Cryptostomata praesentia super folio. Vesicula obovata vel pyriformis usque ad 8 mm longa et 6 mm in diametro, apice mucronata vel folio coronae filiformi usque ad 1 cm longo munita.

Planta dioica. Receptacula in parte distali rami racemose vel paniculatim disposita. Receptacula femina spathulata 2–3 mm longa et 1.5 mm lata. Receptacula masculina linearia, 5–8 mm longa et 0.5 mm lata. Maturatio autumno est.

Holotypus: Nomozaki, Nagasaki Pref., Sept. 24, 1976, leg. T. YOTSUI, SAP 043407 (Fig. 73). Isotypi in BM, L, LD, PC, TNS, UC, US.

Japanese name: Aki-yore-moku (nov.)

Thallus usually up to 50 cm high. Holdfast conical, up to 5 cm in daimeter. Stem erect, terete, 2–3 mm in diameter, branching several times, up to 8 cm high. A few main branches arising from the distal part of the stem annually, leaving scars on the stem. Main branch triquetrous with sharp edges, 2 mm wide, with a few sharp spines about 2 mm long formed on the edge. Lateral branches numerous, but much shorter in length than the main branch. Leaf on the proximal part of main branch retroflexed conspicuously at the base, narrow lanceolate to linear in shape, 3–5 cm long and 4–6 mm wide, with serrate margin. Leaf apex acute, and base ending to decurrent petiole. Midrib immersed, diminishing near the apex. Phyllotaxis of leaves 1/3 on the main branch. Leaf becoming narrower in the middle part of the branch, with inconspicuous dentation on the margin. Leaves on the upper part of thallus filiform, 4–5 cm long and 0.2–0.3 mm wide. Midrib not

Fig. 71. *Sargassum autumnale* YOSHIDA.

Fig. 72. *Sargassum autumnale* YOSHIDA. A, male receptacles. B, female receptacles.

discernible. Cryptostomata present on the leaf. Vesicle obovoid or pyriform in shape, up to 8 mm long and 6 mm in diameter, mucronate at apex or with filiform coronal leaf up to 2 cm long.

The plant dioecious. Receptacle racemosely or paniculately disposed in the distal part of the branch. Female receptacle spatulate, 2-3 mm long and 1.5 mm wide. Male one linear, 5-8 mm long and 0.5 mm wide. Maturation in autumn.

This species grows on rocks near the low water mark, in area rather protected from wave action.

Specimens examined: HONSHU: Kamo, Yamagata Pref., Jul. 1931, leg. W. HIROHASHI, SAP 012079; Kashiwazaki, Niigata Pref., Aug. 10, 1981, leg. H. ISHIBASHI, SAP 043323; Sado, Niigata Pref., Aug. 26, 1971, leg. M. MASUDA, SAP 043300; Shimpo, Ishikawa Pref., Oct. 12, 1962, leg. S. FUNAHASHI, SAP 043303; Tatekabe, Ishikawa Pref., Aug. 1, 1962, leg. S. FUNAHASHI, SAP 043313; Koiji, Ishikawa Pref., Jul. 10, 1962, leg. S. FUNAHASHI, SAP 043314; Wajima, Ishikawa Pref., Oct. 13, 1964, leg. S. FUNAHASHI, SAP 043316; Shibagaki, Ishikawa Pref., Aug. 1924, leg. Y. YAMADA, SAP 021738-9; Wada, Fukui Pref., Oct. 5, 1949, leg. I. UMEZAKI, SAP 025698; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 043310; Maizuru, Kyoto Pref., Aug. 13, 1949, leg. Y. YAMADA, SAP 025687; Kammuri-jima, Kyoto Pref., Dec. 26, 1977, leg. H. KAWAI, SAP 043299; Yuya, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 043307.

KYUSHU: Iwaya, Fukuoka Pref., June 5, 1981, leg. T. YOSHIDA, SAP 043319; Tsuyazaki,

Fig. 73. Holotype of *Sargassum autumnale* YOSHIDA. "Nomozaki, Nagasaki Pref., Sept. 24, 1976, leg. T. YOTSUI" SAP 043707.

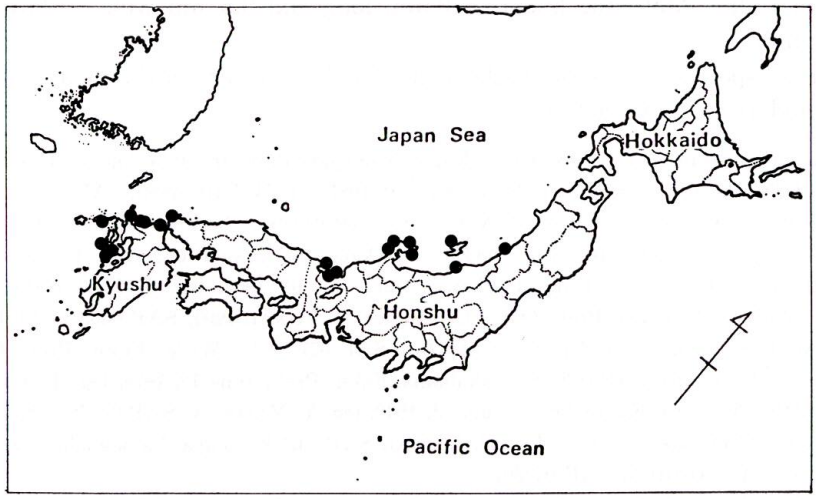

Fig. 74. Distribution of *Sargassum autumnale*, compiled from specimens in SAP.

Fukuoka Pref., Oct. 15, 1977, leg. T. YOSHIDA, SAP 043301; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043659; Hado-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043724; Hirado-jima, Nagasaki Pref., May 26, 1983, leg. T. YOSHIDA, SAP 043683; Nomozaki, Nagasaki Pref., Sept. 9, 1976, leg. T. YOTSUI, SAP 043308; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 043642; Tomioka, Kumamoto Pref., Aug. 9, 1949, leg. Y. YAMADA, SAP 025681-2.

The plants of this taxon were usually referred to *S. tortile* (=*S. siliquastrum*) by earlier authors. Characters such as slender leaves often assuming filiform shape, maturation in autumn to winter, are sufficiently different from *S. siliquastrum* which has wider leaf especially on young shoots and maturation period in spring to early summer. *S. autumnale* grows at shallower and more protected places than *S. siliquastrum*.

23. ***Sargassum siliquastrum*** (MERTENS ex TURNER) C. AGARDH 1820 : 22. (Figs. 75-81)

J. AGARDH 1848 : 292; 1889 : 60; 1896 : 55. DE TONI 1895 : 24. GRUNOW 1915 : 346. SETCHELL 1933 : 38, *pl. 11-12*; 1933 a : 201 (pro parte).

Fucus siliquastrum MERTENS ex TURNER 1809 : 26, *pl. 82*. Lectotype: BM "Port. Nangasaki" (Fig. 77 A).

Cystoseira siliquastra (MERTENS ex TURNER) C. AGARDH 1824 : 288.

Halochloa siliquastra (MERTENS ex TURNER) KÜTZING 1843 : 55; 1849 : 634; 1860 : 34, *pl. 97, f. 1*.

Fucus scoparius MERTENS ex TURNER 1809 : 156, *pl. 132*. Lectotype: BM "e mari Coreano" (Fig. 77 C).

Sargassum scoparium (MERTENS ex TURNER) C. AGARDH 1820 : 26. J. AGARDH 1848 : 292; 1889 : 60; 1896 : 53. DE TONI 1895 : 23. GRUNOW 1915 : 345.

Halochloa scoparia (MERTENS ex TURNER) KÜTZING 1843 : 55; 1849 : 634; 1860 : 33, *pl. 95*.

Fucus tortilis C. AGARDH 1812 : 6. Lectotype: LD (Herb. Agardh No. 2933 "ex Brasilia, TILESIUS") (Fig. 78 A).

Sargassum tortile (C. AGARDH) C. AGARDH 1820 : 15; 1824 : 299. J. AGARDH 1848 : 291; 1889 : 60; 1896 : 53. DE TONI 1895 : 23. YENDO 1907 : 85, *pl. 12, f. 1-8*. GRUNOW 1915 : 344. OKAMURA 1916 : 199; 1924 : 26, *pl. 208*; 1936 : 330, *f. 168*. SEGAWA 1956 : 49, *pl. 29*, No. 219.

Halochloa tortilis (C. AGARDH) KÜTZING 1843 : 56; 1849 : 633; 1860 : 34, *pl. 99, f. 1*.

Fucus tortilis var. *angustifolius* C. AGARDH 1812 : 6. Lectotype: LD (Herb. Agardh No. 2931 "Japonia, TILESIUS") (Fig. 78 B).

Fucus serratifolius THUNBERG 1815 : 144 (non C. AGARDH). Holotype: UPS "e japonia, THUNBERG, incolis Kudawara" (YAMADA 1955, f. B).

Halochloa macracantha KÜTZING 1843 : 55; 1843 a : 366; 1849 : 633; 1860 : 34, *pl. 97, f. 2*. Lectotype: L 937. 55. 274 "Japanisches Meer" (Fig. 79 A).

Sargassum macracanthum (KÜTZING) ENDLICHER 1843 : 31.

Sargassum tortile var. *macracanthum* (KÜTZING) GRUNOW 1915 : 344.

Halochloa polyacantha KÜTZING 1843 : 56 ; 1843 a : 367 ; 1849 : 633 ; 1860 : 34, *pl. 98, f. 1.*
Lectotype : L 937.71.508 "Japanisches Meer" (Fig. 78 C).
Sargassum polyacanthum (KÜTZING) ENDLICHER 1843 : 31.
Sargassum tortile var. *polyacanthum* (KÜTZING) GRUNOW 1915 : 345.
Halochloa tenuis KÜTZING 1843 : 56 ; 1843 a : 367. Lectotype : L 937.71.683 "Japan" (Fig. 78 E).
Sargassum tenuis (KÜTZING) ENDLICHER 1843 : 31.

Fig. 75. *Sargassum siliquastrum* (TURNER) C. AGARDH.

Sargassum scoparium var. *tenuis* (KÜTZING) GRUNOW 1915 : 346.

Halochloa pachycarpa KÜTZING 1843 : 55 ; 1843 a : 366 ; 1849 : 634 ; 1860 : 34, *pl. 96*. Lectotype : L 937.71.695 "Japanisches Meer" (Fig. 79 C).

Sargassum pachycarpa (KÜTZING) ENDLICHER 1843 : 31.

Sargassum scoparium var. *pachycarpa* (KÜTZING) GRUNOW 1915 : 345.

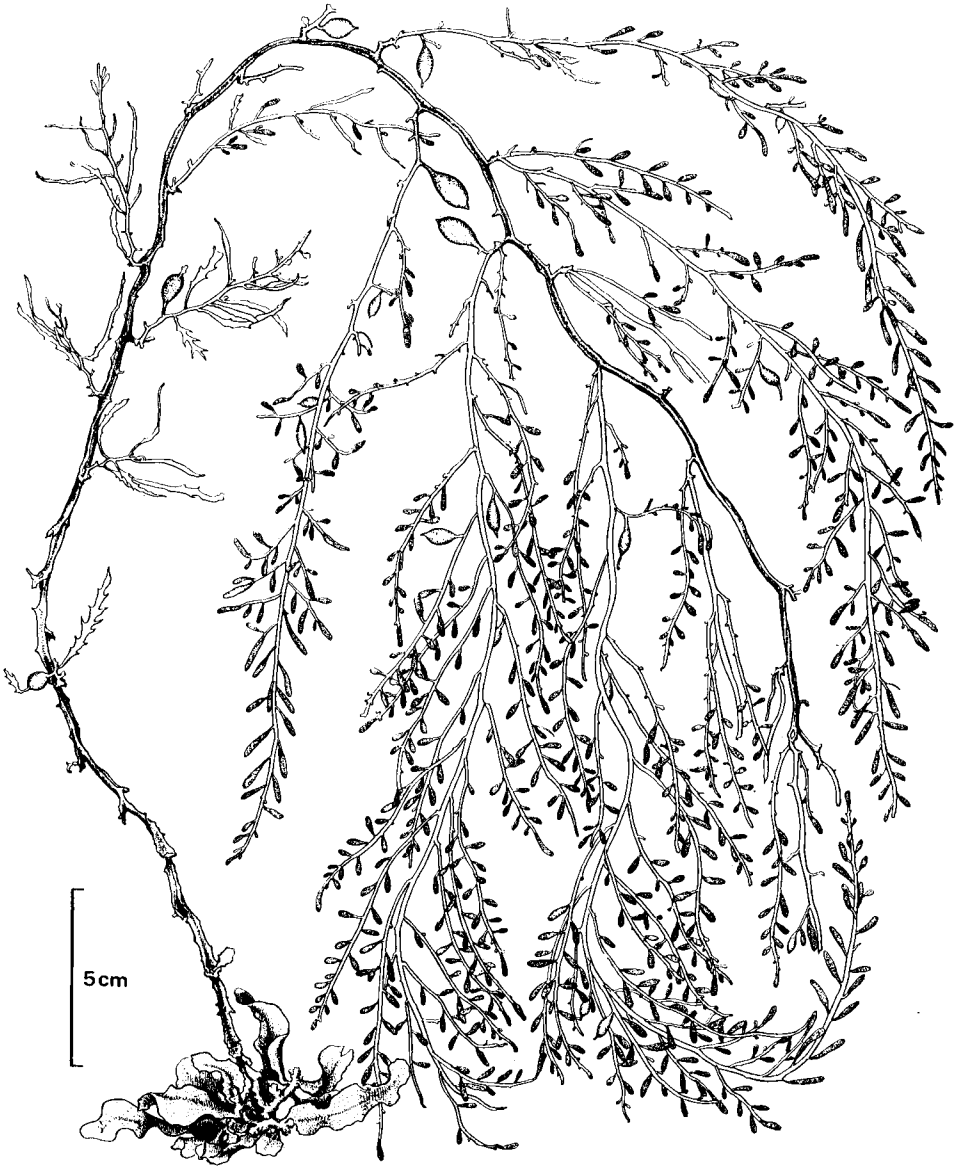

Fig. 76. *Sargassum siliquastrum* (TURNER) C. AGARDH.

Sargassum corynecarpum HARVEY 1859:325. DE TONI 1895:25. GRUNOW 1915:348. DAWSON 1959: 6, *pl. 4*. Type: TCD "ad litora Japoniae prope Simoda, leg. C. WRIGHT" (Fig. 80 A).

Sargassum tortile f. *ulophylla* GRUNOW 1915:345. Type not located "in mari Japonico, Kiushu, leg. REIN".

Sargassum siliquastrum var. *pyrifera* HARVEY 1859:328. DAWSON 1959:6. Type: TCD? "ad litora Japoniae prope Shimoda".

Sargassum siliquastrum var. *niponensis* GRUNOW 1915:347. Type not located "in mari Japonico Nangasaki, leg. SCHOTTMÜLLER".

Sargassum siliquastrum var. *capitellata* GRUNOW 1915:348. Type not located "in mari Japonico, leg. GAERTNER".

Japanese name: Yore-moku.

Thallus usually over 1 m high, attaining several meters. Holdfast conical, up to 3-4 cm in diameter. A single stem arising on top of the holdfast, branching several times, 2-3 cm high. In individuals several years old, growth of holdfast burying the lower part of the stem resulting in an appearance that 2 or more stems arising from the same holdfast. Main branches issued from the distal part of the stem, flat below and triquetrous above, accompanied by the change of phyllotaxis from 1/2 to 1/3, usually with entire edges, but sparsely beset with acute spines on the edge. Leaf near the base of the main branch elliptical to lanceolate in shape, 3-4 cm long and 1-1.5 cm wide with entire margin, often giving bluish iridescence while in the water, coriaceous in texture. Midrib immersed, evanescent near the apex. This type of leaf falling off after the main branch growing longer. Leaf becoming abruptly longer and larger, up to 10 cm long and 1-1.5 cm wide, with conspicuous serration on the margin. Serration on the margin very variable. Single serration being more common, with deep sini reaching to the midrib, giving an appearance of filiform midrib and alternately arising linear spines. Double serration observed in several individuals. Cryptostomata scattered on leaf surface. Vesicle obovoid to elliptical in shape, 10 mm long and 8 mm in diameter, with mucronated apex or with coronal leaf up to 3 cm long. Vesicles on the distal part of the thallus becoming smaller and narrower to fusiform in shape.

Plant dioecious. Receptacle spatulate to linear spatulate in shape, complanated with entire margin, sometimes more or less concave on one surface, rarely triquetrous and in some individuals receptacles with serrulate margin encountered. Receptacles disposing racemosely or paniculately in the distal part of ultimate branches. Female receptacle 5-10 mm long and 2-4 mm wide. Male one up to 1.7 cm long and 2 mm wide. Maturation in spring to early summer in the southern part of its distribution, summer in northern extremes.

This species grows on rocks of subtidal zone down to 15 m deep.

Specimens examined: HONSHU: Ozuchi-wan, Iwate Pref., Mar. 27, 1979 (drift), leg. T. YOSHIDA, SAP 043329; Ofunato, Iwate Pref., May 20, 1951, leg. S. KAWASHIMA, SAP 026887; Matsushima, Miyagi Pref., Apr. 13, 1965 (drift), leg. T. YOSHIDA, SAP 035261; Nagasaki, Fukushima Pref., Jul. 14, 1981, leg. T. YOSHIDA, SAP 043333; Katsuura, Chiba Pref., May 6, 1955, leg. Y. TSUJI, SAP 043376; Kominato, Chiba Pref., Mar. 29, 1978, leg. T. YOSHIDA, SAP 043373; Misaki, Kanagawa Pref., May 1938, leg. Y. YAMADA, SAP 021230; Aburatsubo, Kanagawa Pref., Apr. 3, 1981, leg. T. YOSHIDA, SAP 043271; Zushi, Kanagawa Pref., Sept. 1928, leg. S. AKIYAMA, SAP 7834-6; Kamakura, Kanagawa Pref., Oct. 1923, leg. Y. YAMADA, SAP 024733; Susaki, Shizuoka Pref., Jan. 24, 1961, leg. S. SEGAWA, SAP 028373; Iruma, Shizuoka Pref., May 11, 1975, leg. F. HAYASHIDA, SAP 043370; Ihama, Shizuoka Pref., June 14, 1975, leg. F. HAYASHIDA, SAP 043369; Morozaki, Aichi Pref., Mar. 1951, leg. T. SEGI, SAP 025038; Sugashima, Mie Pref., Apr. 21, 1955, leg. Y. TSUJI, SAP 043360; Hamashima, Mie Pref., May 10, 1979, leg. T. YOSHIDA, SAP 043361; Koza, Wakayama Pref., Jul. 27, 1957, leg. Y. YAMADA, SAP 043354; Shirahama, Wakayama Pref., Nov. 1, 1957, leg. T. YAMAMOTO, SAP 043365; Mihama, Wakayama Pref., Aug. 10, 1959, leg. T. YAMAMOTO, SAP 043364; Yura, Wakayama Pref., Jan. 16, 1959, leg. T. YAMAMOTO, SAP 043366; Yuasa, Wakayama Pref., June 12, 1960, leg. T. YAMAMOTO, SAP 043367-8; Futami, Yamaguchi Pref., June 7, 1978, leg. T. YOSHIDA, SAP 043378; Omi-jima, Yamaguchi Pref., June 8, 1978, leg. T. YOSHIDA, SAP 043379; Tatami-gaura, Shimane Pref., June 6, 1978, leg. T. YOSHIDA, SAP 043380; Setogashima, Shimane Pref., Aug. 30, 1963, leg. T. YAMAMOTO, SAP 043382; Hinomisaki, Shimane Pref., Aug. 2, 1942, leg. Y. NAKAMURA, SAP 023769; Etomo, Shimane Pref., May 22, 1982, leg. S. KAWAGUCHI, SAP 043357; Shichirui, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 043386; Tango, Hyogo Pref., May 18, 1982, leg. S. KAWAGUCHI, SAP 043359; Yura, Kyoto Pref., Nov. 4, 1962, leg. T. YAMAMOTO, SAP 043387; Maizuru, Kyoto Pref., Dec. 26, 1977, leg. H. KAWAI, SAP 043391; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 043393; Ohwi, Fukui Pref., Sept. 23, 1981, leg. M. OHTA, SAP 043394-5; Rokugo-zaki, Ishikawa Pref., May 15, 1982, leg. S. KAWAGUCHI, SAP 043358; Mitsuke-jima, Ishikawa Pref., Oct. 21, 1976, leg. K. TANIGUCHI, SAP 043331; Ogi, Ishikawa Pref., Nov. 8, 1960, leg. Y. YAMADA, SAP 028323-5; Ushitsu, Ishikawa Pref., Oct. 22, 1976, leg. K. TANIGUCHI, SAP 043332; Shiiya, Niigata Pref., May 31, 1981, leg. H. ISHIBASHI, SAP 043398; Sado, Niigata Pref., Jul. 26, 1965, leg. M. NODA, SAP 043381; Toga, Akita Pref., Apr. 23, 1982, leg. M. TSUKIDATE, SAP 042132; Fukaura, Aomori Pref., June 21, 1978, leg. T. YOSHIDA, SAP 043400; Tanosawa, Aomori Pref., May 27, 1982, leg. M. NOTOYA, SAP 043285; Ohma, Aomori Pref., June 20, 1976, leg. M. SAWADA, SAP 043402; Asamushi, Aomori Pref., May 1929, leg. S. INOH, SAP 8537-8.

SHIKOKU: Kozuchi-jima, Kagawa Pref., Oct. 31, 1962, leg. T. YAMAMOTO, SAP 043352; Ikata, Ehime Pref., Mar. 28, 1956, leg. Y. NOMURA, SAP 043351; Misaki, Ehime Pref., May 31, 1979, leg. T. YOSHIDA, SAP 043347; Totoshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 043346.

KYUSHU: Hime-shima, Oita Pref., June 4, 1981, leg. T. YOSHIDA, SAP 043339; Tsukumi, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 043340; Ushinohama, Kagoshima Pref., June

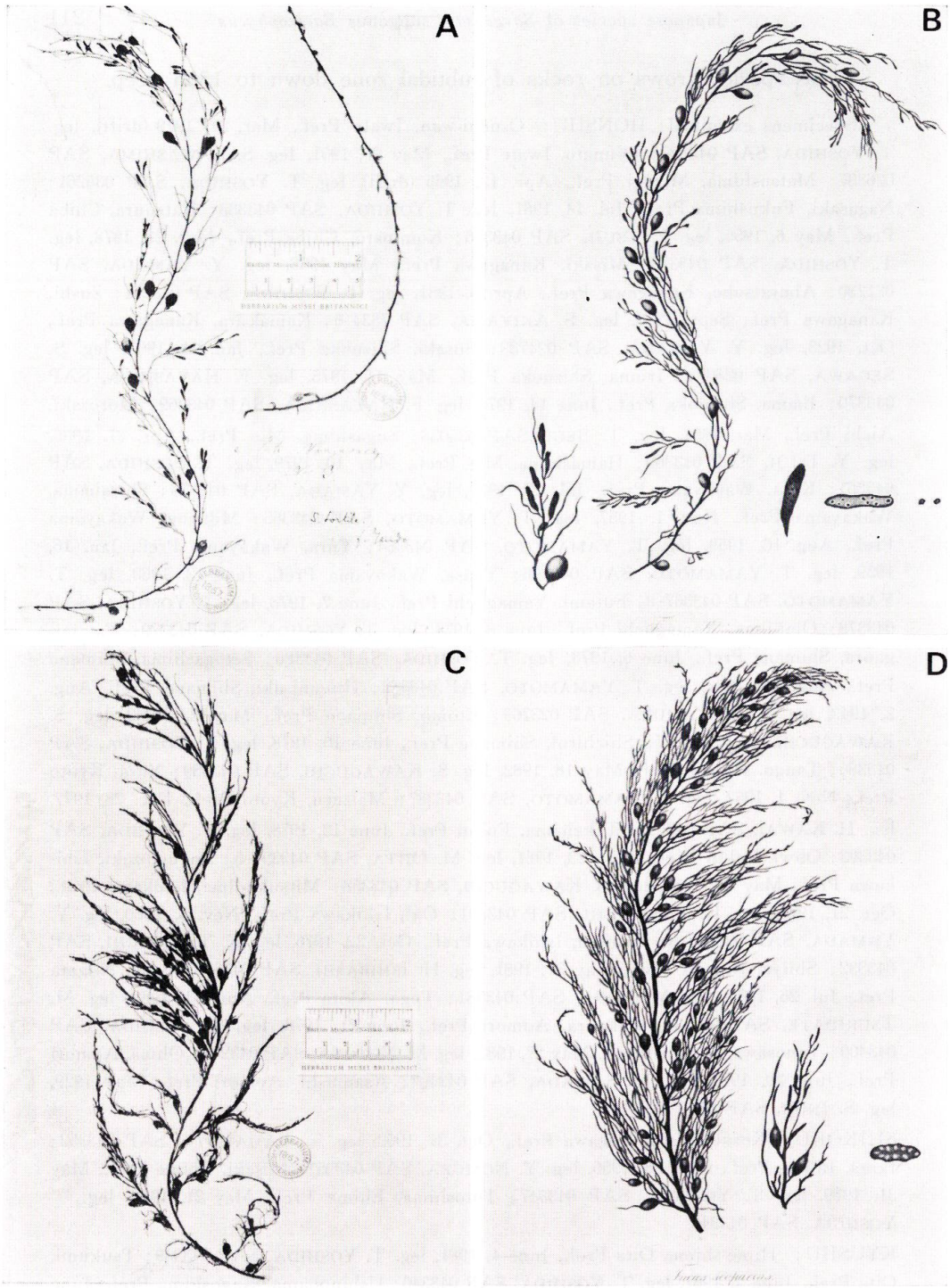

Fig. 77. A. Lectotype of *Fucus siliquastrum* TURNER. "Port. Nangasaki" BM. B. Illustration of *Fucus siliquastrum* TURNER, Hist. Fuc. Pl. 82. C. Lectotype of *Fucus scoparius* TURNER. "e mari Coreano" BM. D. Illustration of *Fucus scoparius* TURNER, Hist. Fuc. Pl. 132.

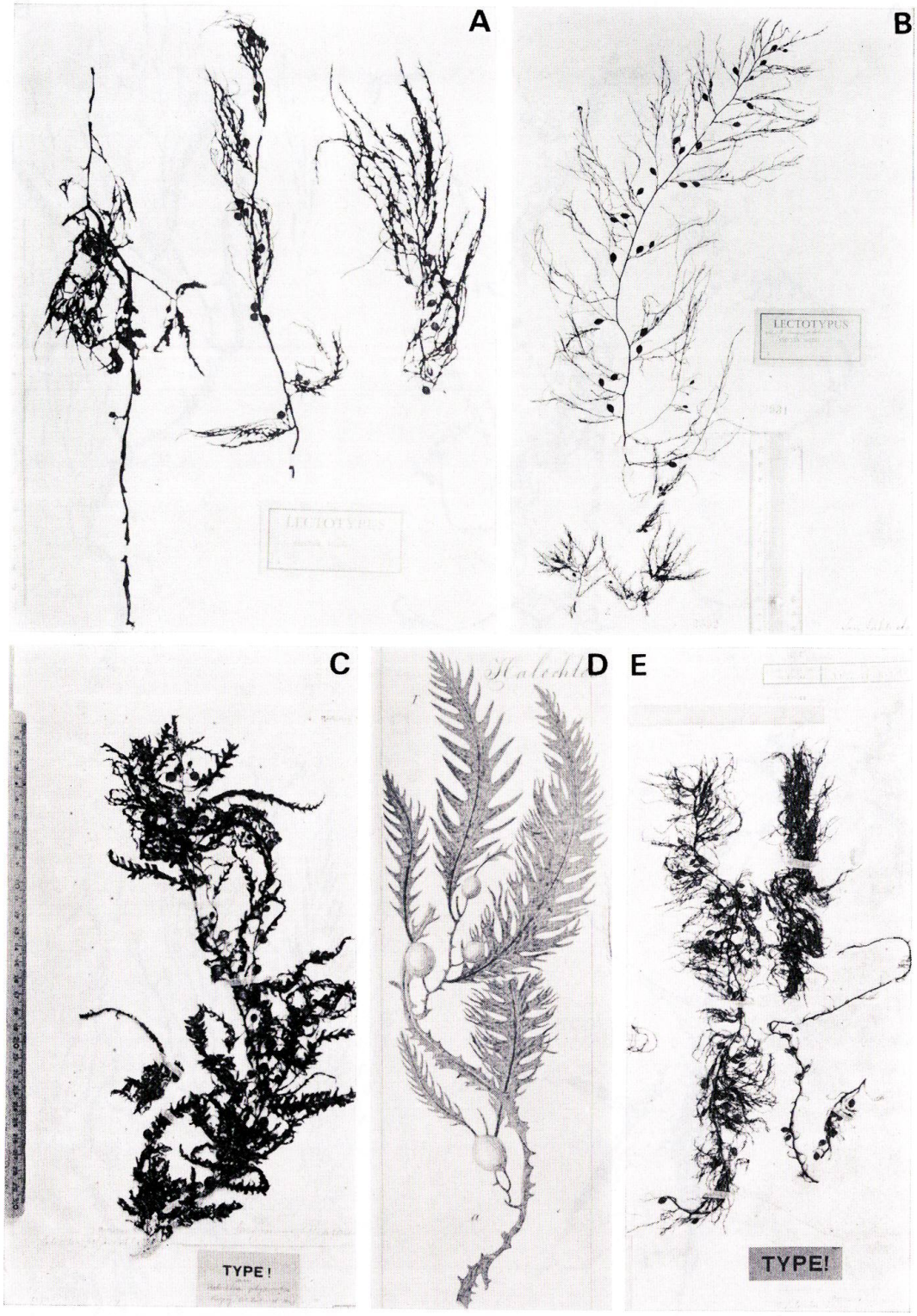

Fig. 78. A. Lectotype of *Fucus tortilis* C. AGARDH. "ex Brasilia, TILESIUS" LD, Herb. Agardh No. 2933. B. Lectotype of *Fucus tortilis* var. *angustifolius* C. AGARDH. "Japonia, TILESIUS" LD, Herb. Agardh No. 2931. C. Lectotype of *Halochloa polyacantha* KÜTZING. "Japanisches Meer" L 937.71.508. D. Illustration of *Halochloa polyacantha* KÜTZING, Tab. Phyc. vol. 10, Pl. 98, f. 1. E. Lectotype of *Halochloa tenuis* KÜTZING. "Japan" L 937.71.683.

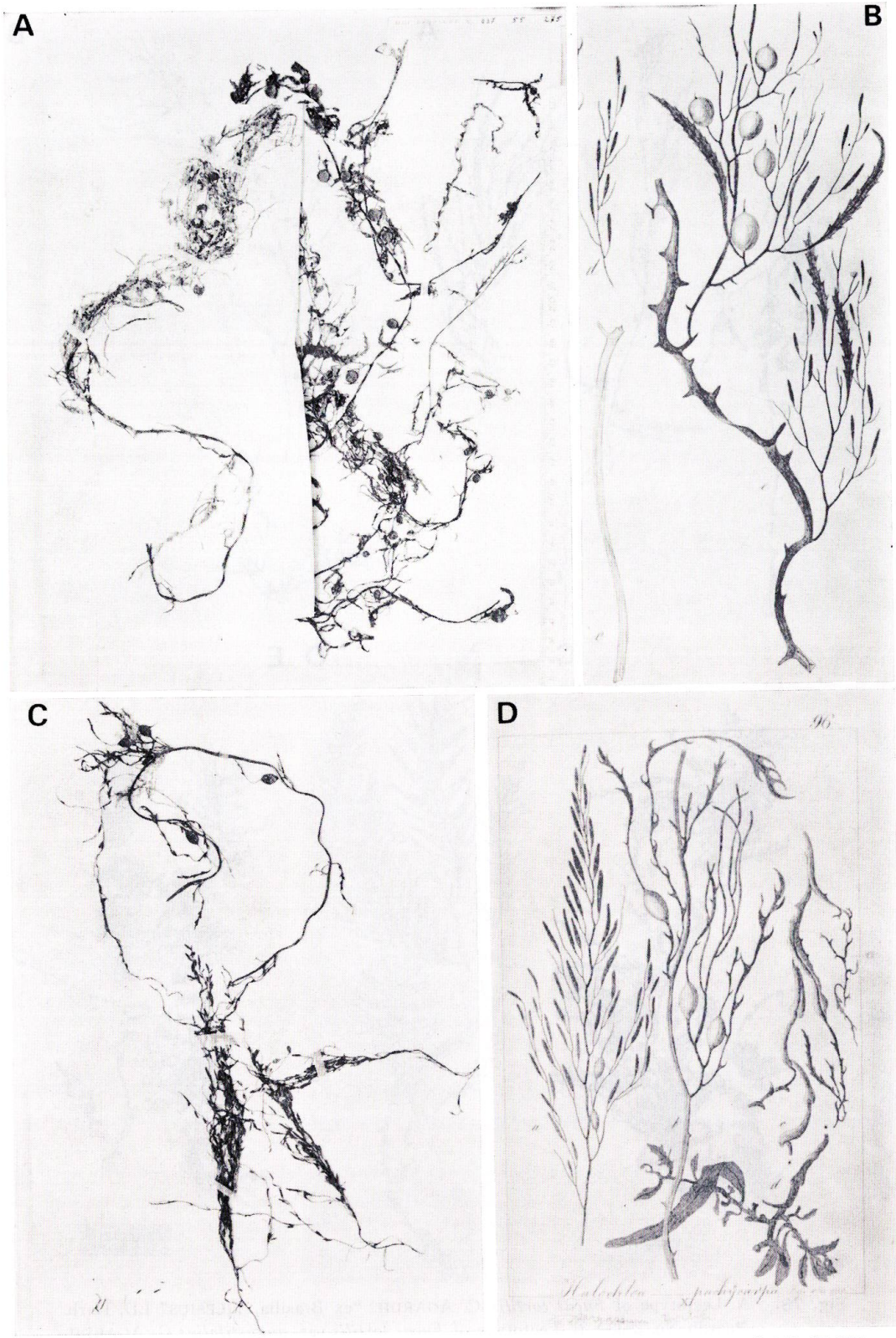

Fig. 79. A. Lectotype of *Halochloa macracantha* KÜTZING. "Japanisches Meer" L 937. 55. 274.
B. Illustration of *Halochloa macracantha* KÜTZING, Tab. Phyc. vol. 10, Pl. 97, f. 2.
C. Lectotype of *Halochloa pachycarpa* KÜTZING. "Japanisches Meer" L 937. 71. 695.
D. Illustration of *Halochloa pachycarpa* KÜTZING, Tab. Phyc. vol. 10, Pl. 96. Scale in A also for C.

13, 1980, leg. T. YOSHIDA, SAP 043336; Shimabara, Nagasaki Pref., Aug. 1933, leg. T. TANAKA, SAP 043335; Iimori, Nagasaki Pref., May 23, 1983, leg. T. YOSHIDA, SAP 043601; Nomozaki, Nagasaki Pref., June 5, 1978, leg. T. YOSHIDA, SAP 043341; Matsushima, Nagasaki Pref., Oct. 4, 1981, leg. T. TERAWAKI, SAP 043338; Fukue, Nagasaki Pref., Jul. 26, 1942, leg. YAMADA and NAKAMURA, SAP 043343; Shugen-jima, Nagasaki Pref., Jul. 29, 1942, leg. YAMADA and NAKAMURA, SAP 023861; Hirado-jima, Nagasaki Pref., Mar. 11, 1981, leg. H. KITO, SAP 043592; Imari, Saga Pref., Aug. 2, 1979, leg. T. YOTSUI, SAP 034731; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043653; Tsuyazaki, Fukuoka Pref., Oct. 15, 1977, leg. T. YOSHIDA, SAP 043345; Iwaya, Fukuoka Pref., June 5, 1981, leg. T. YOSHIDA, SAP 043334.

HOKKAIDO: Okushiri-jima, Hiyama Prov., Jul. 3, 1943, leg. Y. HASEGAWA, SAP 025123; Rishiri-to, Soya Prov., Aug. 5, 1982, leg. NOGAMI, SAP 043461; Muroran, Iburi Prov., Sept. 1, 1969 (drift), leg. M. MASUDA, SAP 034759.

KOREA: Genzan, Oct. 20, 1935, leg. NISHIOKA, SAP 043894.

CHINA: Dairen, Jul. 24, 1937, leg. M. NODA, SAP 043356.

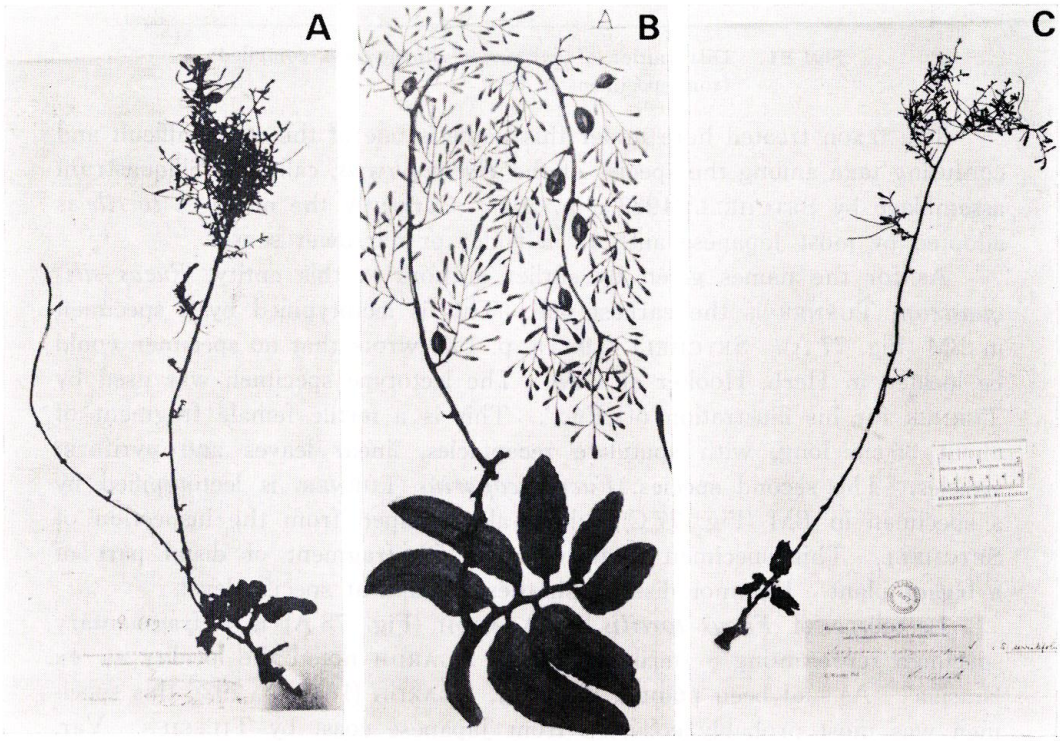

Fig. 80. A. Type of *Sargassum corynecarpum* HARVEY. "ad litora Japoniae prope Simoda, leg. C. WRIGHT" TCD. Reproduced from a photograph deposited in BM. B. Illustration of *Sargassum corynecarpum* HARVEY, taken from DAWSON (1959). C. A specimen (isotype ?) of *Sargassum corynecarpum* HARVEY, deposited in BM.

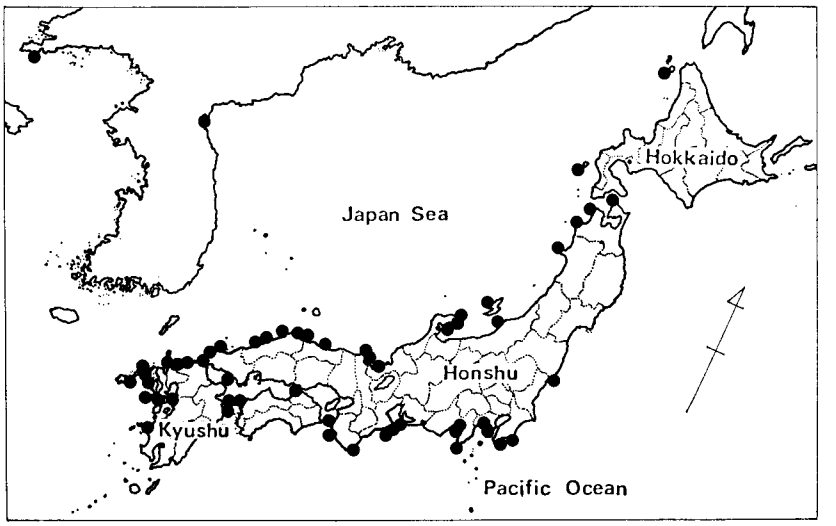

Fig. 81. Distribution of *Sargassum siliquastrum*, compiled from specimens in SAP.

The taxon treated here under this name is one of the most difficult and confusing taxa among the species of the *Bactrophycus*, called as Siliquastrum assemblage by SETCHELL (1933 a, p. 204). Currently the name *S. tortile* is adopted by most Japanese authors in wider or narrower sense.

As for the names given by earlier authors to this entity, *Fucus siliquastrum* TURNER is the earliest one. This is lectotypified by a specimen in BM (Fig. 77 A). SETCHELL (1933 a, p. 193) wrote that no specimen could be located in Herb. Hooker at Kew. The lectotype specimen was used by TURNER for his illustration of 'Fuci'. This is a fertile female fragment of about 35 cm long, with spatulate receptacles, linear leaves and pyriform vesicles. The second species, *Fucus scoparius* TURNER, is lectotypified by a specimen in BM (Fig. 77 C), which also escaped from the inspection of SETCHELL. This specimen is fertile male (??) fragment of distal part of a bigger plant. I cannot distinguish these 2 taxa at specific level.

Lectotype of *Fucus tortilis* C. AGARDH (Fig. 78 A) is a fragmentary specimen representing a sterile state. C. AGARDH noted the locality as 'ex Brasilia'. As had been pointed out by J. AGARDH (1848, p. 292), this specimen was most probably collected from Japanese coast by TILESIUS. Var. *angustifolius* C. AGARDH of this species, lectotypified by a specimen in LD (Fig. 78 B) has very narrow leaves and is also a sterile plant.

KÜTZING (1843), in erecting his new genus *Halochloa*, described new species *H. macracantha*, *H. pachycarpa*, *H. polyacantha* and *H. tenuis*,

basing on the specimens collected from Japan, which had been in possession of MERTENS and now kept in L (Figs. 78 C–E, 79). All these names are subsequently placed in the synonymy of *S. tortile* by YENDO (1907) and of *S. siliquastrum* by SETCHELL (1933 a). I also conclude that the above mentioned taxa fall into the same entity, as shown in a list of synonyms. Another name to be considered here is *S. corynecarpum* of HARVEY (1859). As shown in Fig. 80, specimens identified by HARVEY and his illustration (in DAWSON 1959) have elliptical leaves with entire margin and spatulate receptacles. It seems appropriate to place this name in the synonymy of the species concerned here. The name *S. siliquastrum* has priority over these names, and must be adopted as a legitimate name. SETCHELL (1933 a) applied this name in wider sense. I restrict the usage to that circumscribed above.

This species is distributed rather widely around Japan (Fig. 81) and also as far south to Hong Kong, according to SETCHELL (1933). Variation in subspecific level needs more extensive study.

In the conical holdfast of this species, growth rings are easily observed. YOSHIDA (unpublished) counted up to 4 rings in individuals collected from North Kyushu.

24. *Sargassum serratifolium* (C. AGARDH) C. AGARDH 1820 : 16.
(Figs. 82–85)

J. AGARDH 1848 : 291 ; 1889 : 59 ; 1896 : 53. DE TONI 1895 : 22. GRUNOW 1915 : 343.

Fucus serratifolius C. AGARDH 1815 : 41. Lectotype : LD (Herb. Agardh No. 2939 "in mari Japonico prope Satsuma") (Fig. 83 A).

Halochloa serratifolia (C. AGARDH) KÜTZING 1843 : 56 ; 1849 : 633 ; 1860 : 35, *pl. 99, f. 2.*

Halochloa longifolia KÜTZING 1843 a : 367 ; 1860 : 35, *pl. 100* (non *Fucus longifolius* TURNER). Type : L 937.55.94 "Japonia, TILESIUS" (Fig. 83 D).

Halochloa serratifolia var. *longifolia* (KÜTZING) KÜTZING 1849 : 632.

Japanese name : Usuba-nokogiri-moku (nov.).

Thallus 1 m or more in length. Holdfast discoid, 1–1.5 cm in daimeter. Stem erect, arising on top of the holdfast, terete, 2–3 mm in diameter, up to 2 cm high, unbranched or once, rarely twice branched. A few main branches arising from the distal part of the stem. Main branch acipitous, up to 5 mm wide with smooth margin. Lateral branches well developed. Leaf issued from the basal part of main branch retroflexed conspicuously at the base, oval to laceolate with round apex in shape, up to 10 cm long and 2 cm wide, with entire margin, membranaceous in texture. Midrib elevating, attaining to the apex. Leaf in the lower to middle parts of the main branch linear with cuneate base and acute apex in shape, 10 cm long and 0.5–1 cm wide, shallowly serrate at margin. Midrib percurrent. Cryptostomata, rather rare,

Fig. 82. *Sargassum serratifolium* (C. AGARDH) C. AGARDH.

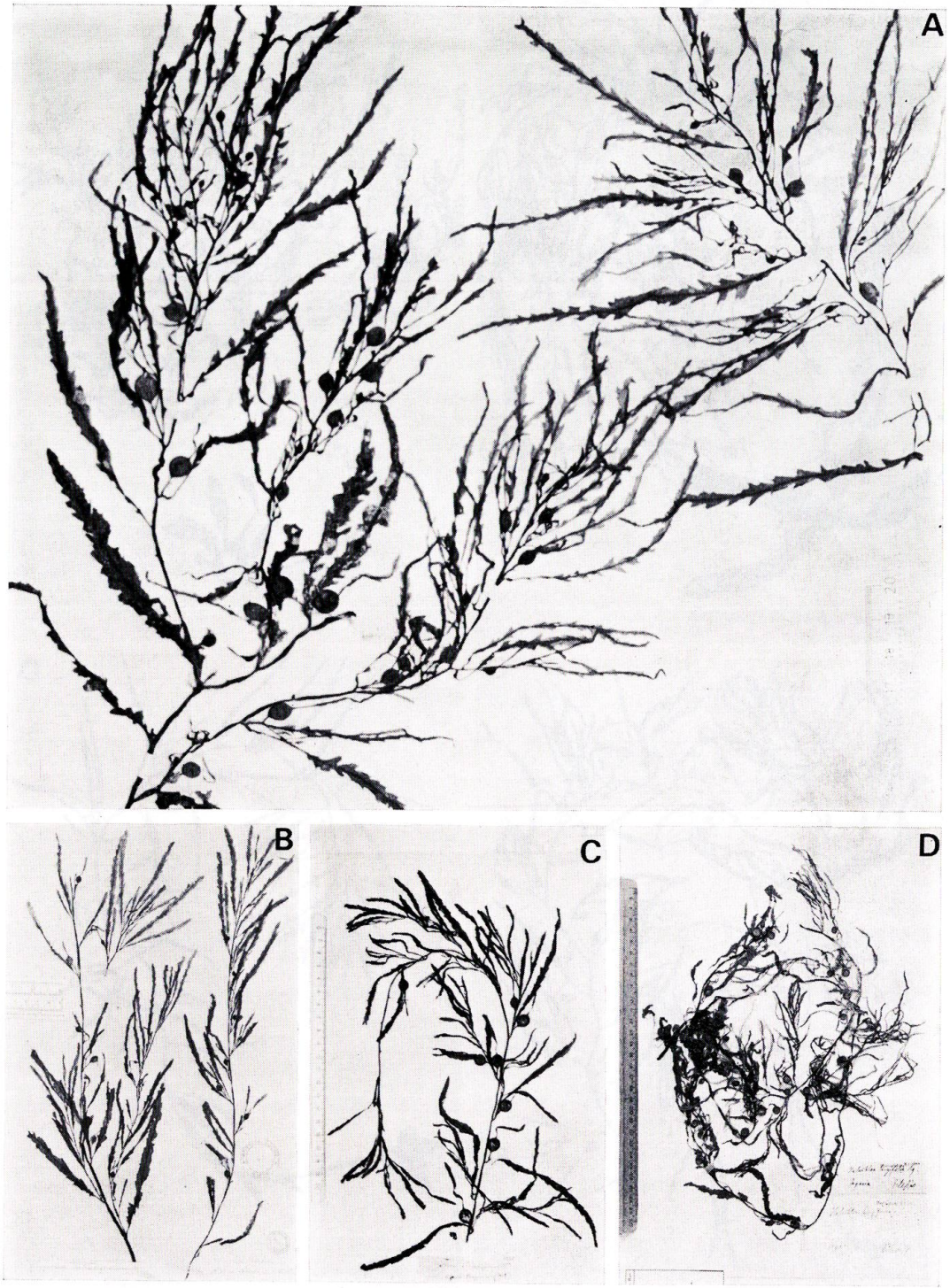

Fig. 83. A. Lectotype of *Fucus serratifolius* C. AGARDH. "in mari Japonico prope Satsuma" LD, Herb. Agardh No. 2939. B. A specimen of *Fucus longifolius* in BM. C. A specimen of *Fucus serratifolius* in PC, sent by MERTENS. D. A specimen of *Halochloa longifolia* KÜTZING. "Japonia, TILESIUS" L. 937.55.94.

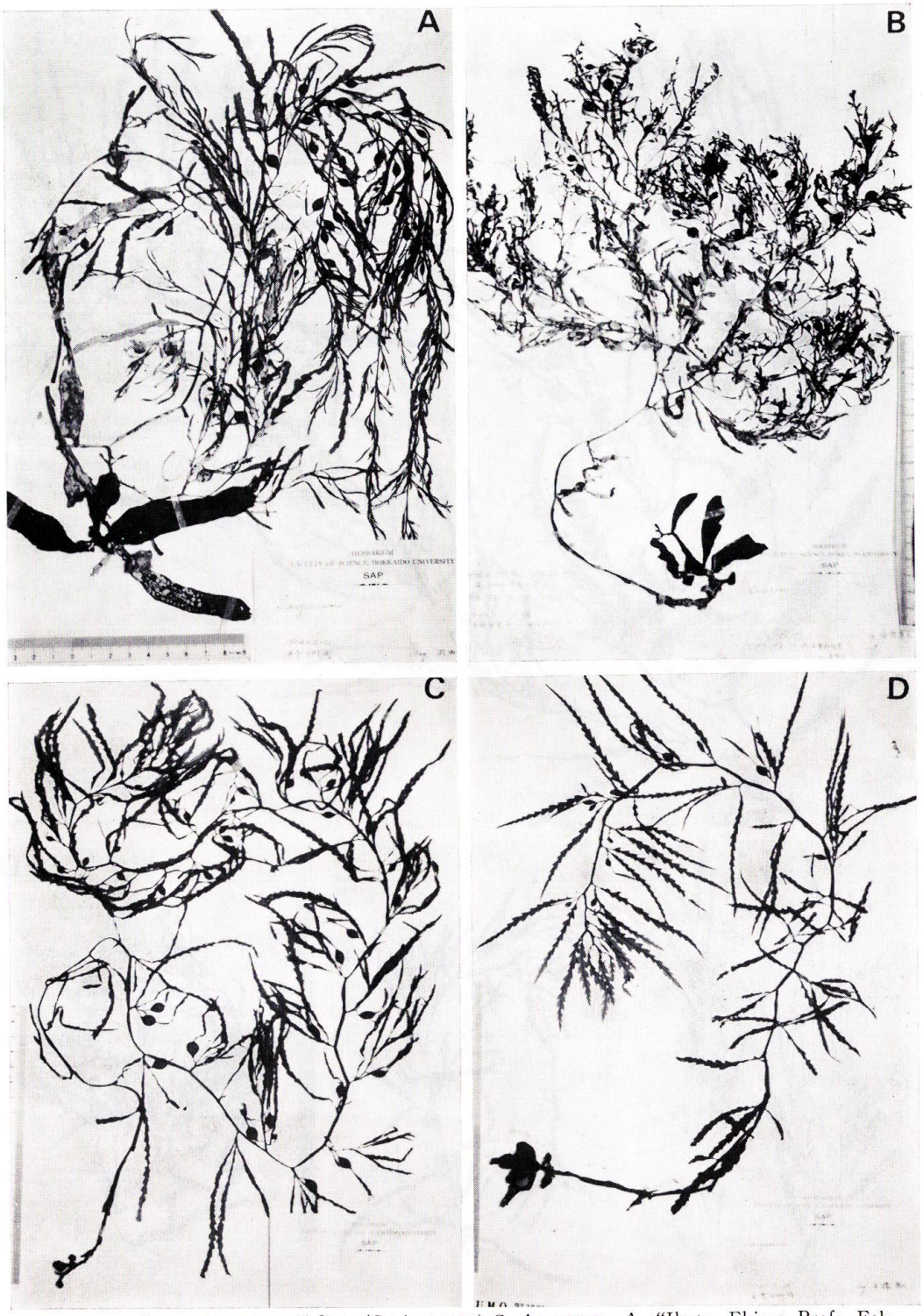

Fig. 84. *Sargassum serratifolium* (C. AGARDH) C. AGARDH. A. "Ikata, Ehime Pref., Feb. 11, 1982, leg. M. OHTA" SAP 043452. B. "Ikata Ehime Pref., May 15, 1982, leg. H. MASUHARA" SAP 043449. C. "Misumi, Shimane Pref., Sept. 27, 1981, leg. T. TERAWAKI" SAP 043456. D. "Hinomisaki, Shimane Pref, Sept. 30, 1981, leg. H. ISHIBASHI" SAS 043458.

scattered on the leaf surface. Vesicles spherical to elliptical, 10 mm long and 9 mm wide, beset with coronal leaf 2-3 cm long, similar to ordinary leaf.

The plant dioecious. Receptacles racemosely or paniculately disposing on the ultimate ramuli. Female receptacle linear lanceolate, 13 mm long and 1.8 mm wide. Male one linear, 10 mm long and 0.9 mm wide. Maturation in late spring to early summer.

This species grows in subtidal zone down to 17 m deep. One of the deep water species.

Specimens examined: KYUSHU: Miiraku, Nagasaki Pref., Sept. 21, 1979, leg. T. YOTSUI, SAP 043453-4; Hirado-jima, Nagasaki Pref., Jul. 30, 1981, leg. H. KITO, SAP 043589-90; Hado-zaki, Saga Pref., May 28, 1983, leg. T. YOSHIDA, SAP 043723; Madara-jima, Saga Pref., Sept. 26, 1978, leg. Saga Suishi, SAP 043459; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043650.
SHIKOKU: Ikata, Ehime Pref., May 15, 1982, leg. MASUHARA, SAP 043448-9; Ikata, Ehime Pref., Nov. 17, 1955, leg. Y. NOMURA, SAP 043450-1.
HONSHU: Misumi, Shimane Pref., Sept. 25, 1981, leg. T. TERAWAKI, SAP 043455-6; Hinomisaki, Shimane Pref., Sept. 30, 1981, leg. H. ISHIBASHI, SAP 043458; Sado, Niigata Pref., Aug. 26, 1971, leg. M. MASUDA, SAP 043460: Shiiya, Niigata Pref., Nov. 9, 1980, leg. H. ISHIBASHI, SAP 043457.

There are 8 sheets of specimens in the cover of *S. serratifolium* in LD, Herb. Agardh Nos. 2939-2946. Among them, Nos. 2939 and 2940 are collection of TILESIUS. I selected No. 2939 (Fig. 83 A) as the lectotype. Sheets Nos. 2941-2944 are collection of J. AGARDH sent from KJELLMAN, PETERSEN

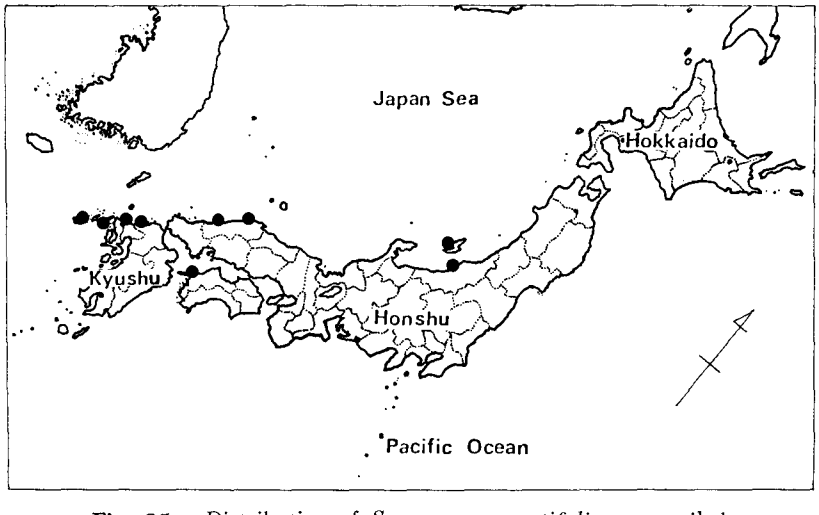

Fig. 85. Distribution of *Sargassum serratifolium*, compiled from specimens in SAP.

and others. These specimens seemed to belong different entity from Nos. 2939 and 2940. The lectotype, its locality is indicated as 'Satsuma', is a sterile fragment of about 25 cm long. Sheet No. 2940 of Agardhian herbarium is a duplicate of the lectotype. Specimens deposited in BM (K) were sent by MERTENS. They were collected at 'port. Nangasaki' and have annotation label by SETCHELL as '*Sargassum serratifolium*'. One of them is shown in Fig. 83 B. In PC, 2 sheets of specimens referable to this entity were located. As shown in Fig. 83 C, this specimen was also sent from MERTENS. A specimen in L (No. 937.55.94) seems to be the same origin and used as a basis for *Halochloa longifolia* KÜTZING. All of these specimens are referable to the same taxon. They have in common thin membranaceous leaves with shallow serration on the margin and spherical vesicles. Margin of its ancipitous branch is smooth. These features contrast to a taxon with coriaceous leaf and branches with irregular projections on its margin and usually applied the name *S. serratifolium* by many Japanese authors. Several collections in SAP (Figs. 82, 84) accord well to the type of *S. serratifolium*. Description of them are given above.

Application of the name *Fucus serratifolius* C. AGARDH is somewhat complicated by the presence of *F. serratifolius* THUNBERG. On the first page of 'Algarum decas quarta' of C. AGARDH, a date 'xv Junii MDCCCXV' was clearly given and this was taken as publishing date. Publication date of the name of THUNBERG is at pressent not clear (SILVA, personal communication), except that the issue of Nova Acta Regiae Societatis Upsaliensis appeared in 1815. I assume that the name of THUNBERG was published not earlier than June 15, to avoid further confusion concerning the name. YAMADA (1955, p. 82) stated that the specimen of *F. serratifolius* THUNBERG was referable to narrow-leaf form of *S. tortile*.

Section ***Repentia*** YOSHIDA, sect. nov.

Caulis decumbens vel procumbens, discos adhaerentes secondarios in pagina ventrali formans, ramus principalis in pagina dorsali caulem enascens. Receptaculum compressum vel complanatum. Species typicus : *S. okamurae* YOSHIDA et T. KONNO.

Stem decumbent or procumbent, forming secondary attaching discs on the ventral surface. Main branch arising from dorsal side of the stem. Receptacle compressed or complanate.

25. *Sargassum okamurae* YOSHIDA et T. KONNO 1983 : 153, *f. 20-29.* (Figs. 86-88)

Holotype: SAP 034691 "Kominato, Chiba Pref., Oct. 23, 1979, leg. T. KONNO" (Fig. 87). Isotype in the herbarium of Tokyo University of Fisheries.

Sargassum sagamianum YENDO (pro parte) 1907, *pl. 17, f. 10.* OKAMURA 1924, *pl. 215.*

Japanese name: Hira-neji-moku (YOSHIDA & KONNO)

Thallus up to 60 cm high. Stem decumbent or procumbent, 1.5-2 mm in diameter, up to 2 cm long, pseudodichotomously branched, interwoven with each other. Attaching discs small, numerosuly formed on ventral side of the creeping stem, sometimes fused with each other to form an irregularly shaped disc. Basal part of an individual forming a creeping mass of about 4-5 cm in diameter. Main branches issued vertically from dorsal side of the creeping stem, compressed with thin margin, 3-5 mm in width, 30-60 cm long, often strongly twisted, curving at the distal part in younger stage. Leaves issued alternately from the margin of the flat branch with phyllotaxis of 1/2 divergence. Leaves near the basal part of the main branch retroflexed, decurrent at the base, ovoid, elliptical to lanceolate in shape, 1-2 cm long and 5-8 mm wide, with entire margin, apex acute or blunt. Leaves in lower and middle parts of the main branch narrow lanceolate to linear, 4-6 cm long and 3-6 mm wide, also with entire margin, midrib evanescent, not reaching to the apex. Leaves on the upper part of the main branch and on lateral branches linear in shape. Leaves frequently becoming apparently secund because of the tortion of the branch, arranging along the external side of curved branch. Cryptostomata rare or nearly absent. Vesicle with short stipe 2-4 mm long, elliptical or fusiform in shape, 1-1.8 cm long and 4-6 mm in diameter, with mucronate apex or beset with linear coronal leaf up to 1 cm long. Vesicle formed singly in axil of leaf, rather few in number or wholly dropped off in older branches.

Plant dioecious. Receptacle spatulate or oblanceolate in shape, often forking 1 or 2 times, rarely 3 times, arranging in racemose or paniculate manner. Female receptacle 6-10 mm long, 1.5-2 mm wide. Male one longer than the female, 10-15 mm long. Maturation period in autumn to winter.

This species grows on rocks exposed to strong wave action, from lower intertidal to upper subtidal zones.

Specimens examined: HONSHU: Kominato, Chiba Pref., May 7, 1955, leg. Y. TSUJI, SAP 042064; Enoshima, Kanagawa Pref., Apr. 2, 1935, leg. T. TERAOKA, SAP 019937-8; Enoshima, Kanagawa Pref., June 30, 1981, leg. S. KAWAGUCHI, SAP 035735; Susaki, Shizuoka Pref., Apr. 1938, leg. YAMADA and NAKAMURA, SAP 024056; Shimoda, Shizuoka Pref., June 15, 1981, leg. Y. YOKOHAMA, SAP 035709; Yui, Shizuoka Pref., June 17, 1981, leg. F.

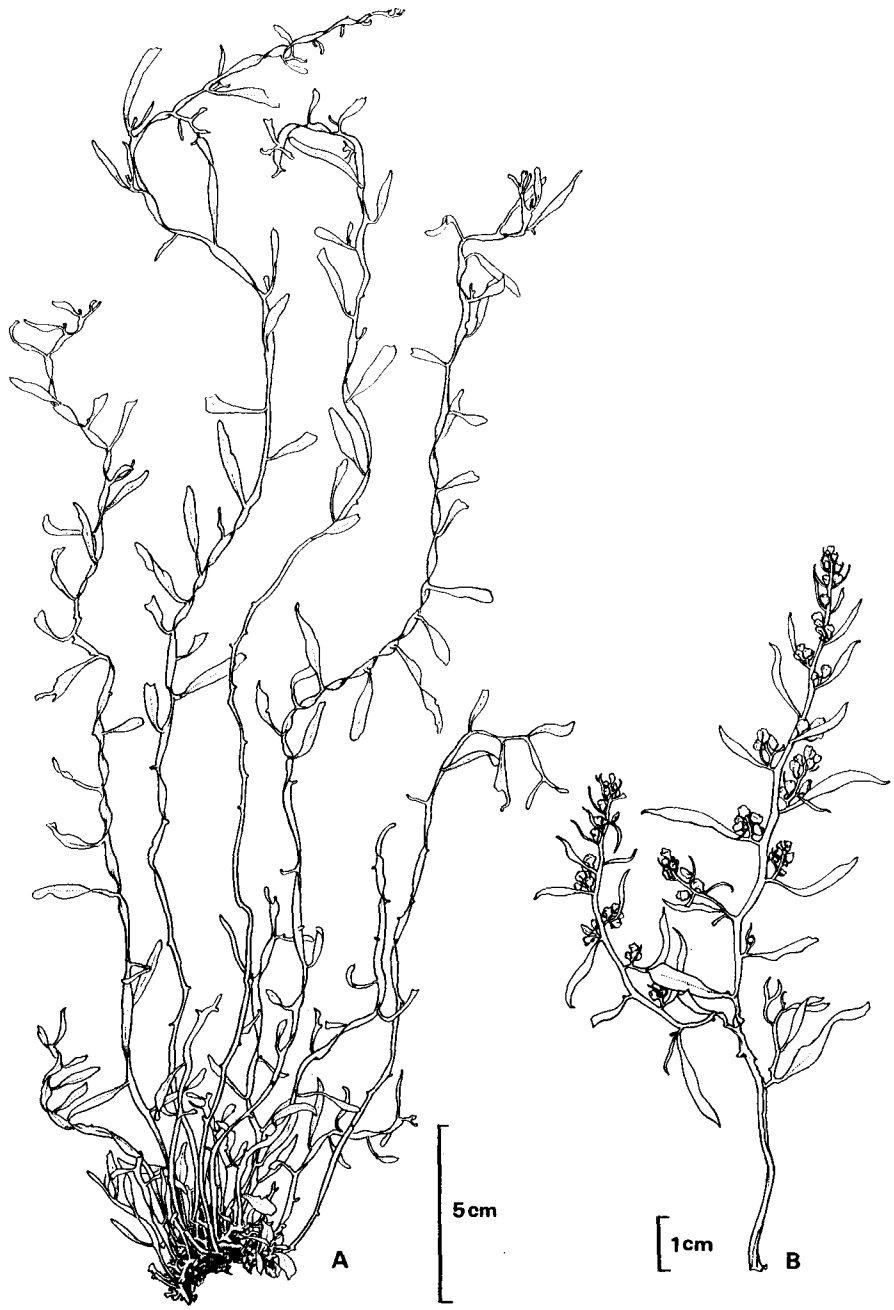

Fig. 86. *Sargassum okamurae* YOSHIDA et T. KONNO. A. Young plant. B. Terminal part of a branch with receptacles, collected at Sada misaki, Ehime Pref.

HAYASHIDA, SAP 035720; Wagu, Mie Pref., Apr. 26, 1955, leg. Y. TSUJI, SAP 042081; Goza, Mie Pref., May 11, 1979, leg. T. YOSHIDA, SAP 034615; Hamashima, Mie Pref., Oct. 27, 1981, leg. YOSHIDA and KONNO, SAP 041295; Nagashima, Mie Pref., May 12, 1979, leg. T. YOSHIDA, SAP 034612-3; Koza, Wakayama Pref., Oct. 29, 1981, leg. YOSHIDA and KONNO, SAP 041294; Shionomisaki, Wakayama Pref., Apr. 2, 1957, leg. Y. TSUJI, SAP 034806; Kushimoto, Wakayama Pref., Apr. 2, 1957, leg. Y. TSUJI, SAP 041973; Mirotsu, Wakayama Pref., Oct. 29, 1981, leg. YOSHIDA and KONNO, SAP 041296; Yura, Wakayama Pref., Aug. 29, 1961, leg. T. YAMAMOTO, SAP 034313; Tanabe, Wakayama Pref., June 1930, leg. S. INOH, SAP 8559; Sakai, Wakayama Pref., May 1914, leg. J. IKARI, SAP 034317.

SHIKOKU: Hiwasa, Tokushima Pref., Aug. 1950, leg. Y. YAMADA, SAP 027198; Murotomisaki, Kochi Pref., May 27, 1979, leg. T. YOSHIDA, SAP 034614; Hane, Kochi Pref., May 27, 1979, leg. T. YOSHIDA, SAP 034611; Tei, Kochi Pref., Aug. 14, 1894, anonym., SAP 034316; Nomi-wan, Kochi Pref., May 25, 1979, leg. T. YOSHIDA, SAP 034706; Oogata, Kochi Pref., June 1, 1981, leg. T. YOSHIDA,

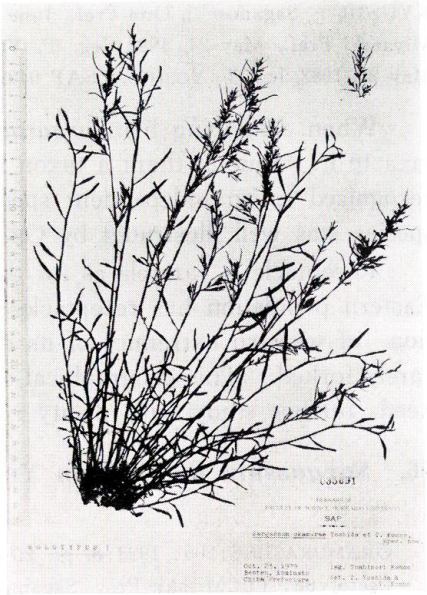

Fig. 87. Holotype of *Sargassum okamurae* YOSHIDA et T. KONNO. "Kominato, Chiba Pref., Oct. 23, 1979, leg. T. KONNO" SAP 035691.

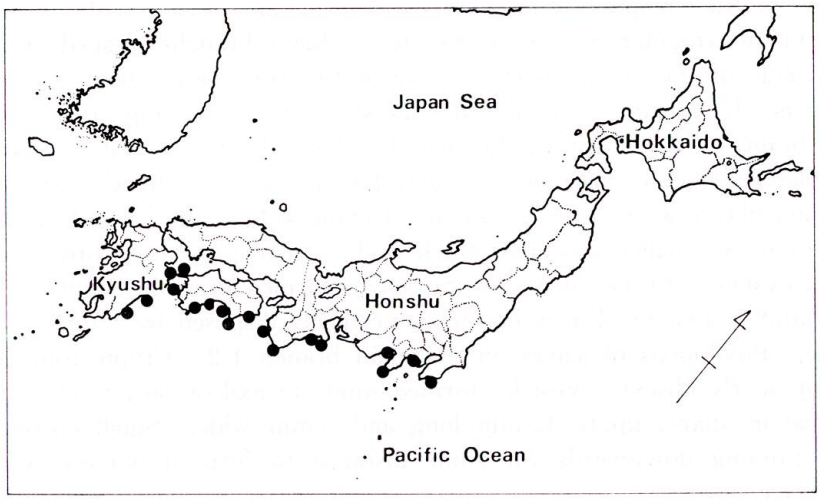

Fig. 88. Distribution of *Sargassum okamurae*, compiled from specimens in SAP.

SAP 035728; Hidagawa, Kochi Pref., Jan. 17, 1954, leg. Y. YAMADA, SAP 034318; Totoshima, Ehime Pref., May 21, 1982, leg. T. YOSHIDA, SAP 042146; Sata-misaki, Ehime Pref., 1981, leg. A. TAKASAKI, SAP 043275.
KYUSHU: Saganoseki, Oita Pref., June 2, 1981, leg. T. YOSHIDA, SAP 035755; Kadokawa, Miyazaki Pref., May 24, 1982, leg. T. YOSHIDA, SAP 042145; Oryuzako, Miyazaki Pref., May 25, 1982, leg. T. YOSHIDA, SAP 042196.

When describing his *Sargassum sagamianum*, YENDO (1907) included 3 taxa to it. Among them a taxon with above mentioned circumscription was recognized as an independent species by YOSHIDA & KONNO (1983). This species was well illustrated by OKAMURA (1924, pl. 215).

Receptacle is variable as for the external form and frequency of forking. Eastern population has receptacles slenderer and forked frequently. Population of western extremity of its distribution has wider spatulate receptacles rarely forked. This geographical or clinal variation in receptacle morphology needs further study with plenty specimens and field observations.

26. *Sargassum nigrifolium* YENDO 1907: 127, *pl. 16, f. 1-3.*
(Figs. 89-91)

OKAMURA 1916: 206; 1923: 8, *pl. 204*; 1936: 345. SEGAWA 1956: 51, *pl. 30*, No. 230.
Lectotype: TI "Misaki, Prov. Sagami, Aug. 1906" (Fig. 90).

Japanese name: Narasamo (YENDO).

Thallus less than 0.7 m long. Stem terete, branched, decumbent or procumbent, 1.5 mm in diameter. Attaching discs formed on the ventral surface of the creeping stem. Discs enlarging and fusing with each other to form an irregular mat with the stem. Main branches issued from the dorsal side of the stem, ancipitous except the very base, about 3 mm wide with smooth margin. Lateral branches short in length, appearing after the main branches attained their full length. Leaf shortly stipitate, elliptical to lanceolate, obliquely spatulate or nearly hemiphyllous in shape, with cuneate base and obtuse apex, 25 mm long and 10 mm wide in the lower leaf, becoming gradually smaller upwards, thick and cartilaginous in texture. Margin entire, evanescently costate. Several leaves formed near the stem extending horizontally, then the leaves becoming vertically disposed by a tortion at the petiole. Phyllotaxis of leaves on the main branch 1/2. Cryptostomata very rare or nearly absent. Vesicles formed singly in axil or on lateral branches, elliptical in shape, up to 12 mm long and 6 mm wide. Small coronal leaf often running downwards for some distance to form a narrow wing-like appendage.

Plant dioecious. Receptacle compressed, obovoid to spatulate in shape,

formed singly or racemosely on a short ramulet in axil of a subtending leaf. Female receptacle 5 mm long and 3 mm wide, often provided with marginal dentation. Male one longer than the female, 7 mm long also with dentation

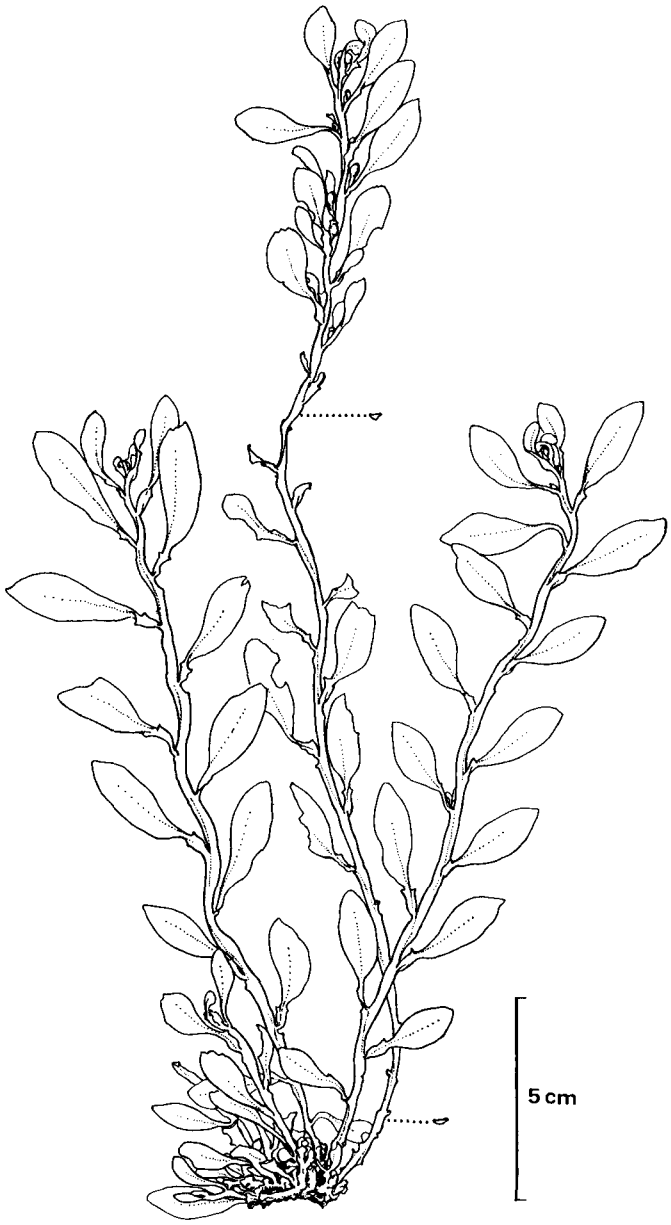

Fig. 89. *Sargassum nigrifolium* YENDO. Young plant.

on the margin. Maturation in spring to early summer.

This species grows on rocks exposed to strong wave action in the lower intertidal zone.

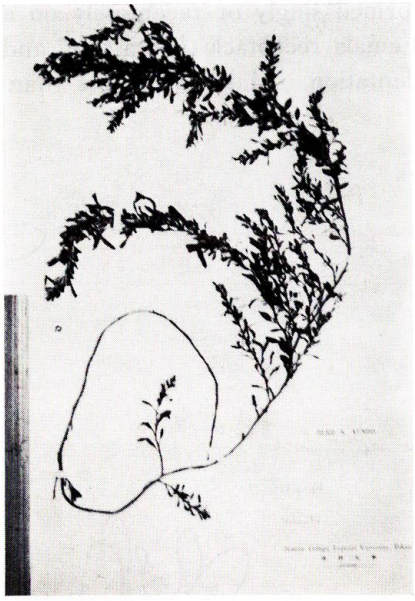

Fig. 90. Lectotype of *Sargassum nigrifolium* YENDO. "Misaki, Prov. Sagami, Aug. 1906" TI.

Specimens examined: HONSHU: Kominato, Chiba Pref., Mar. 30, 1978, leg. T. YOSHIDA, SAP 034294; Futomi, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 042079; Jyogashima, Kanagawa Pref., May 1950, leg. Y. YAMADA, SAP 025740; Misaki, Kanagawa Pref., May 1929, leg. S. INOH, SAP 8550; Enoshima, Kanagawa Pref., Apr. 4, 1935, leg. Y. YAMADA, SAP 026612; Hajizaki, Aichi Pref., Mar. 1941, leg. T. SEGI, SAP 025037; Omi-jima, Yamaguchi Pref., June 8, 1978, leg. T. YOSHIDA, SAP 034291; Tatamigaura, Shimane Pref., June 9, 1978, leg. T. YOSHIDA, SAP 034199; Hinomisaki, Shimane Pref., June 10, 1978, leg. T. YOSHIDA, SAP 034200; Kasumi, Hyogo Pref., June 11, 1978, leg. T. YOSHIDA, SAP 034292; Tango, Hyogo Pref., May 18, 1982, leg. S. KAWAGUCHI, SAP 042199; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 034193; Kammuri-jima, Kyoto Pref., Apr. 9, 1981, leg. H. KAWAI, SAP 035483; Monzen,

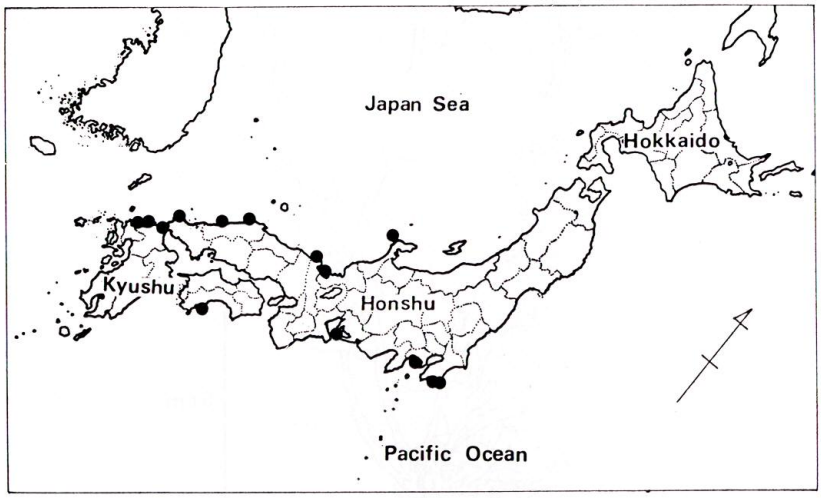

Fig. 91. Distribution of *Sargassum nigrifolium*, compiled from specimens in SAP.

Ishikawa Pref., Jul. 24, 1976, leg. K. TANIGUCHI, SAP 042028.
SHIKOKU: Kammuri-jima, Kochi Pref., May 18, 1952, leg. I. UMEZAKI, SAP 034295.
KYUSHU: Iwaya, Fukuoka Pref., June 5, 1981, leg. T. YOSHIDA, SAP 035701; Tsuyazaki, Fukuoka Pref., Feb. 15, 1957, leg. T. YOSHIDA, SAP 034855; Keya, Fukuoka Pref., Apr. 23, 1983, leg. K. NANRI, SAP 043656.

This species is easily recognizable by its elliptical leaves with entire margin and a creeping stem. Construction of basal part with a prostrate stem resembles to that of *S. okamurae*.

YENDO (1907) classed this taxon in his Section *Micracanthae*. Discussion on the subgeneric relation is made in the note under *S. micracanthum*.

27. *Sargassum yezoense* (YAMADA) YOSHIDA et T. KONNO 1983: 151, *f. 15-18*. (Figs. 92-95)

Sargassum sagamianum var. *yezoense* YAMADA in YAMADA et KINOSHITA 1950: 8, *pl. 52*. KAWASHIMA 1963: 1, *f. 1-2*. OGAWA 1977: 73, *f. 1-3*. Lectotype: SAP 024318 "Nozuka, Shiribeshi Prov., Hokkaido, Aug. 1943, leg. Y. YAMADA" (Fig. 94).

Japanese name: Ezo-no-neji-noku (YAMADA)

Thallus less than 1 m in length. Holdfast small discoid. Stem terete, about 2 mm in diameter, branched, procumbent or decumbent, attaching to the substratum with small discs formed on the ventral surface of the stem. Main branches issued from the dorsal side of the creeping stem, triquetrous with round edges, 2-3 mm wide, often loosely twisted. Lower leaves spread horizontally, shortly stipitate, not retroflexed at the base, long elliptical to broad linear in shape, 2-4 cm long and 5-8 mm wide, with obtuse apex and cuneate base. Leaf margin entire or coarsely serrate. Midrib evanescent at a half length to the apex. Phyllotaxis of leaves on the main branch 1/3. Upper leaves linear or linear lanceolate, sparsely serrate on the margin. Cryptostomata usually present but difficult to discern, sometimes very rare. Vesicles stipitate, long elliptical to fusiform in shape, 8 mm long and 5 mm wide, mucronate or with linear coronal leaf.

The plant usually dioecious. Receptacles flat, broad spatulate or obovoid in shape, with slightly emarginate apex, formed singly or racemosely in axil of the subtending leaf. Female receptacle 2.5-3 mm long, 1-1.5 mm wide. Male one more slender and longer. Maturation in summer.

This species grows on rather exposed rocks in a zone from lower intertidal to subtitdal down to about 3 m deep.

Specimens examined: HOKKAIDO: Yagishiri-jima, Rumoi Prov., Aug. 5, 1964, leg. I. YAMADA, SAP 035403; Teuri-jima, Rumoi Prov., Aug. 18, 1943, leg. T. TANAKA, SAP 034910; Oshoro, Shiribeshi Prov., Jul. 15, 1976, leg. T. YOSHIDA, SAP 034391; Tomari,

Fig. 92. *Sargassum yezoense* (YAMADA) YOSHIDA et T. KONNO.

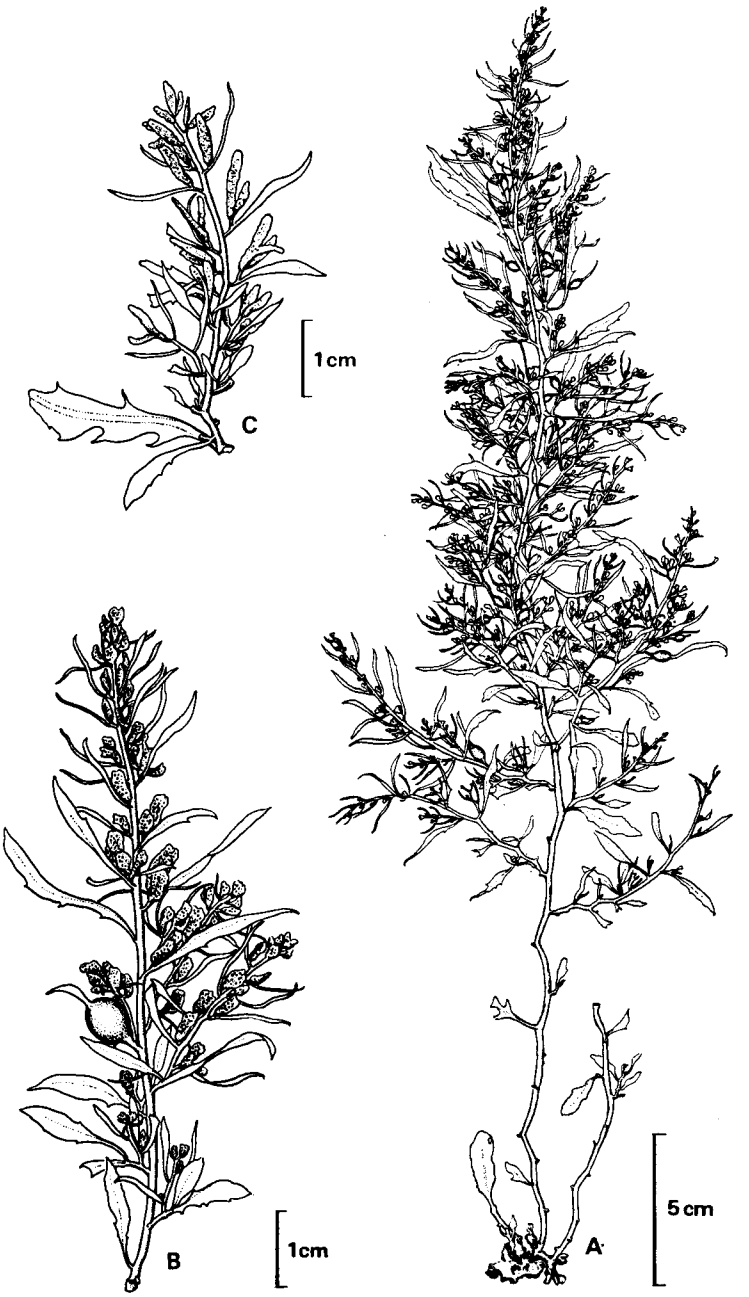

Fig. 93. *Sargassum yezoense* (YAMADA) YOSHIDA et T. KONNO. A, fertile plant. B, branch with female receptacles. C, branch with male receptacles.

Shiribeshi Prov., Aug. 3, 1954, leg. Y. TSUJI, SAP 034815; Okushiri-jima, Hiyama Prov., Jul. 8, 1943, leg. Y. HASEGAWA, SAP 025124; Esashi, Hiyama Prov., Apr. 25, 1978, leg. T. YOSHIDA, SAP 034381; Shirakami, Oshima Prov., Apr. 25, 1978, leg. T. YOSHIDA, SAP 034382; Yoshioka, Oshima Prov., Aug. 17, 1958, leg. N. TAZAWA, SAP 034838; Fukuyama, Oshima Prov., Aug. 19, 1958, leg. N. TAZAWA, SAP 034827; Hakodate, Oshima Prov., Jul. 1954, leg. Y. TSUJI, SAP 027494; Yamase-domari, Oshima Prov., June 22, 1931, leg. Y. YAMADA, SAP 011148; Higashiura, Oshima Prov., Aug. 5, 1964, leg. I. YAMADA, SAP 035403.

HONSHU: Onagawa, Miyagi Pref., Aug. 1936, leg. Y. YAMADA, SAP 034387; Enoshima, Miyagi Pref., Jul. 31, 1974, leg. T. YOSHIDA, SAP 031222-3; Hirota, Iwate Pref., Jul. 27, 1961, leg. S. KAWASHIMA, SAP 028674-5; Oofunado, Iwate Pref., May 20, 1951, leg. S. KAWASHIMA, SAP 026889; Oozuchi, Iwate Pref., Jul. 24, 1979, leg. T. YOSHIDA, SAP 034703; Shimofuro, Aomori Pref., Aug. 4, 1955, leg. S. KAWASHIMA, SAP 028676; Toga, Akita Pref., Apr. 23, 1982, leg.

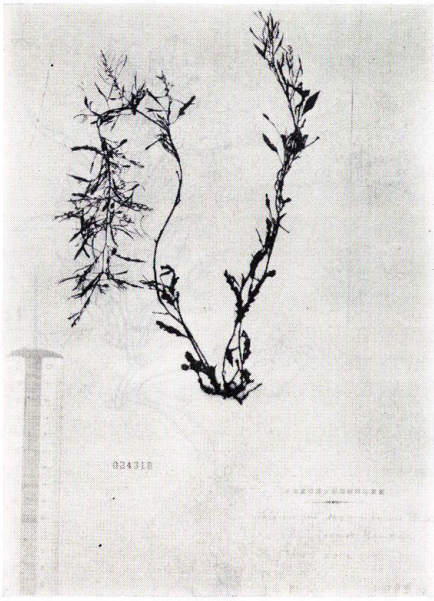

Fig. 94. Lectotype of *Sargassum sagamianum* var. *yezoense* YAMADA. "Nozuka, Shakotan Peninsula, Hokkaido, Aug. 1941, leg. Y. YAMADA" SAP 024318.

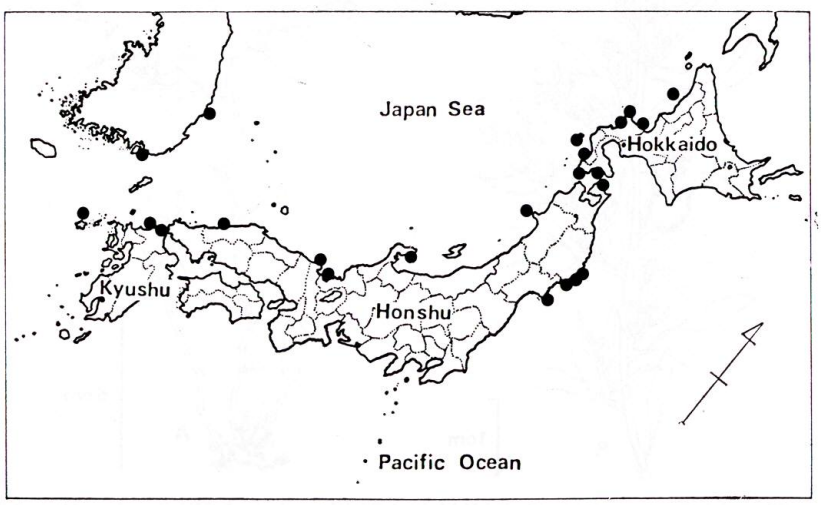

Fig. 95. Distribution of *Sargassum yezoense*, compiled from specimens in SAP.

M. TSUKIDATE, SAP 042122; Tsukumo-wan, Ishikawa Pref., Mar. 7, 1963, leg. S. FUNAHASHI, SAP 034384; Takahama, Fukui Pref., June 12, 1978, leg. T. YOSHIDA, SAP 034385; Tango, Kyoto Pref., May 18, 1982, leg. S. KAWAGUCHI, SAP 042197; Tatamigaura, Shimane Pref., June 9, 1978, leg. T. YOSHIDA, SAP 034386.
KYUSHU: Iwaya, Fukuoka Pref., Apr. 5, 1978, leg. T. YOSHIDA, SAP 034383; Tsuyazaki, Fukuoka, Pref., June 3, 1958, leg. T. SAWADA, SAP 031748; Miiraku, Nagasaki Pref., Sept. 1979, leg. T. YOTSUI, SAP 034726.
KOREA: Pusan, Aug. 13, 1975, leg. YOO, SAP 034597; Kan-nun, Mar. 29, 1974, leg. I. K. LEE, SAP 034598.

YOSHIDA & KONNO (1983) recently raised this taxon to specific rank, because it has lower leaves not retroflexed, its branches is triquetrous with rounded edges, its attaching discs are smaller, not forming solid holdfast, and it has distribution range chiefly on the coast of Japan Sea.

Although this taxon was not recognized by YENDO and OKAMURA, the specimens referable to this species were collected by PETERSEN in Hakodate and classed in the cover of *S. corynecarpum* by J. AGARDH in his herbarium (LD, Herb. Agardh Nos. 2992-2994).

28. *Sargassum yamadae* YOSHIDA et T. KONNO 1983: 148, *f. 5-14.* (Figs. 96-99)

Holotype: SAP 025741 "Jyogashima, Kanagawa Pref., May 1950, leg. Y. YAMADA" (Fig. 98).

Sargassum sagamianum YENDO 1907: 151 (pro parte).

Japanese name: Azuma-neji-moku (YOSHIDA & KONNO)

Thallus up to 1.5 m or more in length. Stem terete, procumbent or decumbent, branching several times, forming attaching discs on its ventral surface. The attaching discs developing well to fuse each other and with stem to form a solid basal system. Main branches issued from the drosal side of the creeping stem, triquetrous with sharp edges, 3 mm wide, more or less twisting. Lateral branches developing up to 40 cm long. Leaves on the lower part of the main branch disposing spirally with 1/3 phyllotaxis, spreading horizontally, and retroflexing with decurrent base, ovate or spatulate in shape, with entire margin. Leaves on middle or upper part of the main branch lanceolate to linear in shape, about 4 cm long and 3-6 mm wide, with sparse serration on the margin. Midrib not conspicuous. Cryptostomata sparse or nearly absent, and difficult to discern. Vesicles rather few in number, with short stipe 2-4 mm long, elliptical or fusiform in shape, 1.5-2 cm long and 4-6 mm in diameter, mucronate or with linear coronal leaf up to 1 cm long.

Plant dioecious. Receptacles compressed, obovate or spatulate in shape,

formed singly or in racemose manner on ramulet in the axil of bracteal leaf. Female receptacle 6–8 mm long and 2.5–3 mm wide, and male one 10–13 mm long, 2–2.5 mm wide. Maturation in late spring to summer. Color blue-greenish brown with bluish iridescence in living state, becoming

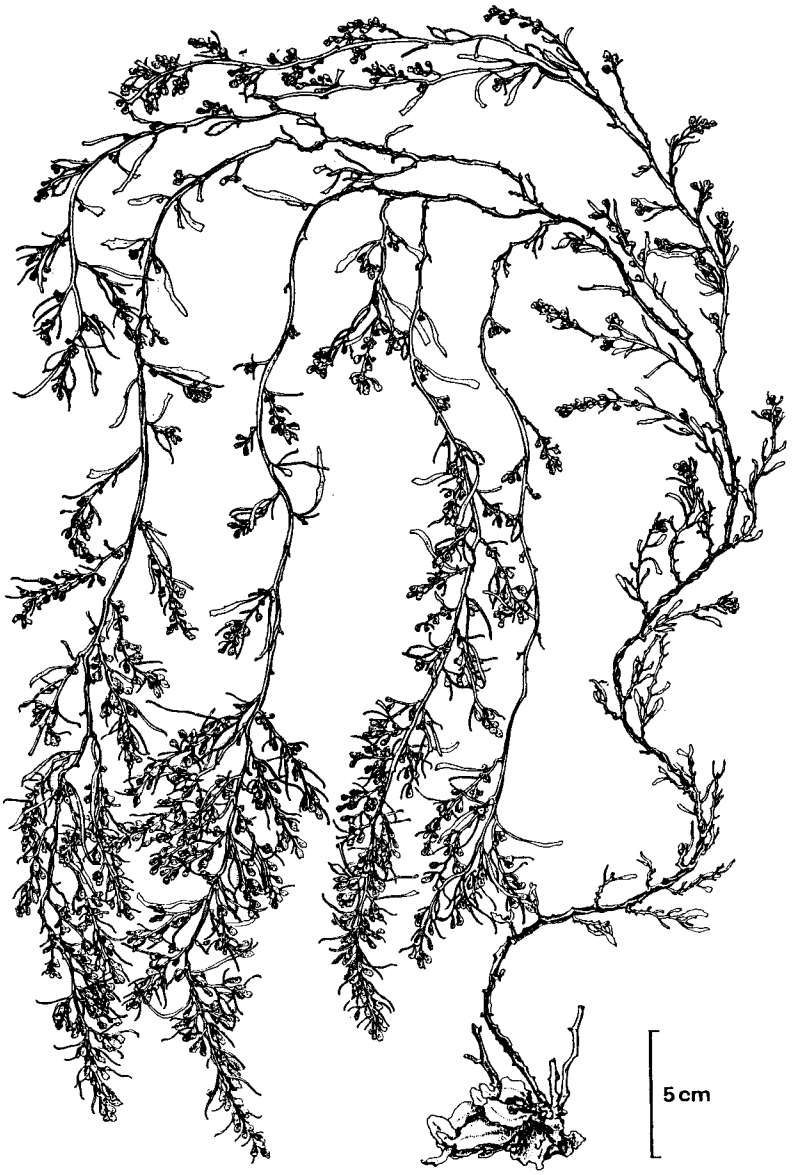

Fig. 96. *Sargassum yamadae* YOSHIDA et T. KONNO.

dark brown to almost black in drying.

This species grows on rocks exposed to strong wave action, from lower intertidal to subtidal zones down to 2 m deep.

Specimens examined: HONSHU: Ena, Fukushima Pref., Jul. 1, 1981, leg. K. TANIGUCHI, SAP 035712; Nagasaki, Fukushima Pref., Jul. 14, 1981, leg. T. YOSHIDA, SAP 035692; Sukegawa, Ibaraki Pref., Jul. 14, 1935, leg. S. KAWABATA, SAP 042043; Nakaminato, Ibaraki Pref., Jul. 3, 1981, leg. K. TANIGUCHI, SAP 035713; Katsuura, Chiba Pref., June 20, 1976, leg. K. AOKI, SAP 034312; Kominato, Chiba Pref., Mar. 30, 1978, leg. T. YOSHIDA, SAP 034311; Futomi, Chiba Pref., Mar. 30, 1982, leg. M. MASUDA, SAP 042003; Amatsura, Chiba Pref., Apr. 1935, leg. Y. YAMADA, SAP 026616-7; Jyogashima, Kanagawa Pref., June 1929, leg. S. INOH, SAP 8556-8; Shimoda, Shizuoka Pref., May 27, 1981, leg. Y. YOKOHAMA, SAP 035710; Iruma, Shizuoka Pref., May 11, 1975, leg. F. HAYASHIDA, SAP 034310.

This species was included in *S. sagamianum*. YOSHIDA & KONNO (1983) are of opinion that this taxon must be separated from *S. sagamianum*, by

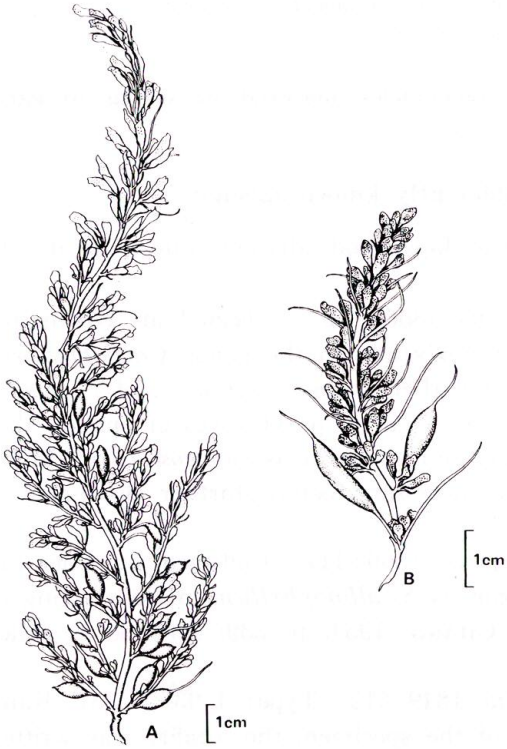

Fig. 97. *Sargassum yamadae* YOSHIDA et T. KONNO. A, branch with male receptacles. B, branch with female receptacles.

Fig. 98. Holotype of *Sargassum yamadae* YOSHIDA et T. KONNO. "Jyogashima, Prov. Sagami, May 1950, leg. Y. YAMADA" SAP 035741.

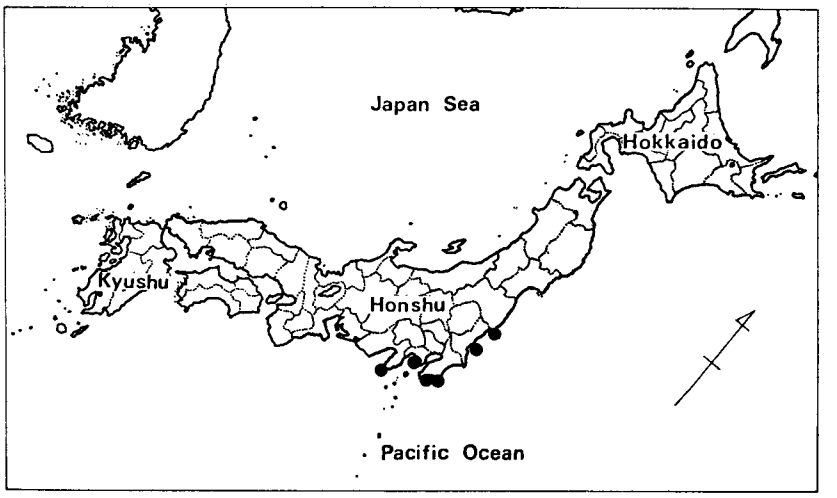

Fig. 99. Distribution of *Sargassum yamadae*, compiled from specimens in SAP.

its decumbent stem, its spatulate receptacles matured in spring to early summer.

Doubtful or insufficiently known species

The following species credited to Japan and adjacent waters are insufficiently known.

Anthophycus japonicus MARTENS 1866 : 115. Collected at Yokohama. DE TONI (1895, p. 122) referred it doubtfully to the genus *Carpophyllum*. While YENDO (1907, p. 65) considered that it was a synonym of *S. patens* in the subgenus *Schizophycus*. GRUNOW (1915, p. 343) was of opinion that it was referable to *S. ringgoldianum* and named it as var. *costata* at variety rank. Examination of specimen is necessary before further discussion is made.

Halochloa heterophylla MARTENS 1866 : 117. Collected at Chee-Fu, China. GRUNOW renamed this taxon as *S. alloiophyllum* in transferring to the genus *Sargassum*. TSENG & CHANG (1954, p. 239) referred it under synonymy of *S. pallidum*.

Sargassum fuliginosum KÜTZING 1849 : 612. Type: L 937.71.361 "Kamtschatka, HORNER". On the label of the specimen, the locality was written as Kamtschatka. However, this specimen seems to belong to the subgenus *Sargassum*. I presume that this specimen was collected in the warmer sea, and erroneously referred to Kamtschatka.

Sargassum hemiphylloides KÜTZING 1849 : 608. Type : L 937.84.37 "Java, ZOLLINGER No. 2385". The type is a small fragment of about 7 cm long. Leaves are hemiphyllous and in this respect similar to *S. hemiphyllum*, but other features show that this is a species of the subgenus *Sargassum*, not of the *Bactrophycus*, though YENDO (1907, p. 99) placed it under the synonymy of *S. hemiphyllum*.

Sargassum oophorum GRUNOW 1915 : 349. Habitat unknown. GRUNOW enumerated it just after *S. fulvellum*. Relation between them is at present unknown.

Several subspecific taxa were described by GRUNOW (1915) : *Sargassum serratifolium* f. *poliophyllum*, f. *subserra*, var. *amblyocystum*, var. *fecundum*. The type material of most of them are at present not located. Among these taxa, specimens identified as *S. serratifolium* var. *poliophyllum* are housed in PC and UC. The 2 specimens seemed to difficult to attribute to the same entity. As for other subspecific taxa, it is needed to locate the type material to extend further discussion.

Sargassum siliquastrum var. *pyriferum* HARVEY 1859 : 328. HARVEY gave no figure of this taxon. YENDO (1907, p. 86) referred it doubtfully in the synonymy of *S. tortile*. Examination of the type is needed.

Pattern of geographical distribution around Japan

Species of the *Bactrophycus* are distributed only in the Northern Hemisphere. Northern limit of distribution seems to be north of Sakhalin island (PETROV 1968), and the record was represented by *S. confusum* (as *S. pallidum*). This is the northernmost locality for the genus as a whole. To the south, several species have their distribution range to Hong Kong, as documented by SETCHELL (1931). But records from Viet-Nam of this subgenus are rather doubtful.

In this study, I prepared distribution maps for each species. Specimens used as a basis for this are deposited in SAP and their localities are represented in the list of the "specimens examined" for each species. In a few cases, information from other sources is added. Distribution ranges of each species around Japan fall into several categories.

1) Species restricted to Pacific coast : *S. ammophilum* (Fig. 29), *S. giganteifolium* (Fig. 67), *S. nipponicum* (Fig. 35), *S. okamurae* (Fig. 88), *S. sagamianum* (Fig. 61), *S. segii* (Fig. 42), *S. tenuifolium* (Fig. 50), *S. yamadae* (Fig. 99), and *S. yamamotoi* (Fig. 46).

2) Species restricted to the coast of Japan Sea and west coast of Kyushu: *S. autunmale* (Fig. 74), *S. microceratium* (Fig. 13), *S. pallidum* (Fig. 19),

and *S. serratifolium* (Fig. 85).

3) Species distributed chiefly on the coast of Japan Sea, extending to northeast coast of Honshu and Seto Inland Sea : *S. confusum* (Fig. 16) and *S. yezoense* (Fig. 95).

4) Species distributed both Pacific and Japan Sea coasts : *S. filicinum* (Fig. 10), *S. fulvellum* (Fig. 27), *S. hemiphyllum* (Fig. 32), *S. horneri* (Fig. 8), *S. macrocarpum* (Fig. 70), *S. micracanthum* (Fig. 64), *S. muticum* (Fig. 23), *S. nigrifolium* (Fig. 91), *S. siliquastrum* (Fig. 81) and *S. thunbergii* (Fig. 25).

5) Species seems to be restricted to Seto Inland Sea : *S. trichophyllum* (Fig. 58). This species was originally recorded from Nagasaki, though I have not yet met with in the west coast of Kyushu.

Recent extension of distribution of *S. muticum* to the Pacific coast of North American and to European coasts was artificially introduced and not to be considered here.

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It is my pleasure to dedicate this work to the late Professor emeritus Yukio YAMADA, who paid much effort to the systematics of *Sargassum* throughout his carrier. His accumulation of herbarium specimens and information concerning this group is the major base of my present work.

Summary

Following the 5 subgenera system of J. AGARDH, the subgenus *Bactrophycus* of the genus *Sargassum* (Phaeophyta, Fucales) is here treated in a wider sense, including the *Micracanthae* of YENDO, defined as having horizontally spreading leaves at least in proximal part of the main branch, and producing usually simple receptacles, with the distribution range in temperate waters of the Northern Hemisphere.

Morphological relation of portions of the thallus is discussed with the developmental view point. The stem is defined as a structure formed by the activity of an apical cell differentiated early in embryological development. Main branches are lateral formation from the stem without subtending leaf and bear leaves and lateral branches.

Twenty-eight species are credited to the *Bactrophycus*. Among them, *S. autumnale* and *S. yamamotoi* are described as new to science. In this subgenus, 4 sections are recognized by the characters of basal morphology, combined with the receptacle features whether it is terete structure or not. The section *Spongocarpus*, typified by *S. horneri*, has elongated stem, lateral formations always arising in axil of leaves, and terete receptacles. *S. filicinum* is included in this section other than the type species. The section *Teretia* is a group of species with more or less abbreviated erect stem and terete receptacles. This section is typified by *S. confusum* and contains the following species: *S. microceratium*, *S. pallidum*, *S. muticum*, *S. thunbergii*, *S. fulvellum*, *S. ammophilum*, *S. hemiphyllum*, *S. nipponicum* and *S. miyabei*. The section *Halochloa*, typified by *S. siliquastrum*, differs from the *Teretia* in having flat or triquetrous receptacles. Other species composing this section are: *S. segii*, *S. yamamotoi*, *S. tenuifolium*, *S. ringgoldianum*, *S. trichophyllum*, *S. sagamianum*, *S. micracanthum*, *S. giganteifolium*, *S. macrocarpum*, *S. autumnale*, and *S. serratifolium*. The section *Repentia* (type species: *S. okamurae*) is defined by its prostrate stem, including *S. nigrifolium*, *S. yezoense* and *S. yamadae*.

Applications of older names described by various authors are strictly reexamined by selection and inspection of types for each name. Through this procedure, *S. pallidum* is concluded to be different taxon from *S. confusum*. The name *S. siliquastrum* has priority over *S. tortile* in the *Siliquastrum* assemblage. Utilization of the name *S. macrocarpum* to the species currently known as *S. serratifolium* by Japanese authors is argued. *S. serratifolium* is an independent entity. *S. trichophyllum* is revived for a taxon distributed in Seto Inland Sea, distinct from *S. tortile* of earlier authors.

For facilitating the identification, a key to the species is given, and line drawings are made from freshly collected materials. Maps are prepared to show distribution range for each species, based on specimens deposited in the herbarium of the Faculty of Science, Hokkaido University (SAP).

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