

The conspecificity of *Laurencia yendoi* Yamada and *L. nipponica* Yamada (Ceramiales, Rhodophyta)¹⁾

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Laurencia yendoi Yamada from several localities in northern Japan is shown to be synonymous with *L. nipponica* Yamada widely distributed in Japanese and adjacent waters. Lenticular thickenings, which have not been reported for *L. yendoi*, can be found in the walls of medullary cells in the lower portions of upright axes of the holotype specimen. This critical character together with other morphological features such as large upright thalli with thick, terete, main axes, irregular radial branching, and absence of projecting surface cells, warrant the treatment of these two entities as being conspecific. The lenticular thickenings are considered to be a useful specific feature. The geographical distribution of *L. nipponica* is described on the basis of historical and contemporary specimens.

Key Index Words: geographical distribution—*Laurencia*—*Laurencia masonii* var. *orientalis*—*Laurencia nipponica*—*Laurencia nipponica* f. *orientalis*—*Laurencia yendoi*—lenticular thickenings—*Rhodophyta*—taxonomy.

Many species of the red algal genus *Laurencia* have been reported from Japanese waters (Yamada 1931, Yamada 1932, Yamada in Okamura 1936, Yamada and Tanaka 1938, Yamada and Segawa 1953, Saito 1967, 1977, 1978, Ohba and Aruga 1982). Some have, however, been reduced to heterotypic synonyms of other species. *Laurencia amabilis* Yamada (in Yamada and Segawa 1953) is considered to be a synonym of *L. yamadana* Howe (1934) (Saito 1969) and *L. japonica* Yamada (1931) of *L. okamurae* Yamada (1931) (Saito 1989). Misidentifications are also apparent; the entity passing under the name *Laurencia glandulifera* in Japan has been shown to be an early seasonal form of *L. nipponica* Yamada (1931) without lenticular thickenings in the walls of medullary cells (Saito 1985). Twenty four species of *Laurencia* are now included in the check-list of Japanese marine algae (Yoshida *et al.* 1990). However, there are

several species for which further investigations are necessary.

Yamada (1931) established *Laurencia yendoi* Yamada on the basis of specimens which were collected at Hidaka and Rishiri Island, Hokkaido and had been reported as *L. heteroclada* Harvey by Yendo (1916). This species has been characterized by an absence of lenticular thickenings and the presence of spirally arranged clusters of stichidial branchlets and large, thick, percurrent axes (Yamada 1931). The latter two features are shared with *L. nipponica* Yamada. *Laurencia yendoi* has been reported from a few other localities in Iwate Prefecture (Kawashima 1955), whereas *L. nipponica* is widely distributed in Japanese and adjacent waters (Saito 1967). In the present paper *L. yendoi* is compared with *L. nipponica*. Furthermore, the taxonomic status of an infraspecific taxon of *L. nipponica*, f. *orientalis* (Yamada) Yamada (in Okamura 1936) will be assessed.

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Materials and Methods

Four herbarium specimens of *Laurencia yendoi* were examined on loan from the Herbarium of University Museum, University of Tokyo (TI). These specimens, which include the holotype sheet (four plants: two tetrasporangial, one cystocarpic and one spermatangial), were collected at Hidaka (locality not described), Hokkaido in July–August 1909 by K. Yendo and determined by Y. Yamada. Two specimens of *L. nipponica* f. *orientalis* (determined by Y. Yamada as *L. masonii* var. *orientalis* Yamada) deposited in TI were examined: 1) the holotype specimen with tetrasporangia collected at Rishiri Island, Hokkaido on 6 August 1891 by K. Yendo and 2) a cystocarpic specimen collected at Nemuro in August 1924 by Y. Yamada. The following herbarium specimens deposited in the Herbarium, Department of Botany, Faculty of Science, Hokkaido University, Sapporo (SAP) were examined: 1) the holotype specimen of *Laurencia nipponica* Yamada collected at Nou, Niigata Prefecture (undated) by Y. Yamada (SAP 013877); 2) two specimens of *L. yendoi* collected at Kuji Bay, Iwate Prefecture on 22 July 1952 by S. Kawashima (SAP 027018); 3) a specimen collected at Nakano, Iwate Prefecture on 20 July 1951 by S. Kawashima (SAP 027017); and, 4) a specimen collected at Okutairahe, Aomori Prefecture on 1 May 1931 by Y. Abe and determined by Y. Yamada (SAP 050806). Furthermore, many specimens deposited in SAP were re-examined and used to describe the geographical distribution of *Laurencia nipponica*. Herbarium specimens collected recently were also used and deposited in SAP. All these specimens are listed in Appendix I.

Small portions were removed from various parts of the thalli using a scalpel under a dissecting microscope and rehydrated. Sections were made by hand using a razor blade and pith stick, mounted in water on microscope slides.

Results and Discussion

The holotype specimen of *Laurencia yendoi* is tetrasporangial (Fig. 1), and is composed of a primary axis and six secondary axes which develop from the lowest portion of the primary axis and stolons. Many first-order branches with indeterminate growth are borne on the primary and secondary axes. Short adventitious branchlets are produced on the axes and branches, and are abundant on the upper portion of the axes. These branchlets are simple or divided once, and are generally fertile. Secondary longitudinal pit-connections are present between adjacent surface cells. Lenticular thickenings are frequently present in the walls of medullary cells of the lower portion of secondary upright axes (Figs. 2, 3), but they have not been found in the lateral branches of any order. Tetrasporangia are formed on ultimate and penultimate branchlets of ordinary and adventitious branches. Tetrasporangial stichidia are formed in an irregularly radial manner except for simple stichidia which may develop adventitiously and look like a cluster to the unaided eye as described by Yamada (1931). Tetrasporangia are arranged parallel to their parent branchlet axis. A cystocarpic specimen of *Laurencia yendoi* has many ovoid cystocarps which are 900–1100 μm long and 750–1000 μm wide. A spermatangial plant bears many fertile branchlets of which the terminal portions are thick and 625–1000 μm long and 800–1250 μm wide.

Herbarium specimens determined as *Laurencia yendoi* and deposited in SAP (see Materials and Methods) have lenticular thickenings in the walls of medullary cells of lateral branches or in the lower portions of secondary axes.

Taxonomic features of *Laurencia yendoi* are compared with those of *L. nipponica* in Table 1. Both of these species have large upright thalli with thick, terete, main axes and can be distinguished as such from other species of the genus found in Japan. *Laurencia yendoi*, however, does not differ from *L. nipponica* in any of morphological features listed in Table 1, and should therefore be regarded as conspecific. Of these two names of the same date



Figs. 1-3. *Laurencia yendoi* Yamada. Fig. 1. Holotype specimen deposited in TI. Figs. 2, 3. Transverse sections of the lower portion of a secondary axis of the holotype specimen, showing lenticular thickenings in the walls of medullary cells (arrowheads). Scale in Fig. 3 also applies to Fig. 2.

(Yamada 1931), *L. nipponica*, which appeared in an earlier page and has been widely known in Japan, should be chosen for the combined taxon.

The presence or absence of lenticular thickenings has been regarded as a diagnostic character of species or groups of species (Yamada 1931 as section). Of the Japanese

Table 1. A comparison of *Laurencia yendoi* and *L. nipponica*

	<i>L. yendoi</i>	<i>L. nipponica</i>
Length of upright thalli (cm)	up to 25	up to 40
Basal system	a discoid holdfast and stolons	a discoid holdfast and stolons
Main axis	percurrent, terete	percurrent, terete
Thickest portion (mm)	2-3	1.4-3.1
Branching	irregularly radial	irregularly radial
Palisade-like surface cell	absent	absent
Secondary longitudinal pit-connection	present	present
Projecting surface cells	absent	absent
Lenticular thickenings	present	present
Apical depression of spermatangial receptacle	single	single
Shape of cystocarps	ovoid	ovoid
Size of cystocarps (μm)		
length	900-1100	700-1150
width	750-1000	660-1000
Arrangement of tetrasporangia	parallel-type	parallel-type

species, their presence characterizes *L. okamurae* Yamada, *L. venusta* Yamada, *L. nidifica* J. Agardh, *L. mariannensis* Yamada, and *L. nipponica*. The occurrence of such thickenings is exceptionally variable in *Laurencia filiformis* (C. Agardh) Montagne: they are usually present in f. *filiformis* growing in calm water, sometimes present in f. *heteroclada* (Harvey) Saito et Womersley growing on rough-water reefs and usually absent in f. *dendritica* Saito et Womersley growing in deeper water (Saito and Womersley 1974). On the basis of a remark made by McDermid (1988a), Vandermeulen *et al.* (1990) concluded that lenticular thickenings are not particularly significant at any taxonomic level. However, McDermid (1988b) employs this feature to distinguish the Hawaiian species. Her remark (McDermid 1988a, p. 222) "considerable within-species variation of projection of cortical cells, presence of lenticular thickenings, ..." is based upon Cribb (1958, p. 159) "some species, such as *L. obtusa* and *L. rigida*, never show any lenticular thickenings in the walls of the medullary cells, some such as *L. venusta* appear always to possess thickenings in abundance, while in others such as *L. heteroclada*, the thickenings vary from very abundant to entirely absent, depending on the specimens". In *Laurencia nipponica* these thickenings are

not always present in young plants, but they become more abundant with age (Saito 1967, 1985). He points out the necessity of examining fully grown plants for such species. Cribb employs the presence of lenticular thickenings to distinguish some Australian species in a later paper (Cribb 1983). Thus, in many cases the presence of lenticular thickenings can be used for a critical feature at least at species level.

Yamada (1931) described *Laurencia masonii* Setchell et Gardner var. *orientalis* Yamada on the basis of specimens collected at Rishiri Island and Nemuro, Hokkaido. Yamada (in Okamura 1936), however, later reduced this variety to a forma of *L. nipponica*; this forma has been characterized by conspicuously longer lateral branches (Yamada in Okamura 1936), and it has been reported from a few localities of Hokkaido (Hasegawa 1949). Two herbarium specimens of this forma, cited in Materials and Methods, have been examined. The production of many, short, reproductive adventitious branchlets and less frequent occurrence of lenticular thickenings in the medullary cell-walls suggest a relationship with *L. nipponica* than *L. masonii* as Yamada (in Okamura 1936) concluded. On the contrary, *L. masonii* lacks such branchlets and possesses very abundant and much thicker len-

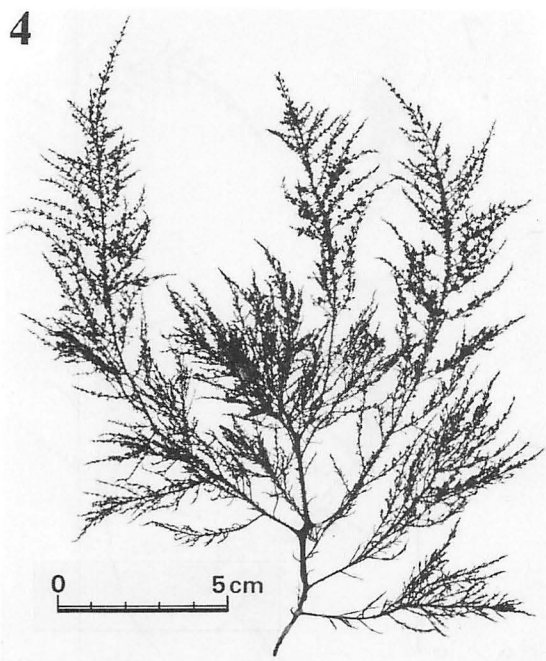


Fig. 4. Herbarium specimen of *Laurencia nipponica* with long lateral branches, collected on 7 July 1989 from a sheltered place at Oshoro, Hokkaido (SAP 056345).

Fig. 5. Holotype specimen of *L. nipponica* f. *orientalis* (Yamada) Yamada (TI, as *L. masonii* var. *orientalis* Yamada).

ticular thickenings (Yamada 1931). Other morphological features of these specimens are very similar in every respect to those of *L. nipponica*. Development of lateral branches may be affected by habitat in Japan. *Laurencia nipponica* grows on rocks or ledge in sheltered to fully wave-exposed places. Plants growing in sheltered calm places (tidal pools or ports) develop long branches (Fig. 4) as does the holotype specimen of *L. nipponica* f. *orientalis* (Fig. 5), whereas those growing in fully wave-exposed places have short lateral branches (Fig. 6) as does the holotype specimen of this species (Fig. 7). There is no need for an infraspecific taxon on the basis of such development of lateral branches. Morphological variability similar to this is common in the species of *Laurencia*, as pointed out by Yamada (1931, p. 185).

Okamura (1899) distributed an exsiccata of Japanese marine algae which included an alga under the name of *Laurencia paniculata* J. Agardh. The specimen of this alga in Okamura Herbarium housed in SAP, collect-

ed at Hakui, Noto Peninsula in May, 1894, is identical with *L. nipponica*. Okamura (1902, 1916) reported *L. paniculata* from various localities of Japan ranging from Okinawa Prefecture to Hokkaido. No specimens other than a duplicate of his exsiccata identified as *L. paniculata* by K. Okamura are included in his herbarium in SAP. His identification might have been tentative and could have been corrected later. As *L. nipponica* has not been reported from Okinawa Prefecture (Segawa and Kamura 1960, Masuda and Kamura unpublished observations), his geographical records may include other species. Yendo's (1916) *L. heteroclada*, of which voucher specimens had been known as *L. yendoi*, is identical with *L. nipponica*. Yamada's *L. glandulifera* (in Okamura 1936) is conspecific with *L. nipponica* as already reported by Saito (1985).

In summary, the synonyms of *L. nipponica* are as follows.

Laurencia nipponica Yamada [1931: 209, pl. 9]

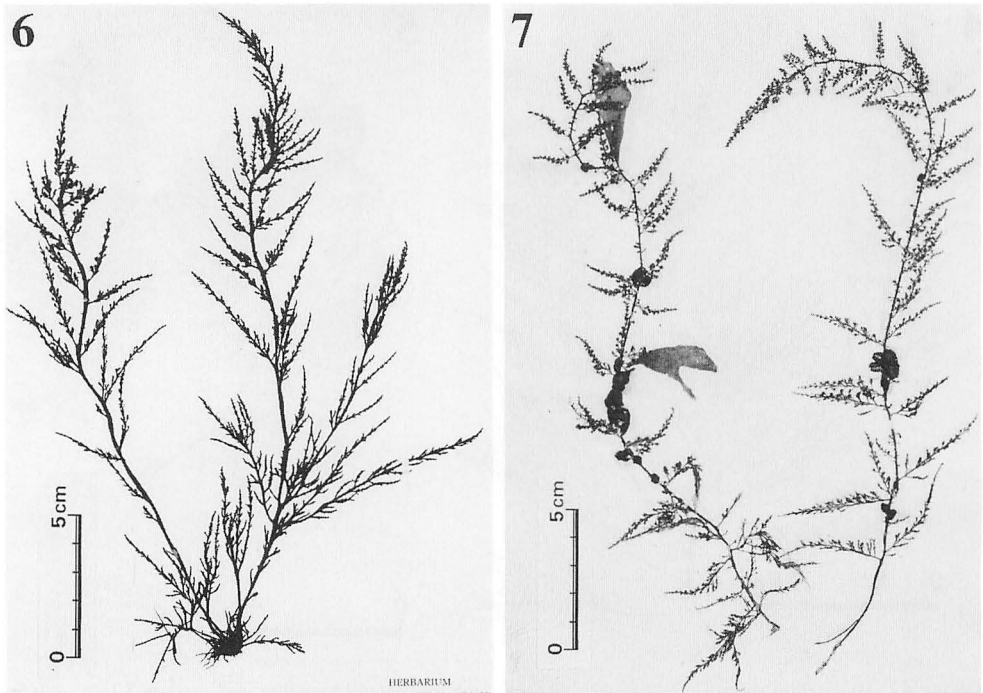


Fig. 6. Herbarium specimen of *Laurencia nipponica* with short lateral branches, collected on 24 June 1989 from a fully wave-exposed habitat at Tanesashi, Aomori Prefecture (SAP 056344).

Fig. 7. Holotype specimen of *L. nipponica* Yamada deposited in SAP (013877).

Synonyms: *Laurencia yendoi* Yamada [1931: 237, pl. 24]. *L. masonii* Setchell et Gardner var. *masonii* Yamada [1931: 210, pl. 10]. *L. nipponica* Yamada f. *orientalis* (Yamada) Yamada [in Okamura 1936: 855]. *L. paniculata* auct. non J. Agardh: Okamura [1902: 54 (*pro parte*), 1916: 68 (*pro parte*)]. *L. heteroclada* auct. non Harvey: Yendo [1916: 89]. *L. glandulifera* auct. non Kützing: Yamada [in Okamura 1936: 858].

The geographical distribution of *Laurencia nipponica* in Japan is shown in Fig. 8; it occurs along the coast of Sea of Japan and the coast of Sea of Okhotsk from Saga Prefecture to the north coast of Hokkaido including the Nemuro Straits, which are under the influence of the Tsushima Warm Current and its terminal branch, the Soya Warm Current. This alga also grows on the coast of Seto Inland Sea and along the Pacific coasts of northern Honshu and southern Hokkaido, which are influenced by the Tsushima Warm Current and its terminal branch, the Tsugaru

Warm Current. Furthermore, its distribution range extends northward to eastern Hokkaido which is exclusively influenced by the Oyashio Cold Current. Of the species of *Laurencia* found in Japanese waters, *L. nipponica* is most adapted to low temperatures and exclusively occurs in north-eastern Hokkaido.

Konno *et al.* (1988) and Ohba *et al.* (1988) reported *L. nipponica* from more southerly localities of Pacific coast, Kominato and Banda, Tateyama, Chiba Prefecture. One of their voucher specimens, collected at Banda, on 15 May 1988 and donated to SAP (054428) was examined. This specimen is much more slender than *L. nipponica* and its surface cells are clearly projecting at the branch apices. Further examination is needed to clarify the occurrence of *L. nipponica* in these localities.

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We are grateful to Professor T. Yoshida,

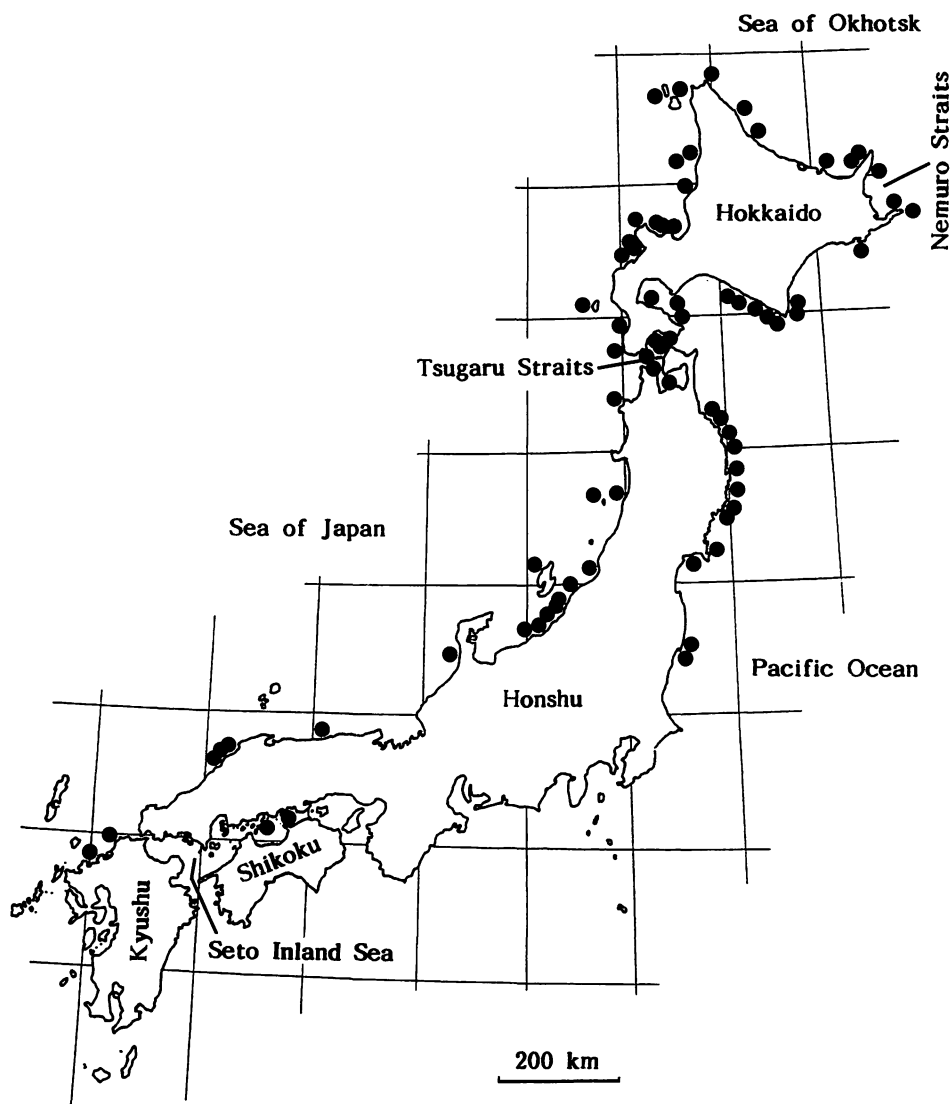


Fig. 8. Geographical distribution of *Laurencia nipponica*, compiled from herbarium specimens in SAP.

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Appendix I.

Voucher specimens used in assessing the geographical distribution of *Laurencia nipponica* Yamada are listed below. All specimens are deposited in SAP and the specimen numbers refer to SAP.

Sea of Japan

Saga Pref.: Karatsu, April 1929, leg. Y. Okamoto (056299). Fukuoka Pref.: Tsuyazaki, 13 April 1957, leg. T. Sawada (031162). Shimane Pref.: Yunotsu, undated, leg. S. Takaki (021092); Shizuma, 16 July 1933, leg. S. Takaki (Okamura Herb.); Torii, 30 March 1933, leg. S. Takaki (Okamura Herb.). Tottori Pref.: Iwami, 8 July 1918, leg. Y. Ikoma (056298). Ishikawa Pref.: Hakui, 20 April 1894, leg. K. Okamura (Okamura Herb.), May 1894, leg. K. Okamura (Okamura Herb.). Niigata Pref.: Gouzu, 2 August 1957, leg. Y. Saito (028246-7); Kujiranami (Kashiwazaki), 17 May 1990, leg. M. Masuda (056317-9); Kannon-misaki (Nishiyama), 15 May 1991, leg. A. Arai (056315), 20 May 1991, leg. Y. Kajita (056316); Ishiji, 13 March 1932, leg. Y. Ikegami (Okamura Herb.), 25 May 1932, leg. Y. Ikegami (Okamura Herb.); Niigata, 8 May 1986, leg. K. Ikehara (051045); Murakami, 17 May 1990, leg. M. Masuda (056312); Ookura (Aikawa), 19 April 1956, leg. N. Tazawa (056313-4). Yamagata Pref.: Tobishima, July 1931, leg. T. Hirohashi (012089). Akita Pref.: Konoura, 20 July 1989, leg. T. Suzuki and M. Masuda (056311). Aomori Pref.: Fukaura, 19 July 1931, leg. T. Kanda (012825), 21 July 1989, leg. T. Suzuki and M. Masuda (056310). Hokkaido: Akagami (Matsumae), 24 June 1988, leg. I. Mine (053976); Esashi, 3 April 1944, leg. Y. Hasegawa (025435); Okushiri, January 1944, leg. Y. Hasegawa (025236), 3 July 1943, leg. Y. Hasegawa (025237); Suttso, 16 June 1950, leg. S. Kawashima (052283); Kayanuma (Tomari), 25 April 1984, leg. K. Kobayashi (056326); Kawashiro, 10 August 1985, leg. K. Kobayashi (056330); Yobetsu, 6 June 1984, leg. K. Kobayashi (056327); Attoma, 1 July 1985, leg. K. Kobayashi (056329); Oshoro, 29 April 1932, leg. K. Inagaki (014054, 022307), 7 July 1989, leg. M. Masuda (056345); Shioya, June 1940, leg. Y. Nakamura (023614); Takashima, 14 June 1954, leg. N. Tazawa (054336); Otaru, 14 June 1954, leg. N. Tazawa (028562); Kumausu, 6 July 1989, leg. T. Suzuki and M.

Masuda (056341); Asari, 1 June 1954, leg. N. Tazawa (028563); Hariusu, 6 July 1989, leg. T. Suzuki and M. Masuda (056342); Rumoi, 22 June 1984, leg. E. Kurosawa and Y. Saito (056333), 5 July 1989, leg. M. Masuda (056346); Yagishiri, August 1910, leg. K. Yendo (056296); Shosanbetsu, 22 June 1984, leg. E. Kurosawa and Y. Saito (056332); Rishiri, 8 June 1899, leg. K. Yendo (056295), 21 July 1929, leg. S. Akiyama (008111-2); Rebun, July 1910, leg. K. Yendo (056297), 24 August 1934, leg. K. Inagaki (022813, 048135).

Seto Inland Sea

Ehime Pref.: Yuge-jima, 11 May 1990, leg. S. Arai and S. Ninomiya (056323-5). Okayama Pref.: Kitagijima (Kasaoka), 3 April 1989, leg. S. Ninomiya (056320-1). Kagawa Pref.: Awashima (Takuma), 5 April 1989, leg. S. Ninomiya (056322).

Pacific coast

Fukushima Pref.: Onahama, 22 July 1990, leg. M. Masuda (056309); Yotsukura, 22 July 1990, leg. M. Masuda (056308). Miyagi Pref.: Shichigahama, 18 May 1955, leg. Y. Tsuji (056300); Ogatsu, 22 June 1989, leg. T. Suzuki and M. Masuda (056307); Karakuwa, 23 June 1989, leg. T. Suzuki and M. Masuda (056306). Iwate Pref.: Hirota, 4 August 1956, leg. Y. Tsuji (056301); Oofunato, 21 May 1951, leg. S. Kawashima (027020); Ootsuchi, 24 July 1979, leg. S. Kawaguchi (052945), 25 July 1979, leg. S. Kawaguchi (053193); Joudogahama (Miyako), 23 June 1989, leg. T. Suzuki and M. Masuda (056305); Kurosaki (Fudai), 24 June 1989, leg. T. Suzuki and M. Masuda (056303-4); Taneichi, 14 April 1952, leg. S. Kawashima (027019, 051835), 24 June 1989, leg. T. Suzuki and M. Masuda (056302); Tanesashi (Hachinohe), 24 June 1989, leg. T. Suzuki and M. Masuda (056344). Hokkaido: Osatsube, 26 July 1938, leg. Y. Yamada (023603); Usujiri, 1 August 1989, leg. T. Suzuki and M. Masuda (056339, 056340); Otoshibe, 25 June 1986, leg. K. Kogame (050392); Muroran, 1 June 1935, leg. Y. Nakamura

(023334); Higashishizunai, 26 May 1975, leg. T. Yoshida and M. Masuda (049497); Mitsuishi, 29 June 1984, leg. E. Kurosawa and T. Suzuki (056334), 4 July 1989, leg. T. Suzuki and M. Masuda (056343); Enrumu-misaki (Samani), 28 May 1975, leg. T. Yoshida and M. Masuda (049458), 24 July 1975, leg. T. Yoshida and M. Masuda (049374); Horoizumi, 4 July 1943, leg. Y. Nakamura (048899); Aburakoma, 27 May 1975, leg. T. Yoshida and M. Masuda (049535), 25 July 1975, leg. M. Kurogi and M. Masuda (049416); Syoya, 24 July 1975, leg. M. Ohta (047894); Oshirabetsu, 23 July 1975, leg. M. Ohta (047895), 18 August 1989, leg. M. Masuda (056337); Akkeshi, 25 June 1933, leg. Y. Yamada (024645); Nosappu-misaki, 25 August 1988, leg. M. Matsumoto (052642).

Tsugaru Straits

Aomori Pref.: Yunoshima, undated, leg. Y. Yamada (008107); Ooma, 16 May 1987, leg. T. Kitayama (052993, 053085). Hokkaido: Fukushima, 16 May 1988, leg. I. Mine (053973); Kikonai, 8 May 1989, leg. I. Mine (053974); Moheji (Kamiiso), 15 June 1984, leg. E. Kurosawa and Y. Saito (056331); Hakodate, undated, leg. T. Moritake (024528); Kamaya (Toi), April 1940, leg. Y. Yamada (023535).

Sea of Okhotsk

Hokkaido: Soya-misaki, 27 July 1980, leg. M. Kurogi (036873); Esashi, 6 August 1947, leg. M. Kurogi (025485); Saruru (Okkope), 28 July 1980, leg. M. Kurogi (036939, 036940); Abashiri, June 1934, leg. T. Muraoka (020035); Utoro, 16 August 1989, leg. M. Masuda (056335); Rusya, 16 September 1943, leg. Y. Yamada (024331).

Nemuro Straits

Hokkaido: Rausu, 17 August 1989, leg. M. Masuda (056336); Nemuro, 3 August 1929, leg. S. Akiyama (008113), 10 August 1987, leg. M. Matsumoto (052467, 052643), 29 June 1988, leg. M. Matsumoto (052644).

増田道夫*・阿部剛史*・齋藤 譲**：紅藻キタソゾとウラボソは同一種

北海道と東北太平洋沿岸の数ヶ所から報告されているキタソゾ (*Laurencia yendoi* Yamada) は、日本海沿岸を主要な分布域として広い範囲に生育しているウラボソ (*L. nipponica* Yamada) の異名である。原記載で存在しないとされていた半月状肥厚が、キタソゾの正基準標本の二次的主軸下部の髄層細胞に観察された。半月状肥厚の存在はウラボソと共通し、太い円柱状の主軸を持つ大きな直立体を生じること、不規則に放射状に分枝すること、小枝末端の皮層最外層細胞が突出しないことなどの他の特徴も両者が同一種であることを示している。種レベルでの特徴としての半月状肥厚の重要性について論じ、ウラボソの日本列島沿岸における地理的分布図を示した。(*060 札幌市北区北10条西8丁目 北海道大学理学部植物学教室；**041 函館市港町3丁目1-1 北海道大学水産学部水産植物学教室)

