NOTE

A New Record of *Sargassum alternato-pinnatum* Yamada (Fucales, Phaeophyceae) from Taiwan

Hiromori Shimabukuro[1*], Masahiro Suzuki[2] and Masami Hamaguchi[1]

1. *National Research Institute of Fisheries and Environment of Inland Sea, Fisheries Research Agency, 2-17-5 Maruishi, Hatsukaichi City, Hiroshima Prefecture, 739-0452, Japan.*
2. *Department of Elementary Education, Tsuru University, 3-8-1 Tahara, Tsuru, Yamanashi Prefecture, 402-8555, Japan.*

* *Corresponding author. Tel: +81-829-55-3463; Fax: +81-829-54-1216; Email: bukuro@affrc.go.jp*

(Manuscript received 8 August 2010; accepted 13 June 2011)

ABSTRACT: This report describes *Sargassum alternato-pinnatum* Yamada as a newly recorded species in Taiwan. The specimens for this study were collected from a shallow tidepool in Lan-yu, Taiwan. This species is characterized by the following features: (1) small discoid holdfast, (2) terete primary branches, (3) sharp spines arising from surface of branches, (4) leaves that furcate 1–3 times, (5) spherical vesicles around the apex, (6) pseudozygocarpic receptacles with leaves or vesicle-like tissues, and (7) male and female conceptacles scattered within the receptacles. In this report, we also present a line drawing and photographs for the identification of *S. alternato-pinnatum*.

KEY WORDS: Lan-Yu, marine algae, new record, Sargassaceae, *Sargassum alternato-pinnatum.*

INTRODUCTION

Members of the genus *Sargassum*, the most species-rich genus of the macroalgae, are widely distributed throughout the world from the subarctic to the tropics. *Sargassum* species play a very important role in the marine ecosystem because seaweed beds composed of these organisms serve as nursery grounds, i.e., egg-laying sites and feeding grounds, for various fishes and shellfishes (Okuda, 2008). Therefore, these species need to be studied in order to better understand the coastal ecosystems.

Many species of genus *Sargassum* have been found in Taiwan because this country is located between the tropical and subtropical regions, at the very center of distribution of these species. Thirty-four species of the genus *Sargassum* have been recorded in Taiwan (Chou and Chiang, 1981; Lewis and Norris, 1987). Recently, Huang (2003) reported *Hizikia fusiformis* (Harvey) Okamura, currently designated as *Sargassum fusiforme* (Harvey) Setchell, as a newly recorded species from Taiwan.

Firstly, *Sargassum alternato-pinnatum* was described by Yamada (1942) based on the specimen collected from Aburatsu, Miyazaki Prefecture, Japan. According to the specimens housed in the herbarium at the Graduate School of Science, Hokkaido University, Japan, this species was distributed from Kii Peninsula to Amami Island in Southern Japan. There was no report that the growth of this species in the other site and adjacent waters. However we collected the *S. alternato-pinnatum*-like specimens (Fig. 1) from Lan-Yu Township, Taiwan. In this paper, we present detailed morphological and anatomical observations of this species.

MATERIALS AND METHODS

All specimens were collected from Crocodile Rock (22° 5' N, 121° 30' E), Lan-Yu Township, Taidong County, Taiwan (Fig. 1) at May 24, 2009 and preserved in 10% formalin/seawater. Voucher herbarium specimens for this species were deposited at the Department of Botany, National Museum of Nature and Science, Japan (*TNS-AL #*). Specimens from the herbarium at the Graduate School of Science, Hokkaido University, Japan (*SAP #*) and National Research Institute of Fisheries and Environment of Inland sea (*FEIS #*) were also used in this study for comparing morphological observations. The morphological features of all samples were observed both macroscopically and microscopically using a stereomicroscope (Olympus SZX7). Hand-sectioned receptacle specimens were observed under a biological microscope (Nikon Eclipse E600). All images were imported into Adobe® PhotoShop® CS for plate assembly.

RESULTS

Sargassum alternato-pinnatum Yamada 1942. Yamada, 1944; Yoshida, 1988; Ajisaka et al. 1994. Figs. 2 - 4

Synonym: *Sargassum asymmetricum* Yamada 1942

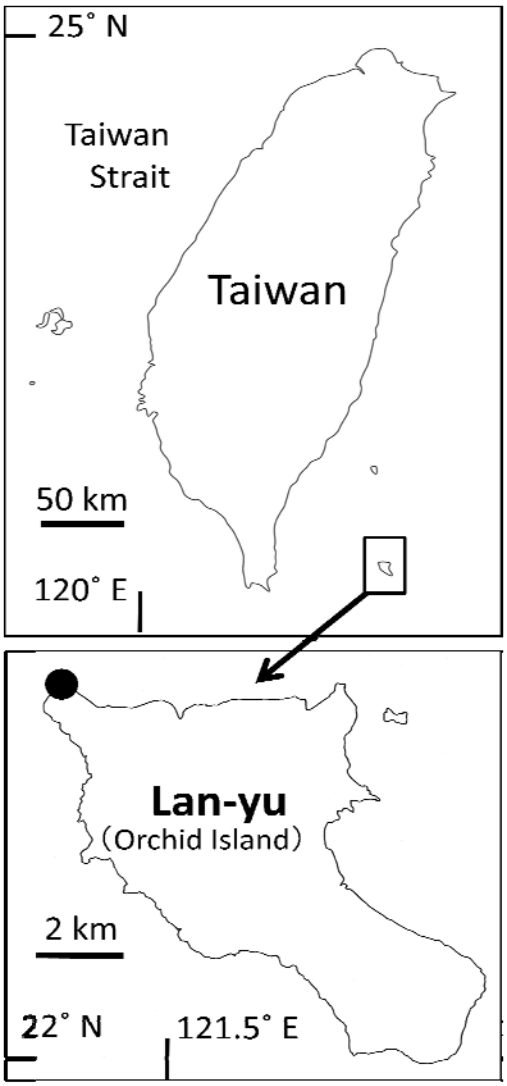


Fig. 1. Map of Lan-yu (Orchid Island), Taiwan. Black circle indicates the sample-collection site of this study.

Type locality: Aburatsu, Nichinan City, Miyazaki Prefecture, Japan.

Geographical distribution: Japan (Honshu, Shikoku, Kyushu, and Okinawa Islands) and Taiwan

Specimen examined: FROM TAIWAN: *TNS-AL 171366* (May 24, 2009) and *SAP 108391* (May 24, 2009) collected from Crocodile Rock (22° 5' N, 121° 30' E), Lan-Yu Township, Taidong County. FROM JAPAN: *SAP 23645* (Holotype, Fig. 2) (August 1940) collected from Aburatsu, Nichinan City, Miyazaki Prefecture; *SAP 60748* (May 20, 1954) collected from Usuki, Amami City, Kagoshima Prefecture; *SAP 94037* (June 12, 1980) collected from Natsui, Shibushi City, Kagoshima Prefecture. *FEIS 397 - 398* (June 6, 1980) collected from Seseguchi, Kagoshima City, Kagoshima Prefecture.

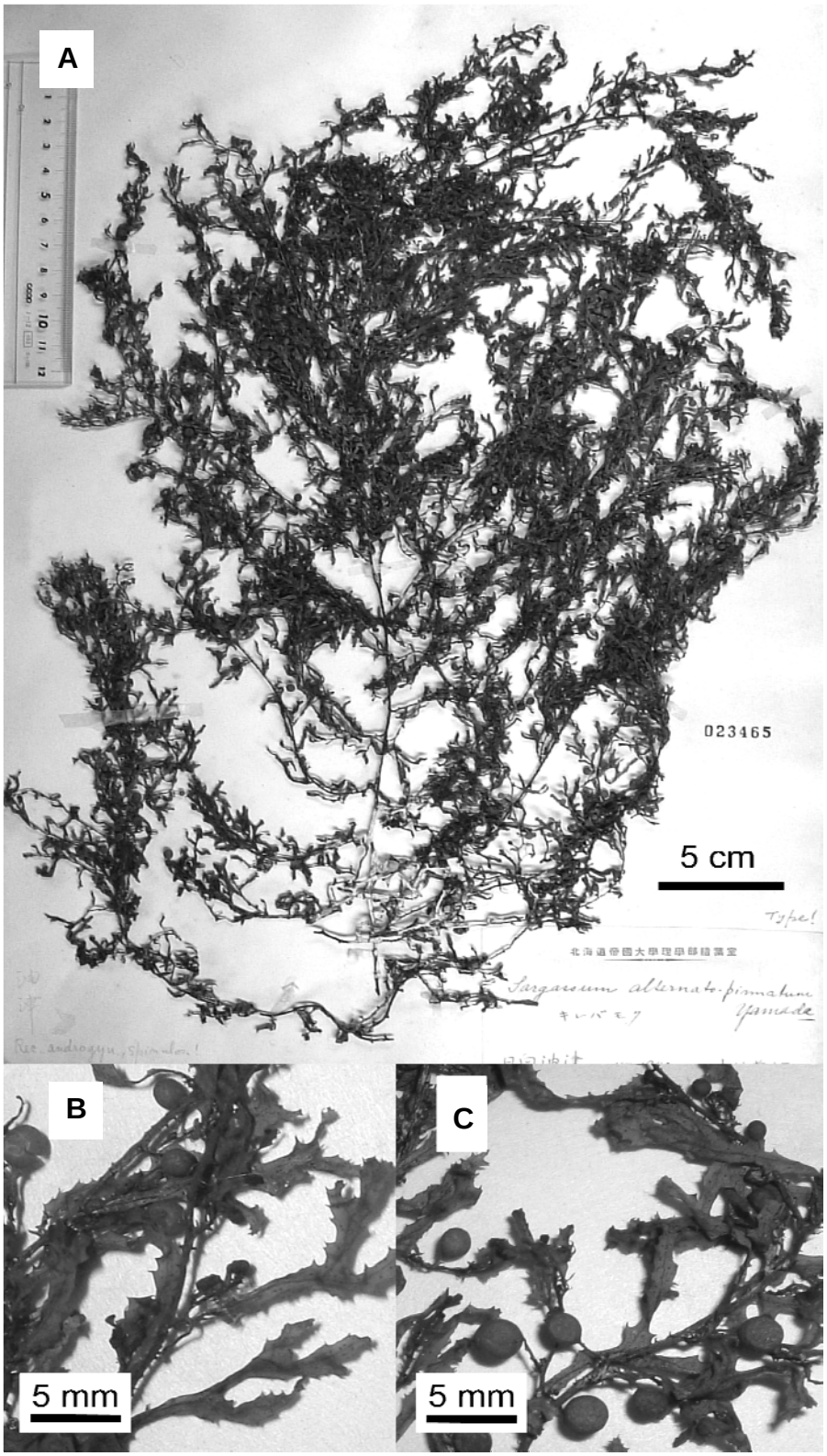
Thallus, 20 to 60 cm tall (Fig. 3A); small discoid holdfast, 5 – 12 mm diameter; stem, short and terete with a warty surface and arising from the center of the holdfast, 3 – 10 mm long, and 2 – 3 mm diameter. Leaves, linear to narrow lanceolate, 1 – 4 cm long and 5 mm wide, dentate and slightly wavy margin; acute apex; furcating 1 – 3 times, rarely non-furcating and simple; basal portion of leaves, asymmetrical to cuneate; midrib attached to the apex; cryptostomata scattered on the leaf surfaces (Fig. 3B); Vesicles, spherical, of 3 – 7 mm diameter, usually observed around the apex of the branches, rarely crowned; stalks with a similar diameter as that of the vesicles or less, and rarely spiny (Fig. 3C); cryptostomata scattered on the surface; medullary filaments not present within the vesicles (Fig. 3D). Primary branches arise spirally from the apical part of the stem; primary branches, terete, 2 – 3 mm diameter, usually with short and often bifurcating spines arising on the surface (Fig. 3E); Secondary branches, 3 – 20 cm long, with 1 – 2 mm diameter arising spirally from the primary branches at 2 – 15 cm intervals.

Plants are monoecious. Receptacles arise from the axil of the leaves on the branches, terete or slightly compressed, furcated 1 to several times, warty surface, 2 – 5 mm long, and 1 mm wide; the pseudozygocarpic receptacles had leaves or vesicle-like tissues (Fig. 3F). Male and female conceptacles were scattered within the receptacles and were 200 – 300 μm in diameter. Oogonia were 80 – 100 μm in diameter (Fig. 3G).

DISCUSSION

Sargassum alternato-pinnatum was first described by Yamada (1942), who found it in Miyazaki Prefecture, Japan. The species is characterized by the following features: (1) small discoid holdfast, (2) terete primary branches, (3) sharp spines arising from the surface of branches, (4) leaves furcating 1 – 3 times, (5) spherical vesicles around the apex, (6) pseudozygocarpic receptacles with leaves or vesicle-like tissues, and (7) male and female conceptacles scattered within the receptacles. We collected *S. alternato-pinnatum*-like specimens from tide pools at Crocodile Rock, located in the northern part of Lan-Yu Township, Taiwan. We identified these Taiwanese specimens as *S. alternato-pinnatum* by comparing the morphological characteristics of these specimens collected from Japan and the holotype specimen.

S. alternato-pinnatum is similar to *S. polycystum* in that both species have small lanceolate leaves and sharp spines on the surface of the branches. Huang (2006) also recorded *S. polycystum* from Crocodile Rock, the same region from where we collected *S. alternato-pinnatum* of this study. However, *S. alternato-pinnatum* has the following characteristics that are different from those of *S. polycystum*: furcated leaves and monoecious receptacles. In addition, *S. polycystum* has rhizoidal branches.



Figs. 2. Holotype specimen of *Sargassum alternato-pinnatum* Yamada. (*SAP 23465*, Aburatsu, Miyazaki Prefecture, Japan. August 1940). A: Thallus of the holotype specimen. B & C: A closer view of the leaves, vesicles, and branches of the holotype specimens.

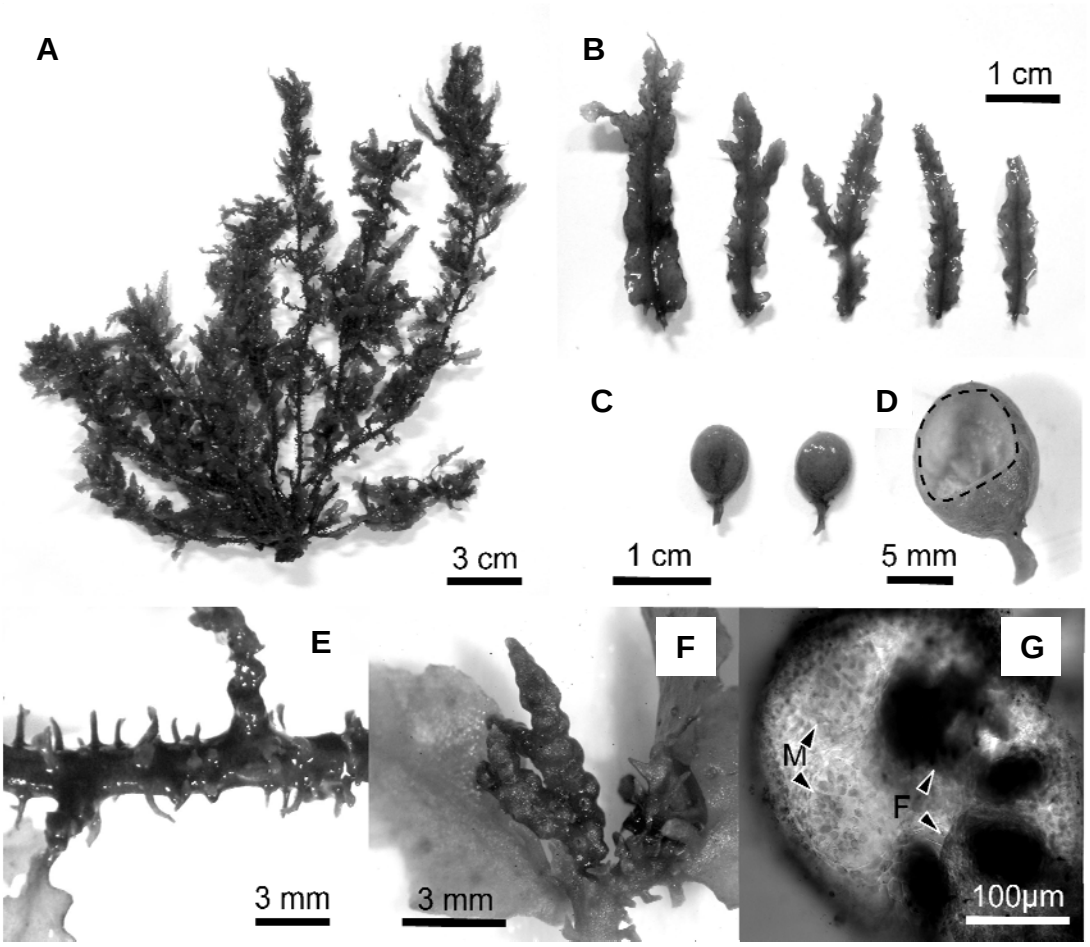


Fig. 3. *Sargassum alternato-pinnatum* Yamada, Lan-yu Township, Taidong County, Taiwan (May 21, 2009). A: Thallus. B: Leaves of various shapes. C: Vesicles around the apex. D: Cross section of the surface of a vesicle. Area enclosed by the dotted lines is the inner portion of the vesicle. E: Spiny branches. F: Androgynous receptacles. F: Transverse section of a receptacle. F **indicates female conceptacles.** M **indicates male conceptacle.**

Some quantitative traits of the morphological features (e.g., length of thallus and leaves) differed slightly between the Taiwanese *S. alternato-pinnatum* and the typical Japanese *S. alternato-pinnatum*. Phenotypic plasticity occurs in marine algae because of an interaction with the environment, and this interaction changes the genetic characteristics. A comparative genetic analysis of the Taiwanese and Japanese *S. alternato-pinnatum* will be performed in the near future (Uwai et al., 2009).

S. alternato-pinnatum is known to be distributed in the central regions of the Honshu, Shikoku, Kyushu, and Okinawa islands of Japan. However, in this study, this species was reported from Lan-Yu Township in Taiwan. At present, Lan-Yu is the southern limit of the distribution of *S. alternato-pinnatum*. The Kuroshio Current flows northward along the eastern coast of Taiwan and the Okinawa Island to the central region of Honshu in Japan. Lan-yu is located in the path of the Kuroshio Current. It appears that *S. alternato-pinnatum* is distributed along the Kuroshio Current.

In recent years, global environmental changes are causing a shift in the geographical distribution of all *Sargassum* species. We will continue to monitor seaweeds including those of the genus *Sargassum* on the border of the tropical and subtropical regions in Taiwan.

ACKNOWLEDGMENTS

We sincerely thank Prof. Tateo Horiguchi and Asso. Prof. Kazuhiro Kogame, Graduate School of Science, Hokkaido University, and Dr. Taijyu Kitayama, Department of Botany, National Museum of Nature and Science, for giving us the privilege to examine the specimens housed in the herbaria of their institutions. We also thank Dr. Sun Zhongmin, Kobe

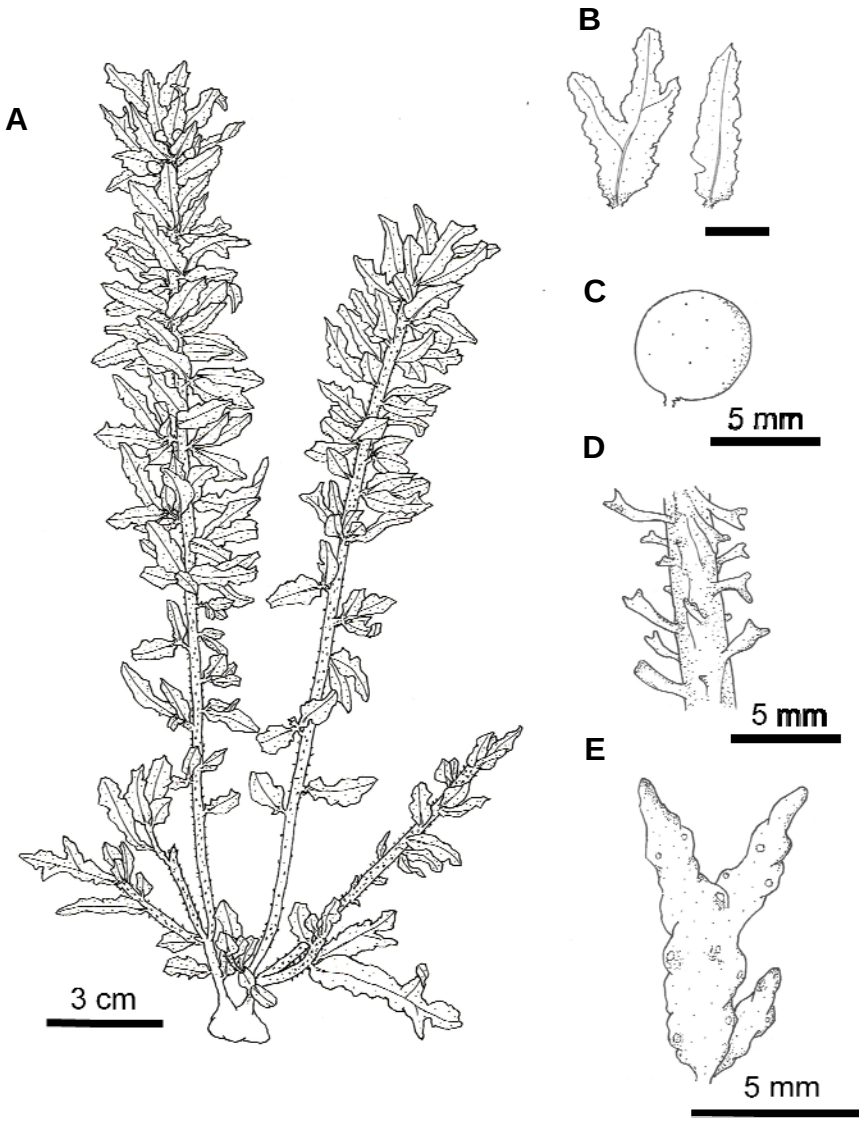


Fig. 4. Drawing of *Sargassum alternato-pinnatum* Yamada collected in this study. A: Thallus. B: Leaves. C: Vesicle. D: Spiny branches. E: Receptacle.

University Research Center for Inland Seas, for preparing the Chinese manuscript.

LITERATURE CITED

Ajisaka, T., T. Noro, G. C. Jr Trono, Y. M. Chiang and T. Yoshida. 1994. Several *Sargassum* species (subgenus *Sargassum*) in East Asia with furcately branching leaves. In: Abbot, I. A. (ed.) Taxonomy of Economic Seaweeds **4**: 9-22. University of California, California Sea Grant College System. U.S.A

Chou, H. N. and Y. M. Chiang. 1981. The *Sargassum* of Taiwan. Acta Oceanographica Taiwanica Science Reports of the National Taiwan University. **12**: 132-149.

Huang, S. F. 2003. *Hizikia fusiformis* (Harvey) Okamura: a new record for Taiwan (Heterokontophyta, Fucales, Sargassaceae). J. Natl. Taiwan Museum. **56**: 1-5.

Huang, S. F. 2006. Benthic marine algae of Lan-Yu (Orchid Island), Taiwan. J. Natl. Taiwan Museum. **59**: 19-50.

Lewis, J. E. and J. Norris 1987. A history and annotated account of the benthic marine algae of Taiwan. Smithson. Contrib. Mar. Sci. **29**: 1-38.

Okuda, K. 2008. Coastal environment and seaweed-bed ecology in Japan. Kuroshio Science. **2**: 15-20.

Uwai, S., K. Kogame, G. Yoshida, H. Kawai and T. Ajisaka 2009. Geographical genetic structure and phylogeography of the *Sargassum horneri*/*filicinum* complexin Japan, based on the mitochondrial *cox3* haplotype. Mar. Biol. **156**: 901-911.

Yamada, Y. 1942. Notes on *Sargassum* from the southern parts of Japan, III. J. Jap. Bot. **18**: 553-562.
Yamada, Y. 1944. Diagnoses of new *Sargassums* from Japan. Scientific Papers of the Institute of Algological Research, Faculty of Science, Hokkaido Imperial University. **3**: 1-10.
Yoshida, T. 1988. Japanese and Taiwanese species of *Sargassum* subgenus *Sargassum*. In: Abbots, I.A. (ed.). Taxonomy of Economic Seaweeds **2**: 5-21. University of California, California Sea Grant College System. U.S.A

臺灣產馬尾藻之新記錄種 *Sargassum alternato-pinnatum* Yamada

Hiromori Shimabukuro[(1*)], Masahio Suzuki[(2)] and Masami Hamaguchi[(1)]

1. *National Research Institute of Fisheries and Environment of Inland Sea, Fisheries Research Agency, 2-17-5 Maruishi, Hatsukaichi City, Hiroshima Prefecture, 739-0452, Japan.*
2. *The Department of Elementary Education, Tsuru University, 3-8-1 Tahara, Tsuru City, Yamanashi Prefecture, 402-8555, Japan.*

* 通信作者。*Tel: +81-829-55-3463; Fax: +81-829-54-1216; Email: bukuro@affrc.go.jp*

(收稿日期：2010 年 8 月 8 日；接受日期：2011 年 6 月 13 日)

摘要：本文對臺灣之新記錄馬尾藻 *Sargassum alternato-pinnatum* Yamada 進行闡述。標本採集於蘭嶼海岸淺潮池中。該種具有以下之特徵：一、小型盤狀固著器；二、主軸呈圓柱形；三、刺棘生於藻枝表面；四、藻葉一至三次分叉；五、氣囊為球形且尖端鈍圓；六、生殖托與藻葉或似氣囊結構同柄混生；七、雌雄生殖巢散生於同一生殖托。本文提供繪圖及相片作為鑑定該種之依據。

關鍵詞：蘭嶼、新記錄種、馬尾藻科、*Sargassum alternato-pinnatum*。