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Three new species of *Sargassum* (Sargassaceae, Phaeophyta) from Japan

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Sargassum wakayamaense is described as a new species based on specimens from Wakayama Prefecture. It differs from *S. tenuifolium* Yamada in its dioecism and linear receptacles. *Sargassum araii* sp. nov. has a solid basal system similar to *S. micracanthum*, but has linear lanceolate leaves with an entire margin and spathulate receptacles without denticulation. *S. araii* is known from Sado, Awashima and Tobishima islands in the Sea of Japan. *Sargassum bulbiferum* sp. nov. is a species belonging to the zygocarpic group of the subgenus *Sargassum* from the coast of the Sea of Japan, Hyogo Pref. This species has stunted, bulbous main branches which form during the latter part of the growing season.

Key Index Words: *Fucales—Phaeophyta—Sargassaceae*—Sargassum araii—Sargassum bulbiferum—Sargassum wakayamaense—*Taxonomy.*

Members of the *Sargassum* subgenus *Bactrophycus* are characterized by their simple receptacles and retroflexed leaves. They are distributed on the coasts of East Asia and are especially diverse around Japan. Yoshida (1983) enumerated 28 species of this subgenus from Japanese coast. Several other species were brought to my attention through the meticulous collections of Mr. T. Yamamoto, Mr. S. Arai and others. In this article, two species belonging to the subgenus *Bactrophycus* are recognized as previously undescribed species, one from Wakayama Prefecture, Pacific coast of central Honshu and one from islands in the Sea of Japan. In addition, one species of the subgenus *Sargassum* is described with a peculiar morphology of main branches, from a small island on the coast of the Sea of Japan, Hyogo Prefecture. These three newly described are confined to a rather restricted distribution area.

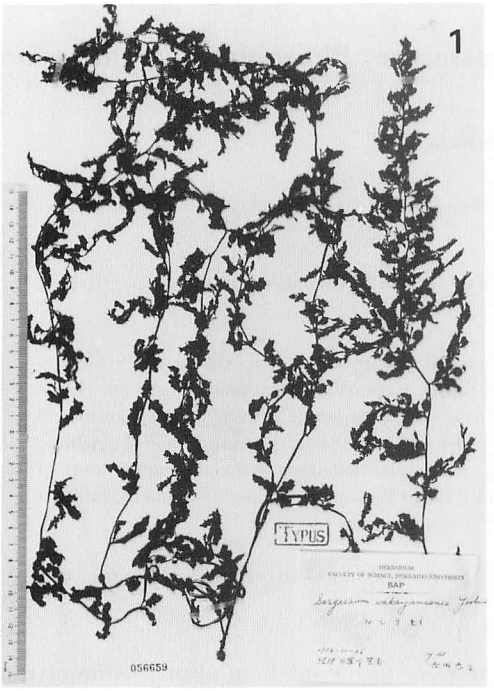
Sargassum wakayamaense Yoshida, sp. nov.
Figs. 1, 3-5

Japanese name: Nanki moku (named by Mr. Torao Yamamoto)

Hapteron discoidea, parum 1 cm in diametro. Caulis erectus, teres, 2 mm in diametro, usque ad 1 cm altus. Aliquot rami principales ex parte distali caulis spiraliter enascentes. Rami principales triquetri, aliquot spinis in margine sparse exorientibus. Folia in parte proximali rami principalis papyracea, basi retroflexa, breviter petiolata, simplicia, lanceolata usque ad 5 cm longa et 1.2 cm lata. Apex foliis obtusus vel acutis. Margine folii irregulariter incisa. Costa in apicem versus evanescens. Cryptostomata in pagina foliis dispersa. Folia in parte distali angustescentia, margine profunde serratis vel incisa. Vesiculis sphaericis vel obovatis, usque ad 6 mm in diametro, eglandulosis, apice mucronatis vel foliola coronatis, petiolis brevior.

Planta dioica. Receptaculis linearis, compressis in parte distales ramis superioribus racemose disposita. Receptacula femina compressa, 7 mm longa et 1.2 mm lata, raro margine minute spinulosis, simplices vel semel dividua. Receptacula masculina 10 mm longa et 1.1 mm lata, sine spinulis, simplices vel semel dividua.

Holdfast disc shaped, 1 cm in diameter; a single erect stem 2 mm in diameter arising from the center of the holdfast, less than 1 cm in hight; two to 3 main branches issued



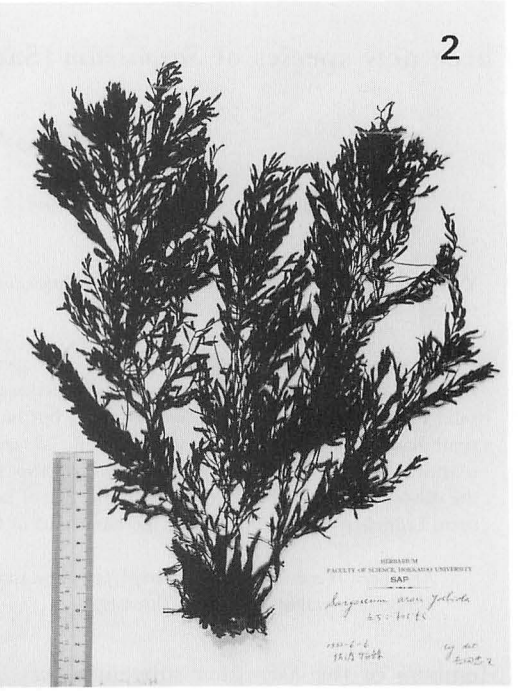


Fig. 1. *Sargassum wakayamaense* Yoshida. Holotype, SAP 056659. Kasaho Bay, Hiki, Wakayama Pref., Nov. 26, 1984. Leg. T. Yoshida.

Fig. 2. *Sargassum araii* Yoshida. Holotype, SAP 057947. Inakujira, Sado Island. Niigata Pref., June 6, 1992. Leg. T. Yoshida.

spirally from the distal part of the stem, triquetrous with small spines beset sparsely on the edge; lower leaves retroflexed at the base, shortly stipitate, lanceolate with obtuse or acute apex, irregularly incised at the margin, up to 5 cm long and 1.2 cm wide, midrib evanescent near the apex, leaf papyraceous in substance; cryptostomata scattered on the leaf surface; leaves on the distal part of the branch becoming narrower and smaller in size, with deeper serration and incision on the margin; vesicles spherical to obovoid in shape, up to 6 mm in diameter, devoid of cryptostomata, with mucronate apex or coronal leaf up to 1 cm long similar to ordinary leaves, stipe of vesicle 2-3 mm in length, always shorter than vesicle.

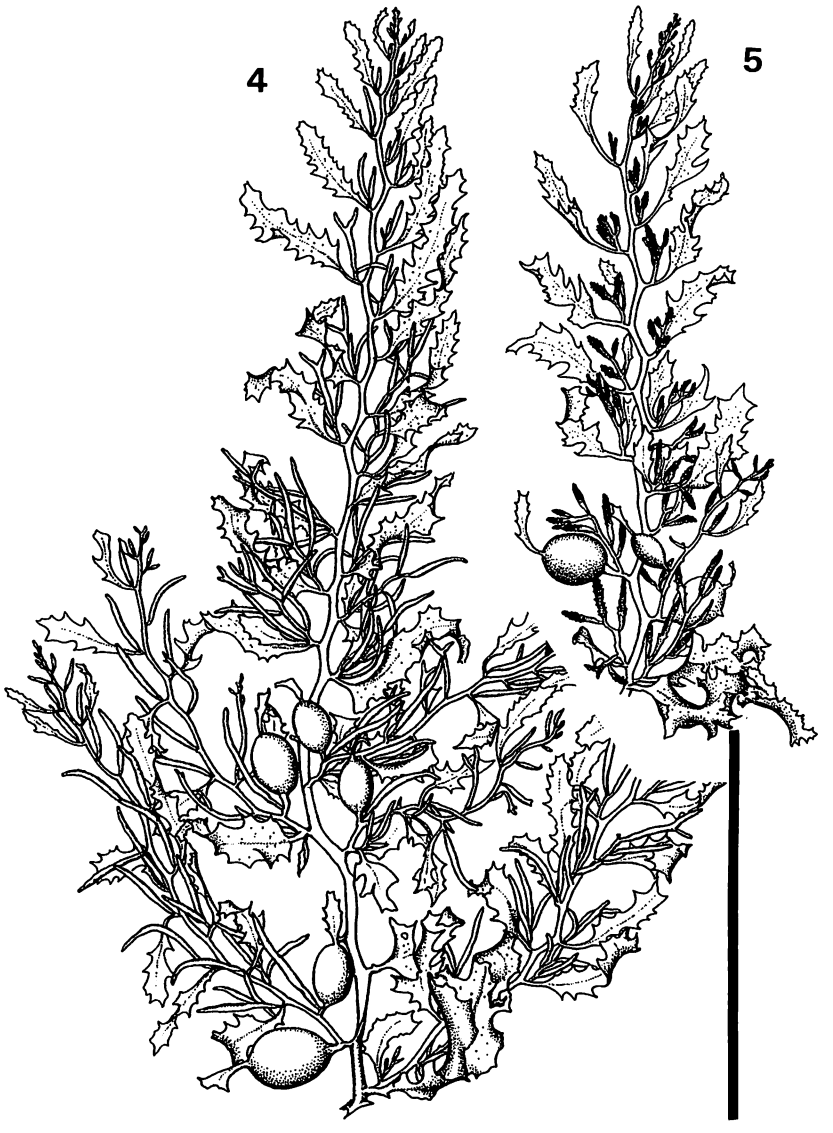
Plant dioecious. Receptacle linear, compressed, disposing racemosely on the distal part of the ultimate branches. Female receptacle (Fig. 5) compressed, 7 mm long and 1.2 mm wide, rarely with spinous processes on the edge, simple or once branched. Male receptacle (Fig. 4) 10 mm long and 1.1 mm wide, without spinous process, usually simple, sometimes once furcated. Maturation in November to December.

This species grows on rocks in the subtidal zone to a depth of 10 m. Plants seem to be annual in longevity.

Holotype: Kasaho Bay, Hiki, Wakayama Prefecture. 33°35′N, 135°25′E. Nov. 26, 1984. Leg. T. Yoshida. SAP 056659. Isotypes in TNS, UC and SNU.

Specimens examined (all from Wakayama Pref.): Sue, Ooshima. May 2, 1942. Leg. M. Takamatsu. SAP 056655; Shirahama. July 7, 1984. Leg. T. Yamamoto. SAP 056653; Kasaho, Hiki. Oct. 4, 1972. Leg. T. Nishikawa. SAP 056649; Kasaho, Hiki. Oct. 13, 1982. Leg. S. Fuse. SAP 056651; Kasaho, Hiki. Oct. 26, 1985. Leg. T. Yamamoto. SAP 056660; Shirahama. Oct. 29, 1977. Leg. T. Yamamoto. SAP 056648; Shirahama.

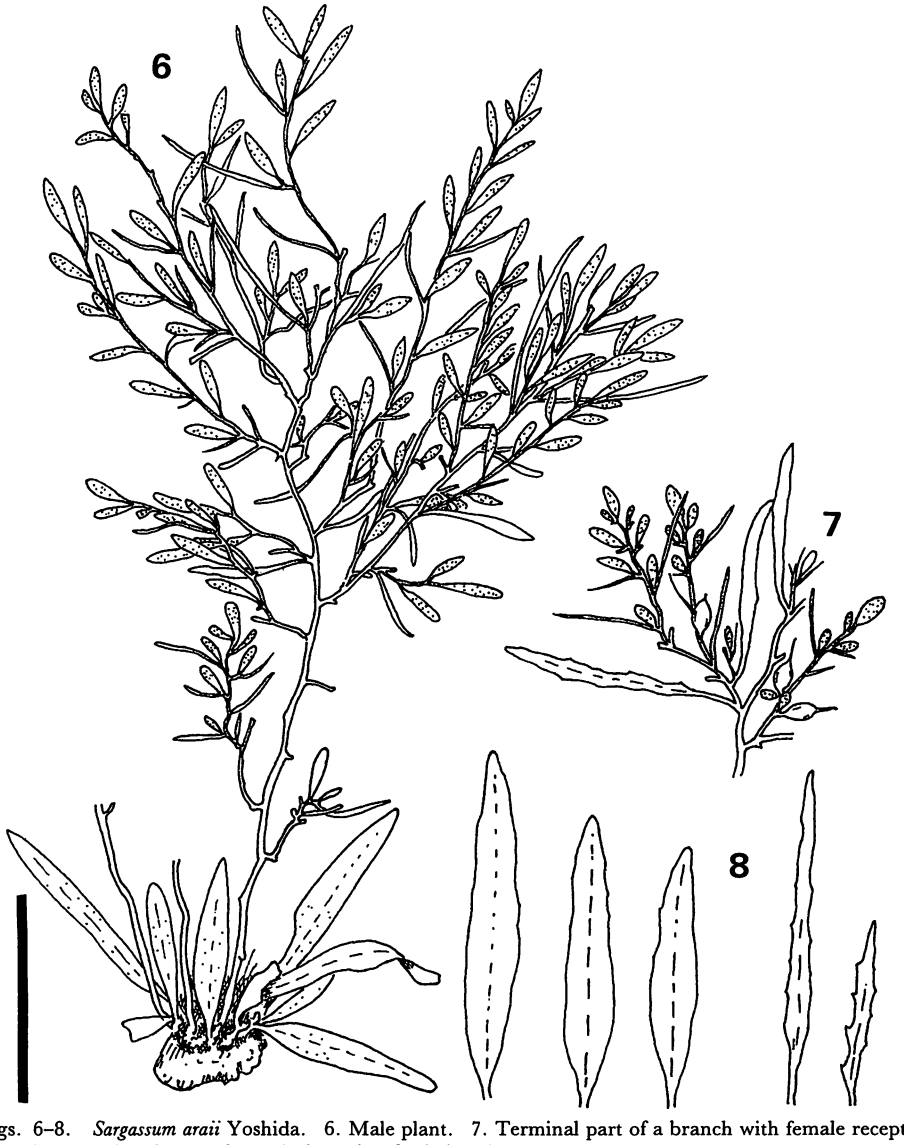
Fig. 3. *Sargassum wakayamaense* Yoshida. Scale bar 5 cm.



Figs. 4–5. *Sargassum wakayamaense* Yoshida. 4. A part of a male plant with receptacles. 5. Terminal part of a branch with female receptacles.

Nov. 1, 1957. Leg. T. Yamamoto. SAP 056656; Kasaho, Hiki. Nov. 1, 1978. Leg. T. Nishikawa. SAP 056647; Kasaho, Hiki. Nov. 2. 1971. Leg. T. Nishikawa. SAP 056650; Minoura. Nov. 22, 1980. Leg. T. Nishikawa. SAP 056646; Kasaho, Hiki. Dec. 6, 1984. Leg. S. Fuse. SAP 056652; Kasaho, Hiki. Jan. 27, 1986. Leg. S. Fuse. SAP 056661.

Flat receptacles and the erect stem of this species are the characters attributable to the section *Halochloa* of the subgenus *Bactrophycus*. This species has some similarity to *S. tenuifolium* Yamada (1942: 505), in vegetative appearance, but larger leaves with shallow dentation, linear receptacles, dioecism, and a later maturation period clearly differ from this species. To date, this species has been collected only from a very restricted area on the southwest coast of Kii Peninsula, between Kushimoto and Shirahama.



Figs. 6–8. *Sargassum araii* Yoshida. 6. Male plant. 7. Terminal part of a branch with female receptacles. 8. Leaves from the basal part of a main branch. Scale bar 5 cm.

Sargassum araii Yoshida, sp. nov.

Figs. 2, 6-8

Japanese name: Echigo nejimoku (named by Mr. Shogo Arai)

Thallus altitudinem 40 cm. Hapteron conicum usque ad 4 cm in diametro. Caulis 1.5–2 mm in diametro, compluriens ramificans. Ramis principalis ad superficie dorsale caulis enascentes, leviter compressis, 1.5 mm latis in parte inferiore. Rami lateralis breviter, numerosi. Folia enascentia primaria prope partem basalem simplicia linari-lanceolata, usque ad 10 cm longa et 1.5 cm lata, basi attenuati et apice obtuse, margine integri. Costa immersa. Texture folii crassa membranacea. Cryptostomata minuta et in pagina foliis sparsa. Folia in parte distali versum linearia angustescentia, margine integra vel raro parce dentata. Vesicula rara, fusiformis vel elliptica, 8-9 mm longa et 4–5 mm in diametro.

Planta dioica. Receptacula femina com-

pressa, obspathulata, basi attenuata, apice obtusis vel retusis, 10–15 mm longa et 3–5 mm lata. Receptacula masculina linearia, compressa, apice obtusis, 20–23 mm longa et 3 mm lata.

Thallus attaining up to 40 cm high. Holdfast conical up to 4 cm in diameter; stem 1.5–2 mm in diameter, branched after short distance, lower parts buried in the conical holdfast, giving the appearance of many stems arising from the upper part of the holdfast; main branches issued from the upper side of decumbent stem, slightly compressed, 1.5 mm wide in the lower part, up to 40 cm long; secondary branches shorter in length, numerous; leaves alternately issued with wide angle, linear in shape; leaves (Fig. 8) near the base of main branch narrow lanceolate, attaining 9 cm long and 1.5 cm wide with attenuate base and obtuse apex, margin nearly entire, midrib buried and extending to near the apex, thick and coriaceous in substance; cryptostomata small and very scarce, scattered on the surface of the leaves; phyllotaxis 1/2; leaves on the upper part of the main branch and laterals becoming smaller in size and narrower in width to filamentous appearance, margin entire or with sparse dentation with sharp apices; vesicles very rare on the specimens at hand, fusiform to elliptical in shape, 8–9 mm long and 4–5 mm in diameter, with short stipe about 2 mm long and linear coronal leaf up to 18 mm long.

Plant dioecious. Female receptacle (Fig. 7) obspathulate with attenuate base and obtuse or retuse apex, 10–15 mm long and 3–5 mm wide. Male receptacles (Fig. 6) linear in shape with obtuse apex and attenuate base, longer than the female ones, measuring 20–23 mm long and 3 mm wide. Maturation in June to July.

This species grows on rocks of 0–2 m in depth exposed to very strong wave action, especially during winter, on the west coast directly facing the Sea of Japan. Perennial in longevity.

Holotype: Female, Inakujira, Sado Island, Niigata Prefecture. 38°00′N, 138°15′E. June 6, 1992. Leg. T. Yoshida. SAP 057947. Isotypes in TNS, UC and SNU.

Specimens examined: Inakujira, Sado Island. Jul. 14, 1991. Leg. T. Yoshida. SAP 056670-2; Nagate-misaki, Sado Island. June 7, 1992. Leg. T. Yoshida. SAP 057949; Awa-shima, Niigata Pref. Jul. 18, 1991. Leg. T. Terawaki. SAP 057948; Tobi-shima, Yamagata Pref. Jul. 7, 1981. Leg. S. Arai. SAP 057950.

This species belongs to the Section *Halochloa* of the subgenus *Bactrophycus* with erect stem and complanate receptacles. Basal parts are similar to *S. micracanthum* with a large, conical holdfast issuing several branched stems, but the new species differs in its thick, entire leaves and receptacle characteristics. Paucity of vesicles is a character common in such surf-loving species as *S. okamurae*.

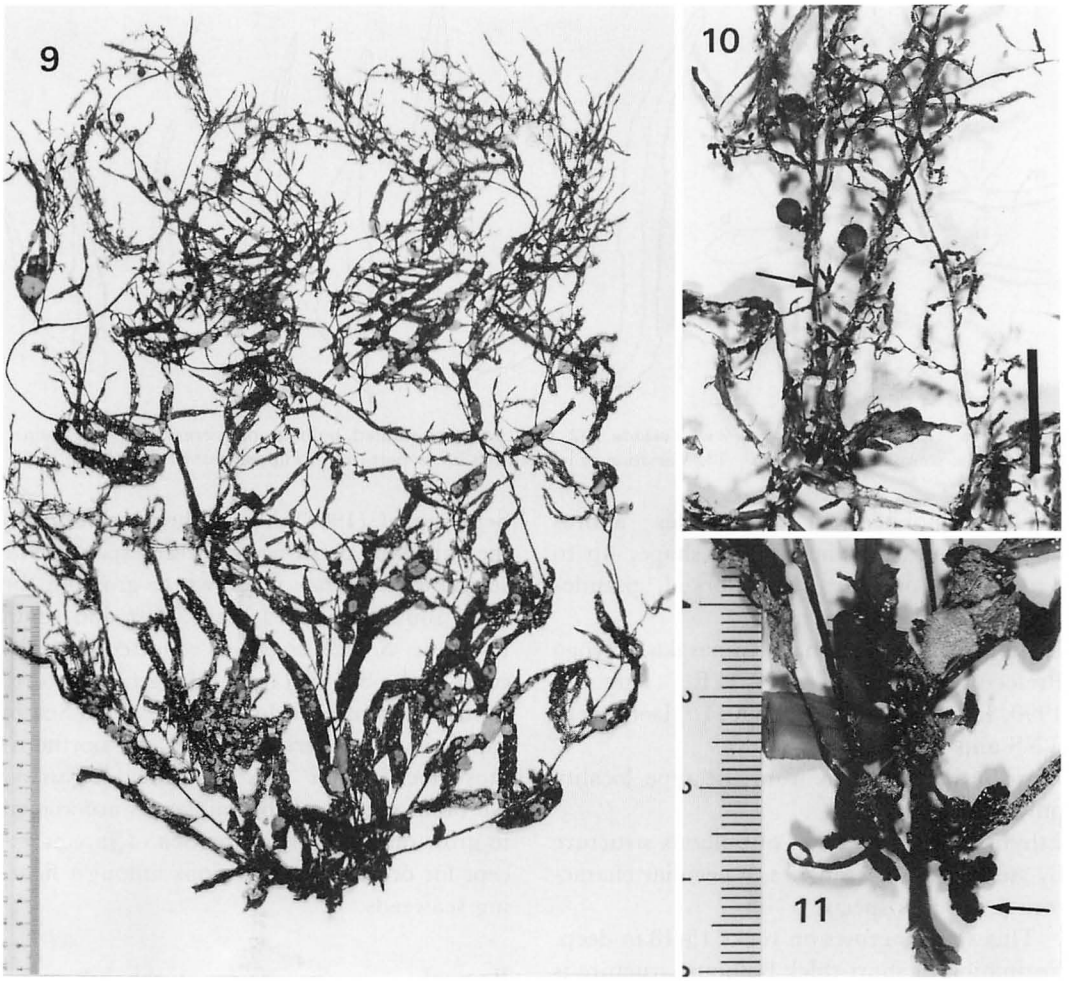
The specific epithet is named in honour of Mr. Shogo Arai, Marine Algae Research Co., Ltd, an excellent diver and keen observer of marine algae, who just brought my attention to this new species. *S. araii* is known presently from the three islands mentioned above in the Sea of Japan.

Sargassum bulbiferum Yoshida, sp. nov.
Figs. 9–11

Japanese name: Tamaeda moku (nov.).

Hapteron discoidea, usque ad 2 cm in diametro. Caulis erectus, teres, 1 cm altus, 2 mm in diametro, interdum semel furcatus. Rami principales aliquot per caulis ex parti distali spiraliter disponiti. Rami principales compressi 2 mm lati, margine integra sine spini, 50 cm longi. Rami principali enascenti postea in tempi crescentia bulbis similis, 8 mm longi, 3 mm lati cum appendicibus parvis. Folia enascentia prope partem basalem lineari vel laneari-lanceolati usque ad 10 cm longi, 1 cm lati, margine integri vel sparse denticulata, simplicia vel saepe semel divise, costa ad apicem attingens. Folia in parte distali minutatim angustescentia, alternate enascens. Cryptostomata parviora, in pagina foliis dispersa. Vesiculae sphaericae vel obovatae 3 mm in diametro, petiolo filamentoso 3 mm longo.

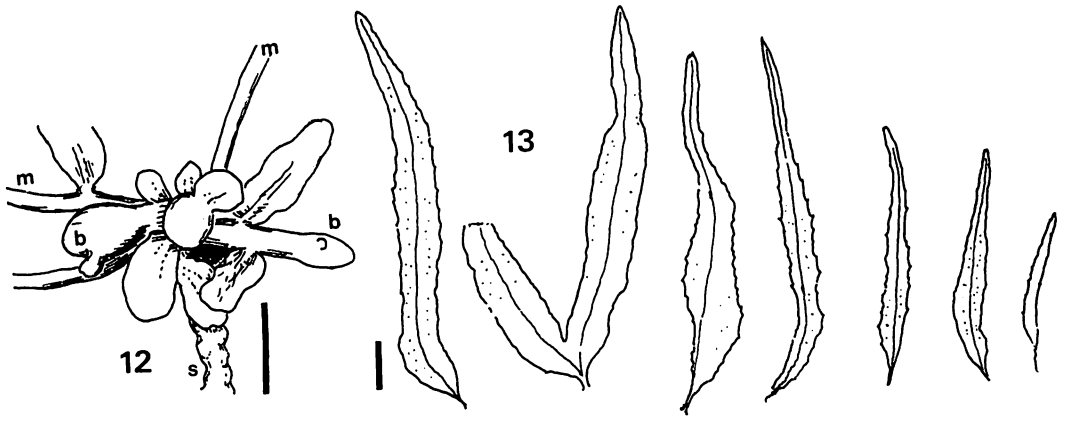
Planta monoica. Receptacula androgyna,



Figs. 9–11. *Sargassum bulbiferum* Yoshida. 9. Holotype, SAP 059011. Oburi-shima, Hamasaka, Hyogo Pref., Aug. 3, 1990. Leg. S. Arai. 10. Fertile part of a branch with pseudozygocarpic receptacles (arrow). Scale bar 1 cm. 11. Basal part of the thallus showing stunted, bulbous main branches (arrow).

teres, usque ad 7 mm longa, semel divisa, pseudozygocarpicae.

Holdfast discoid, up to 2 cm in diameter; stem cylindrical, 1 cm high and 2 mm in diameter, often once forked at the upper part, surface verrucous with the vestige of fallen branch; several main branches radially arise from the apical part of stem, 50 cm or more in length, compressed 2 mm in width, smooth on surface, issuing alternately leaves, lateral branches 10 cm or more in length; several main branches formed later in season not growing longer and becoming thicker, about 8 mm long and 3 mm in diameter with a few small appendages on the surface (Fig. 11, arrow; Fig. 12, b); leaves on the lower part of main branch linear to linear lanceolate up to 10 cm long and 1 cm wide, entire or sparse and small denticulation on the margin, papyraceous in texture, midrib reaching the apex, lower leaves often once forked, leaves on the upper part of main and lateral branches thinner in texture becoming narrower and shorter in length (Fig. 13); cryptostomata very small, scattered on the surface of leaves; vesicles spherical to round obovate, 3 mm in diameter, with filamentous stipe up to 3 mm long.



Figs. 12–13. *Sargassum bulbiferum* Yoshida. 12. Basal part with stunted, bulbous main branch (b). m: main branch; s: stem. Scale bar 1 cm. 13. Variation in leaves from lower part (left) to upper part of the branch.

Plant monoecious; receptacles androgynous, slender cylindrical in shape, up to 7 mm long once or twice forked, pseudozygocarpic (Fig. 19, arrow).

Holotype: Oburi-shima, Hamasaka, Hyogo Prefecture, 35°37′N, 134°24′E. Aug. 3, 1990. Leg. S. Arai, SAP 059011. Isotypes in TNS and UC.

Distribution: Known from the type locality only.

Ethymology: Formation of bulbous structure by stunted main branches, a peculiar characteristics of this specis.

This species grows on rocks 15–18 m deep. Formation of short thick bulbous structure is peculiar feature of this interesting specis. Metamorphosis of main branch was already noted in *S. polycystum*, in which several main branches produced in certain season become stunted and decumbent into structure like stolons with short lateral branches. Stockiness of main branch in this new species is very evident reminding one of certain succulent plants. Upper parts of the branches are somewhat similar to *S. carpophyllum* and *S. tenerrimum* with thin and narrow leaves, but leaves on the lower part of the main branch are much larger than these species. The species belongs to the Section *Zygocarpicae* of the subgenus *Sargassum*, with its pseudozygocarpic status of receptacles.

Most species of the subgenus *Sargassum* are distributed in tropical and subtropical seas. Segawa *et al.* (1961) showed the distribution of the subgenus *Sargassum* in west Japan. The subgenus *Sargassum* is known to grow on the coast south of Goto Islands, east and south Kyushu. *S. bulbiferum* was collected from the coast of the Sea of Japan, Hyogo Prefecture, central part of Honshu, Japan. The Sea of Japan is a temperate region and northernmost locality for the subgenus *Sargassum*. No other species of this subgenus are known to grow on the coast of the Sea of Japan, except for occasional collections amongst floating seaweeds.

Remarks

All three species described here have a rather restricted distribution, in comparison with other species hitherto reported from Japan. Along the coast of Kii Peninsula, *S. segii* Yoshida and *S. sagamianum* Yendo also have a very restribted range of distribution (Yoshida, 1983). *S. wakayamaense* is known from the coast between Shirahama and Shionomisaki on the southwest part of Kii Peninsula. *S. araii* was collected from three islands in the Sea of Japan, and was not found on the coast of Honshu. *S. bulbiferum* is known from the type locality only.

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吉田忠生：日本産ホンダワラ属（褐藻ヒバマタ目）の3新種について

和歌山県南部からナンキモク *Sargassum wakayamaense* を記載した。この種は *Bactrophycus* 亜属で *Halochlora* 節に属し，ウスバモクより大型で雌雄異株であることなどで異なる。新潟県佐渡島，粟島，山形県飛島に産する同じ節のエチゴネジモク *S. araii* はトゲモクのような大型の付着部をもち，披針形の全縁の葉をもつなどの特徴があり，波当たりの激しい場所に生育する。兵庫県浜坂町大槌島の深所で採集されたタマエダモク *S. bulbiferum* は，マジリモクのような薄い細い葉をもち，成長期の終わりに形成される主枝が太く短縮している点が特異である。この種は *Sargassum* 亜属 *Zygocarpicae* 節のものである。（060 札幌市北区北10条西 8 丁目　北海道大学理学研究科生物科学専攻）