Bull. Natl. Mus. Nat. Sci., Ser. B, 40(4), pp. 133–138, November 22, 2014

Morphology of *Aneurianna ogasawaraensis* sp. nov. (Rhodomelaceae, Rhodophyta), A New Marine Deep Sublittoral Red Alga from the Ogasawara Islands, Japan

Taiju Kitayama

Department of Botany, National Museum of Nature and Science,
Amakubo 4–1–1, Tsukuba, Ibaraki 305–0005, Japan
E-mail: kitayama@kahaku.go.jp

(Received 14 August 2014; accepted 24 September 2014)

Abstract A new red alga, *Aneurianna ogasawaraensis* sp. nov. (Rhodomelaceae, Ceramiales, Rhodophyta) was collected from the deep sublittoral water (73–97 m in depth) off Hahajima Island and Chichi-jima Island, Ogasawara Islands, Japan. This genus was established by Phillips (in 2006) separating from *Lenormandia* (including *Lenormandiopsis*) mainly because of the presence of endogenous branching and elliptic blade-surface pattern ("elliptical areolation"). This new species from Ogasawara Islands belongs to *Aneurianna* in having "elliptical areolation" and is distinguishable from the other known species of the genus in having occasionally branching stipes, elliptical blades rounded at the base, dentate margins, and conspicuous midribs.

Key words: *Aneurianna ogasawaraensis*, morphology, Ogasawara Islands, red algae, Rhodophyta.

Introduction

The red marine algal genus *Aneurianna* Phillips is a member of the tribe Amansieae (Rhodomelaceae, Ceramiales, Rhodophyta), in which only *Aneurianna* and *Lenormandia* Sonder have foliar blades. According to the original description of the genus (Phillips, 2006), *Aneurianna* differs from *Lenormandia* in having endogenous branching and elliptic surface pattern with various irregularly ordered ellipses on the blade (so-called "elliptical areolation") and incurved or inflexed apices, in contrast to absence of endogenous branching, rhombic surface pattern with regularly arranged rhombi ("rhombic areolation") and flat apices of *Lenormandia*. *Aneurianna* includes three species: *Aneurianna lorentzii* (Weber-van Bosse) L.E.Phillips (type species), *A. nozawae* (R.E.Norris) L.E.Phillips and *A. dentata* L.E.Phillips. In particular, the Phillips' new species, *A. dentata*, is unique and different from the other two speices in having elliptical blades with dentate margins.

Though *A. lorentzii* has a broad distribution to the Indo-Pacific Ocean including India, Japan, Philippines, Indonesia, East Timor, Northern Australia and New South Wales, distributions of *A. nozawae* and *A. dentata* are restricted to small areas of South Africa and Western Australia respectively (Guiry and Guiry, 2014). In Japan only *A. lorentzii* was recorded from several islands belonging to Satsunan Islands, Kagoshima Prefecture, Southern Japan: "*Aneuria lorenzii*", by Okamura (1929) and Nozawa (1965); "*Lenormandiopsis lorenzii*", by Yoshida (1998); "*Aneuianna lorenzii*", by Yoshida and Yoshinaga (2010). In Japan, since Okamura (1929), the specific epithet has been spelled as "*lorenzii*", though "*lorentzii*" is correct because in the original description Weber-van Bosse (1911: 31) spelled "*Aneuria Lorentzi* n. sp." as a dedica-

tion to the Dutch explorer, Dr. Hendrikus A. Lorentz, who collected the type specimens of the species in Thursday Island, Torres Strait, Northern Australia in 18 June 1907.

Since 2010, as part of a review of geographical change in the Japanese marine benthic algal flora, the author has investigated deep sublittoral algal habitats around the Ogasawara Islands (= Bonin Islands), where notably rare brown algae, *Discosporangium mesarthrocarpum* (Meneghini) Hauck (Kitayama, 2012) and *Zosterocarpus ogasawaraensis* Kitayama (Kitayama, 2013) have also been collected so far. During the investigations in the Ogasawara Islands, a red algal material referable to *Aneurianna*, which was unable to be identified with any known species, was collected twice. In this study, to confirm the identity of a deep sublittoral red algal species collected from off the coasts of both Hahajima Island and Chichijima Island, in the Ogasawara Islands, the author make anatomical observations on the alga using a microscope.

Materials and Methods

The red algal material referable to the genus *Aneurianna* was collected from the deep sublittoral zone (73–97 m in depth) off Hahajima Island and Chichijima Island in the Ogasawara Islands by dredge using the research vessel, the *Koyo* (87 tonnage), operated by the Ogasawara Fisheries Center, Tokyo Metropolitan in 2010 and 2013. For preservation, the material was dried on sheets of paper or fixed in 10% Formalin-seawater. Anatomical observations were made on the material using a microscope. Voucher specimens were deposited in the algal herbarium of the National Museum of Nature and Science (TNS). In this paper I basically follow the terminology used by Phillips (2006).

Results

Order Ceramiales Oltmanns, 1904

Family Rhodomelaceae Areschoug, 1847

Tribe Amansieae Schmitz, 1889

Aneurianna ogasawaraensis Kitayama, sp. nov. [Figs. 1–11]

Description: Thalli with erect thalli, up to 10 cm in height, stipitate, attached to solid substratum by a discoid holdfast, pink to red in colour. Stipes short, terete, occasionally branched. Blades flattened, orbicular to elliptical, dorsiventral, up to 3.5 cm in width, rounded at the base, with single midribs; apices loosely incurved; margines dentate with triangular spines; surface pattern irregular elliptic. Medullae composed of irregularly ordered cells under a single-layered cortex; a central-axial cell with five pericentral cells and a few pseudopericentral cells present. Reproductive organs unknown.

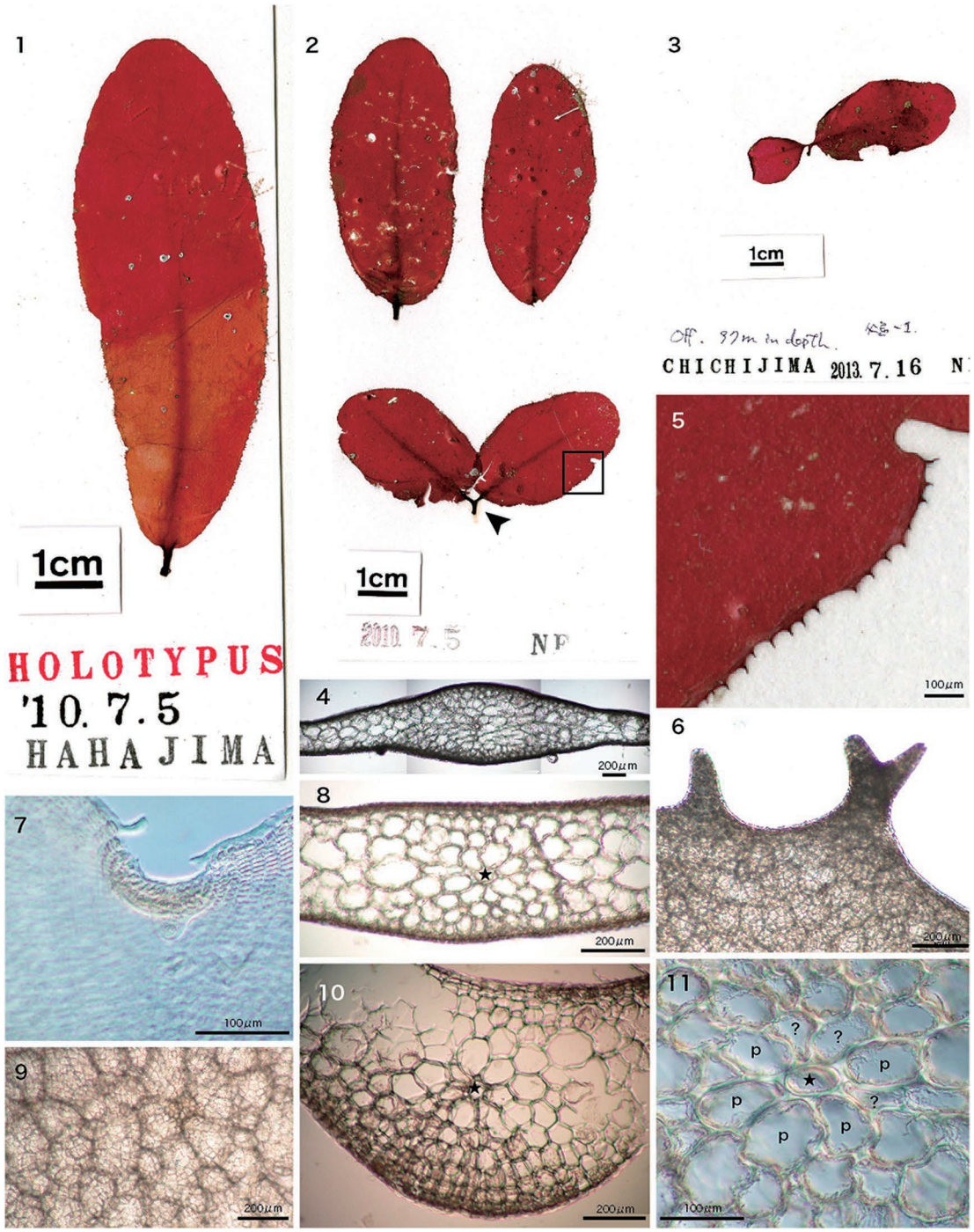
Holotype: TNS-AL 188560 (Fig. 1) deposited in TNS (National Museum of Nature and Science, Tsukuba, Japan).

Type locality: Off Hahajima Island, Ogasawara Islands, Japan (26°44′08–15″N, 142°06′00–

Figs. 1–11. *Aneurianna ogasawaraensis* Kitayama. 1. Holotype. Thallus from Hahajima Island, Ogasawara Islands, Japan (a dried specimen, TNS-AL 188560). 2. Isotypes including a ramified thallus (arrowhead) from Hahajima Island, Ogasawara Islands, Japan (a dried specimen, TNS-AL 188561). 3. A thallus having a branched stipe from Chichijima Island, Ogasawara Islands, Japan (a dried specimen, TNS-AL 188564). 4. Transverse section of midrib in the lower portion of blade. 5. Margin of the blade of the lower thallus showing marginal dentations. This is an enlargement of the square frame in Fig. 2. 6. Detail of marginal dentations showing a triangular spine and a divided spine. 7. Apical portion of blade with loosely incurved apex. 8. Transverse section of upper portion of blade showing a central-axial cell (star). 9. Surface view of blade showing "elliptical areolation," cell pattern with irregularly ordered various elliptical pattern visible through a layer of small cortical cells. 10. Transverse section of basal portion of blade showing a central-axial cell (star). This cross-section is slightly "V"-shaped in outline. 11. Transverse section of middle portion of blade showing a central-axial cell (star), five pericentral cells (p) and three pseudopericentral cells (?).

21″E; 73–81 m in depth).

Specimens examined: Off Hahajima Island, Ogasawara Islands, Japan (26°44′08–15″N, 142°06′00–21″E; 73–81 m in depth), 5 July 2010, leg. T. Kitayama (TNS-AL 188561–188563); Off Chichijima Island, Ogasawara Islands, Japan (27°05′27″–04′68″N, 142°08′50″–08′37″E; 90–97 m in depth), 16 July 2013, leg. T. Kitayama



(TNS-AL 188564).

Etymology: The species epithet 'ogasawaraensis' is from the Japanese name of the Islands (= Bonin Islands).

Japanese name: Sujiari-gusa.

Habitat: Growing on rocky substrata.

Vegetative morphology: Thalli are erect, up to 9.8 cm in height, stipitate, epilithic, attached to stones (Figs. 1, 2). Holdfasts are discoid. Stipes are short, cylindrical, occasionally branched (Fig. 2: arrowhead, Fig. 3). Blades are flattened, orbicular (when young) to elliptical, up to 3.5 cm in width, rounded at the base, dark pink to red in colour (Figs. 1–3). Each blade has a midrib from the lower portion to the middle portion. Midribs are conspicuous, single on each blade, formed by thickening of meddulae in the central portion of the fronds (Fig. 4). Veins or microscopic lines are absent. Margins of the blades are dentate (Fig. 5). The marginal dentations are determinate, composed of many spines arranged at regular intervals. Spines are triangular, occasionally divided (Fig. 6). Apical portions of the blades are caved in the center and the apices are incurved loosely (Fig. 7). The blades are composed of red single-layered cortices with small cells and colorless medullae with irregular-sized cell layers (Fig. 8). The surface pattern is "elliptical areolation". Various irregularly ordered ellipses are visible through a layer of small cortical cells (Fig. 9). The blades are dorsiventral and slightly "V"-shaped in transverse view in the lowermost portions (Fig. 10). Medullae possess a central-axial cell (star), five pericentral cells (p) and a few pseudopericentral cells (?) (Fig. 11).

Reproductive morphology: Unknown.

The specific characters distinguishing *Aneurianna ogasawaraensis* from other members of the genus are shown in Table 1. *A. ogasawaraensis* agrees well with *A. dentata*, except for shape of basal portion of blades, presence of midribs, and ramification of stipes.

Discussion

The new red alga from the Ogasawara Islands, *Aneurianna ogasawaraensis*, possess most of the main characteristics of the genus *Aneurianna* defined by Phillips (2006): broadly foliar blades;

Table 1. Comparisons of habit and morphology among *Aneurianna ogasawaraensis* and the other species of the genus in the world

	A. ogasawaraensis (Present study)	*A. dentata* (Phillips, 2006)	*A. lorentzii* (Phillips, 2006; Weber-van Bosse, 1911)	*A. nozawae* (Phillips, 2006; Norris, 1987a, b)
Height of thalli	up to 10 cm	up to 30 cm	up to 30 cm	up to 38 cm
Blades				
Whole shape	orbicular to elliptical	ovate to elliptical	irregular	various
Width	up to 3.5 cm	up to 8 cm	—	up to 12 cm
Apices	incurved	incurved	flat or inflexed	incurved
Base	round	acute*	round*	acute*
Margins	dentate	dentate	entire or lobed	crenate
Midribs	distinct (macroscopic)	absent	faint (microscopic)	absent (or short)
Endgenous branching	absent	absent	present	present
Stipes	occasionally branched	unbranched	occasionally branched	sometimes branched
Depth of habitat	73–97 m	2–12 m	1–50 m	45–60 m
Distribution	North Pacific (Ogasawara Isls.)	Indian Ocean (S. Australia)	Indo-Pacific (S. India, Japan, Philippines, Indonesia, East Timor, N. Australia, New South Wales)	Indian Ocean (Natal)

* Judging from Figs. 4, 6, 7, 19, 21, 31–33 in Phillips (2006).

discoid to hapteral holdfast, central axes encircled by five pericentral cells and 1–4 pseudopericentral cells; apices incurved or inflexed or flat; two interdigitating layers derived from dorsal lateral pericentral cells; cortex single-layered; blade surfaces marked by irregularly ordered elliptical pattern ("elliptic areolation"). In microscopic morphology, the present species is basically not so different from all other species of *Aneurianna*. However, Phillips (2006) mentioned another two essential generic features: endogenous branching and lacking of midribs. The present species has no endogenous branching and possesses conspicuous midribs.

Endogenous branching observed in the tribe Amansieae is inner ramification of central axes running under the cortical layers in the blade. On the basis of the presence of endogenous branching in her new species, "*Aneuria lorentzii*," Weber-van Bosse (1911) raised J. Agardh (1982)'s subgenus "*Aneuria*" to a new genus separating from *Lenormandia*, though J. Agardh's "*Aneuria*" included only *Lenormandia latifolia* Harvey et Greville in Harvey (1847). Papenfuss (1967) established *Lenormandiopsis* as a subsutitution for "*Aneuria*" because it was a later homonym of the liverwort genus *Aneura* Dumortier. *Aneurianna* defined by Phillips, who synonymized *Lenormandiopsis* Papenfuss with *Lenormandia* Sonder, is almost equivalent to "*Aneuria*" (J.Agardh) Weber-van Bosse (Phillips, 2006, p. 214). *Lenormandia latifolia* has no endogenous branching, and thus endogenous branching is regarded as the most essential generic character for *Aneurianna*. However, *Aneurianna ogasawaraensis* and *A. dentata* have no endogenous branching in their blades. Both species keep fine elliptical blades without dividing all through the growth, while *A. lorentzii* and *A. nozawae* formed irregular or various blades with many lobes and branches. It suggests that absence of endogenous branching maintains a simple elliptical outline of blades in *A. ogasawaraensis* and *A. dentata*.

Midribs are macroscopic structures of thickening medulla and distinguishable from microscopic veins, which are composed of several filaments of central axes. *Aneurianna ogasawaraensis* differs from the other three species of the genus in having a clear macroscopic midrib on each blade. In fact, *A. lorentzii* has also faint midribs or midlines (Phillips, 2006, p. 222), though the structures are microscopic and may be axial filaments inside the blade tissue. On the other hand, midribs in *A. ogasawaraensis* are macroscopic structures formed by thickening of central areas of the blade, which is caused by cell divisions of medullary layers in the central portion of blades. In addition, according to Norris (1987b, p. 88), *A. nozawae* has "a short midrib sometimes evident adjacent to stipe" on the blade, but there is no detail of the structures.

Although the significance of absence of endogenous branching and presence of midribs in the present species is still unknown, the four species of *Aneurianna* at the present state are unified only on basis of the "surface areolation of irregularly sized ellipses" as Phillips (2002) made a key to this taxon (as *Lenormandiopsis* pro parte). "Areolation" means blade–surface pattern when viewed under a microscope: "rhombic areolation" is used for the generic features of *Lenormandia*, which has surface pattern with orderly lined rhombi on the blades. In particular, for separating the two genera, *Aneurianna* and *Lenormandia*, "areolation" seems to be useful rather than absence/presence of endogenous branching and midribs.

To clarify the relationship among the *Aneurianna ogasawaraensis* and other species of the genus *Aneurianna* and to redefine its generic circumscription, observations of reproductive organs and molecular analyses on the new materials from Ogasawara Islands are required.

Key to the species of *Aneurianna*

1a. Blades irregularly shaped; margins of blades entire, lobed or crenate; lacking spines; endogenous branching present 2

1b. Blades elliptical; margins of blades dentate, bearing triangular spines; endogenous branching absent 3
2a. Margins of blades entire, lobed . . . . . *A. lorentzii*
2b. Margins of blades crenate . . . . . *A. nozawae*
3a. Blades acute at the base, lacking midribs; branching of stipes absent . . . . . *A. dentata*
3b. Blades round at the base, with midribs; branching of stipes present . . . . . *A. ogasawaraensis*

Acknowledgments

I am grateful to Mr. Yuji Aoki, director of the Ogasawara Fisheries Center, Tokyo Metropolitan, and the crew of the research vessel, *Koyo*, for providing me the facilities to process the specimens. I thank Drs. Hiroshi Namikawa, Hironori Komatsu, Toshihiko Fujita, and Kazunori Hasegawa, Department of Zoology, National Museum of Nature and Science, for their kind help in the field study in the island. I also thank Dr. Masahiro Suzuki, Department of Biological Sciences, Graduate School of Science, University of Tokyo, for his helpful comments for this study, and Mr. Alex Barnes, North Carolina, U.S.A., for correcting the English of the manuscript. This study was undertaken as a part of the surveys of the flora of Izu and Ogasawara Archipelagoes, Japan during 2006–2010, entitled "Study on Environmental Changes in the Sagami Sea and Adjacent Area with Time Serial Comparison of Fauna and Flora." A part of this study was supported by Grants-in-Aid for Scientific Research (no. 25440225) from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

References

Agardh, J. G. 1892. Anatecta Algologica. Asta Universitets lundensis 28: 1–182.

Guiry, M. D. and Guiry, G. M. 2014. AlgaeBase. Worldwide electronic publication, National University of Ireland, Galway. http://www.algaebase.org; searched on 8 August 2014.

Harvey, W. H. 1847. Nereis Australis. 64 pp., 26 pls. Reeve Brothers, London.

Kitayama, T. 2012. First record of *Discosporangium mesarthrocarpum* (Meneghini) Hauck (Phaeophyceae, Ochrophyta) from the Ogasawara Islands, Japan. Bulletin of the National Museum of Nature and Science, Series B 38: 147–152.

Kitayama, T. 2013. Morphology of *Zosterocarpus ogasawaraensis* sp. nov. (Phaeophyceae, Ochrophyta), a new marine deep-water brown alga from the Ogasawara Islands, Japan. Bulletin of the National Museum of Nature and Science, Series B 39: 159–164.

Norris, R. E. 1987a. *Lenormandiopsis* (Rhodomelaceae), newly recorded from Africa, with a description of *L. nozawae* sp. nov. and comparison with other species. Japanese Journal of Phycology 35: 81–90.

Norris, R. E. 1987b. Structure and reproduction in *Lenormandiopsis nozawae* (Rhodomelaceae, Rhodophyta). Cryptogamie, Algologie 8: 211–221.

Nozawa, R. E. 1965. On the female organ of "Sujinashigusa", *Aneuria lorenzii* Weber van Bosse from Japan. Bulletin of the Japanese Society of Phycology 8: 76–80 (in Japanese).

Okamura, K. 1929. Icones of Japanese Algae 6: 4–5, pl. 253.

Papenfuss, G. F. 1967. Notes on algal nomenclature–V. Various Chlorophyceae and Rhodophyceae. Phykos 5: 95–105.

Phillips, L. E. 2002. Taxonomy and molecular phylogeny of the red algal genus *Lenormandia* (Rhodomelaceae, Ceramiales). Journal of Phycology 38: 184–208.

Phillips, L. E. 2006. A re-assessment of the species previously included in *Lenormandiopsis* including the description of *Aneurianna* gen. nov. (Rhodomelaceae, Ceramiales). Cryptogamie, Algologie 27: 213–232.

Weber-van Bosse, A. 1911. Notice sur quelques genres nouveaux d'algues de l'Archipel Malaisien. Annales du Jardin Botanique de Buitenzorg 24: 25–33.

Yoshida, T. 1998. Marine Algae of Japan [Shin Nihon Kaiso-shi; Nihon-san Kaiso-rui Soran]. 25 + 1222 pp. Uchida Rokakuho, Tokyo (in Japanese).

Yoshida, T. and Yoshinaga, K. 2010. Checklist of marine algae of Japan (revised in 2010). Japanese Journal of Phycology 58: 69–122 (in Japanese).