First Record of *Yoshizakia indopacifica* S.-M.Lin, J.Huisman et C.Payri (Liagoraceae, Rhodophyta) from Japan

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**Abstract** A benthic marine red alga, *Yoshizakia indopacifica* S.-M.Lin, J.Huisman et C.Payri (Liagoraceae, Nemaliales, Rhodophyta) was found from the late Dr. Makoto Yoshizaki (1943–2011)'s Japanese algal collection. Although the generic name was derived from him, this is the first record of this alga from Japan. This alga is similar to young stage of *Liagora japonica* Yamada in appearance, but *Y. indopacifica* is different from *L. japonica* and the liagoracean species with similar external morphology in having a combination of the following features: dioecious thalli, fine branches with regular diameter throughout (0.2–1.2 mm), dense ramification in their terminal, spermatangial formed in clusters at the distal ends of fertile assimilatory filaments, cells of carpogonial branches unfused after fertilization, involucral filaments not intermingled with gonimoblasts, diffuse gonimoblast filaments.

**Key words**: Japan, Liagoraceae, red alga, Yonaguni Island, *Yoshizakia indopacifica*.

Marine algal flora of Japan contains many species of the red algal family Liagoraceae, in which many calcified species are difficult to be identified just based on branching patterns. Before the year 2000 in Japan, only a monographic study on the taxonomy of the family was published (Yamada, 1938), and only two genera and fifteen species were recognized in this family: *Helminthocladia* (3 spp.), *Liagora* (12 spp.) (Yoshida et al., 1995). In the last two decades, however, recent progress of molecular analyses and microscopic anatomy in the red algae has changed dramatically not only the taxonomic lists of this family, but also the marine algal inventory list of Japan. In particular, the largest liagoracean genus *Liagora* J.V.Lamouroux was suggested to be polyphyletic (Huisman, 2002) and was segregated repeatedly into smaller genera (Lin et al., 2011; Lin et al., 2013). As a result, to date at least thirteen genera and twenty-eight species of the Liagoraceae have been reported from Japan: *Akalaphycus* (2 spp.), *Dermonea* (3 spp.), *Dotyophysis* (1 sp.), *Ganonema* (3 spp.), *Helminthocladia* (2 spp.), *Hommersandiophycus* (1 sp.), *Izziella* (1 sp.), *Liagora* (9 spp.), *Patencarpaceus* (1 sp.), *Stenopeltis* (1 sp.), *Titanophycus* (1 sp.), *Trichogloea* (2 spp.), *Trichogloeopsis* (1 sp.) (Yoshida et al., 2015; Guiry and Guiry, 2016).

*Yoshizakia* S.-M.Lin, J.Huisman et C.Payri is a monotypic genus established recently on the basis of *Y. indopacifica* S.-M.Lin, J.Huisman et C.Payri, which is widely distributed in the western Pacific Ocean (Taiwan, New Caledonia) and the Indian Ocean (Western Australia) (Lin et al., 2013). The genus was named for a Japanese phyecologist, the late Dr. Makoto Yoshizaki (1943–2011), for his significant contributions to the taxonomy of Liagoraceae (Lin et al., 2013).
However, *Y. indopacifica* was not reported from Japan when it was first published to science.

After re-examining the collections of the Liagoraceae from Japan made by the late Dr. Yoshizaki, we found some dried specimens of *Y. indopacifica* in the herbarium of National Museum of Nature and Science (TNS). In this study, we report the occurrence of *Y. indopacifica* in anatomical morphology.

**Material and Methods**

The red algal specimens referable to *Yoshizakia indopacifica* were found in the algal herbarium of National Museum of Nature and Science (TNS) under the records of *"Liagora japonica"* collected from Hikawa, Yonaguni Isl., Okinawa Pref., Japan and dated on 10 Feb., 1989. The specimens were also prepared as duplicates of No. 200 of “Algae Maritae Japonicae Exsiccate, Fasc. VIII” (Kitayama, 2016), which were issued to 40 herbaria in 28 countries.

For anatomical observations, photomicrographs were taken on a microscope with a digital camera. Several young tips taken from thallus branches were examined and the fragments were sectioned by hand. As the young tips were only lightly calcified, so that they were not treated with any HCl solution as did in Lin *et al.* (2013). The sections were mounted in glycerin solution after staining with 1% aniline blue solution.

**Results**

Order Nemaliales Schmitz in Engler, 1892
Family Liagoraceae Kützing, 1843

*Yoshizakia indopacifica* S.-M.Lin, J.Huisman et C.Payri
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Type locality: Nan Wan, Pintung County, S. Taiwan [Holotype: NTOU-NW-2ii2010-75] (Lin *et al.*, 2013).

Vegetative morphology: Thalli are erect, up to 7 cm in height, pale gray, purple to reddish brown in color. Thalli are bushy, composed of several terete axes with 5–12 orders of irregularly dichotomous branches arising from a small discoidal holdfast (Fig. 1). Main axes are moderately to heavily calcified, while terminal branchlets are lightly calcified. The thalli are multiaxial, composed of assimilatory filaments with round to elongate, pigmented cells (Fig. 2) and colourless medullary filaments.

Reproductive morphology: Gametophytes are dioecious. Spermatangia (arrowheads) are produced from spermatangial parental cells (asterisks) in clusters on the distal ends of the assimilatory filaments (Figs. 2, 3). Spermatangia are spherical, 2–3 μm in diameter. Carposgonial branches (cb) are more or less curved, four- or five-celled, situated in the lower part of assimilatory filaments (Fig. 4). After presumed fertilization, gonimoblasts (g) are produced from the carpogonia, while involucral filaments (arrows) are cut off from the vegetative cells above and below supporting cells (sc) (Fig. 5). Carposporophytes are diffuse without interminglement of gonimoblasts and involucral filaments (arrows) (Fig. 6).


Japanese name: Yoshizaki-konahada (nom. nov.).

Distribution: *Indian Ocean*: Western Australia (Lin *et al.*, 2013); *Pacific Ocean*: New Caledonia, Taiwan (Lin *et al.*, 2013), Japan (Yonaguni Island, present study).

**Discussion**

When Lin *et al.* (2013) established the genus *Yoshizakia* on the basis of their molecular data and carposporophyte development, they showed that *Y. indopacifica* is distinct from the other members of Liagoraceae in having a combination of anatomical features: cells of carpogonial branched unfused after fertilization, spermatangial formed in clusters, involucral filaments not
intermingled with gonimoblasts and diffuse carposporophytes. This is the first record of this monotypic genus from Japan, as a result, the number of genera of Liagoraceae in Japan reaches fourteen.

Although the specimens of *Yoshizakia indopacifica* were collected from Japan for a long time, it was not identified by Japanese phycologists as the alga is morphologically similar to young thalli of *Liagora japonica*, which has been reported from Japan (Yoshida *et al.*, 2015), Korea (Lee and Kang, 1986) and Philippines (Silva *et al.*, 1987). Young plants of *L. japonica* have dense ramifications of narrow branches with more or less regular diameter, whereas the old plants have sparse ramification of broad branches (up to 3 mm) (Yamada, 1938, p. 17). However, *Y. indopacifica* is distinguishable in outward appearance from *L. japonica* in having dense ramification in the terminal and narrow
branches with regular diameter (0.2–1.2 mm) throughout all stages. In order to understand fully the distribution of *Y. indopacifica* and other species composition of the Liagoraceae in Japan, more fieldtrip investigations in Japan are needed.

Moreover, *Yoshizakia indopacifica* has a difficulty in anatomical observation because of their complexities and similarities between vegetative cells and reproductive cells. The cells cut off from the carpogonial branches after fertilization in the materials from Japan (Fig. 5, arrows) should be initials of the involucral filaments based on the observation of Lin et al. (2013, Figs. 6–10). In general, the cells of carpogonial branches do not produce any sterile or involucral cells in the Liagoraceae. In particular, it is difficult to distinguish the initials of involucral filaments from the vegetative cells if the cells are just stained with aniline blue. The cells in the pressed specimens often become very flat and cannot be seen well in terms of cell shape and size. Lin et al. (2012) suggested the hematoxylin staining technique is a good solution for distinguishing the reproductive cells from the ordinary vegetative cells by using freshly preserved liquid specimens. We will need to obtain new fresh material of *Y. indopacifica* from Japan for examining its reproductive structure at early postfertilization in details.

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