NOMENCLATURAL NOTES ON SOME PHILIPPINE SPECIES OF FRESHWATER RED ALGAE (RHODOPHYTA)

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INTRODUCTION

The study of Philippine freshwater algae has primarily focused on microscopic and planktonic forms such as those of Velasquez (1962), Pantastico (1977), Tamayo-Zafaralla (1998) among others, with little information known about macroscopic forms. Among the larger, benthic forms inhabiting freshwater habitats, seven species in five genera of red algae (Rhodophyta) have so far been documented from the Philippines. Two of these species belong to the Batrachospermaceae as currently circumscribed by Entwisle et al. (2009), with one species *Batrachospermum nonocense* Kumano et Liao originally described from the Philippines, with its type locality in Nonoc Island, Surigao del Norte province. Another freshwater red alga, *Nemalionopsis shawii* Skuja, also has a Philippine type locality (Lamao Reserve, Bataan province) and is the generitype species of *Nemalionopsis* Skuja currently placed within the Thoreaceae, which was recently accommodated into its new segregate order, the Thoreales by Müller et al. (2002).

The total number of Philippine freshwater red algae documented to date is low and is likely a product of several factors including poor collection efforts and lack of suitable habitats. Compared to Thailand which has a somewhat parallel history of freshwater red algal research as the Philippines, 26 species in 9 genera have so far been documented as a result of extensive surveys conducted in the western half as well as the southern extremities of the country (Peerapornpisal et al., 2006, Traichaiyaporn et al., 2008). Thailand which is sitting on a contiguous land mass may have more suitable freshwater habitats for red algae than what the archipelagic nature of the Philippines can provide. In Thailand, most of the freshwater red algae were collected from running river and stream waters with clean to moderate quality, and very seldom from polluted water bodies.

MORPHOLOGICAL AND MOLECULAR ANALYSES

Entwisle et al. (2009) performed detailed morphological and molecular analyses in an attempt to increase the monophyly of the Batrachospermaceae. The infrageneric classification of the large genus *Batrachospermum* Roth was re-examined resulting to emended circumscriptions and the recognition of at

least one new genus based on those revised infrageneric definitions. The elevation of *Batrachospermum* section *Contorta* Skuja into the new segregate genus *Kumanoa* Entwisle, Vis, Chiasson, Necchi et Sherwood has somewhat reduced the paraphyly within *Batrachospermum* thus contributing towards the natural taxonomy of the genus.

Members of *Batrachospermum* section *Contorta* formed a clade distinct from the other sections of the genus based on *rbc*L and small subunit (SSU) gene sequences analyzed by Entwisle et al. (2009). Furthermore, the emended morphological description provided by them contained a suite of distinctive female reproductive features that further supported segregation such as carpogonial branches that are curved, twisted or spirally coiled and the central position of the carposporophyte in the branch whorls. Furthermore, members of this group are commonly distributed throughout the tropics and subtropics, compared to the other existing subgeneric taxa within *Batrachospermum* (Necchi et al., 2010).

The Genera *Batrachospermum* and *Thorea* from the Philippines

I. Two Taxa of Genus *Batrachospermum* Roth

The two representatives of Philippine *Batrachospermum* thus far documented belong to section *Contorta* based on the morphological criteria defined for that group.

1) *Batrachospermum nonocense* Kumano et Liao (1987)

Batrachospermum nonocense Kumano et Liao was first described in 1987 from a nickel mine pit stream on what used to be a flourishing nickel mining site on Nonoc Island, situated off the northeastern coast of Mindanao. The distinctive spirally coiled carpogonial branch is present (Kumano and Liao, 1987, figs. 8-12) and so is the mature carposporophyte nestled centrally among the whorled branches (Xie at al., 2003, fig. 3.1). The most distinctive character, however, is the gonimoblast filament that is indistinguishable from the primary branchlets which is composed of 6-10 fusiform cells concatenated to form filaments as long as the primary branchlets. Chloroplasts are abundant in these filaments and primary branchlets suggesting a nutritive role for these tissues (Kumano and Liao, 1987, figs. 18, 19). Originally thought to be a Philippine endemic owing to its unique habitat in its type locality, this species has now been reported by Xie et al. (2003) from one site in China and by Peerapornpisal et al. (2006) in Thailand. Chinese specimens were collected from Shouning village in the northern edge of subtropical Fujian province (SE China) and were found in flowing streams. The mature carposporophytes were shown to be borne centrally within the branch whorls (Xie et al., 2003, fig. 3.1) while carpogonia are slightly distorted terminating in flattened or spathulate bodies (=trichogyne) towards their distal ends (Xie et al., 2003, fig. 3.2). Thai specimens, on the other hand, were collected from the tropical Krabi province in southern Thailand where they occurred in clean to moderate

stream water quality in the peat lands of Tha Tiaew (Peerapornpisal et al., 2006). Their Figure 2-9 showed moniliform branches arising verticillately without any obvious reproductive structures.

2) *Batrachospermum hirosei* Ratnasabapathy et Kumano (1982)

A second species of *Batrachospermum* in the Philippines, *B. hirosei* Ratnasabapathy et Kumano was reported by Liu et al. (2004, first author erroneously listed as Ratnabapathy) from the pristine waters of Palogtoc Falls in Sorsogon province.

This report constitutes an eastward extension of its distributional range from its type locality in Selangor, peninsular Malaysia and the first such record outside of the type locality. The distinctive spirally twisted carpogonial branches have been demonstrated clearly (Liu et al., 2004, figs. 2F, G, 3G) while the carpogonia are also distally inflated often appearing spatula-shaped (Liu et al., 2004, figs. 2G, 3F, G) with a basal constriction, as opposed to *B. nonocense* which is only indistinctly stalked or constricted at its base (Kumano and Liao, 1987, figs. 11-13).

Kumano (2000: 176-177) has employed this and other characters in distinguishing subsections within section *Contorta*, but Entwisle et al. (2009: 711) do not support such subsections citing weak molecular support.

Based on the foregoing cited molecular analysis and revised circumscriptions, these two Philippine species previously treated as *Batrachospermum* should be transferred into the new genus *Kumanoa* as recognized by Entwisle et al. (2009). Two new combinations have to be proposed as follows:

Kumanoa nonocensis (S. Kumano *et* L.M. Liao) L.M. Liao, **comb. nov.**

Basionym: *Batrachospermum nonocense* Kumano *et* Liao, Sorui, *Jpn. J. Phycol.* 35: 101, figs. 1-19 (1987).

Kumanoa hirosei (Ratnasabapathy *et* S. Kumano) L.M. Liao, **comb. nov.**

Basionym: *Batrachospermum hirosei* Ratnasabapathy *et* Kumano, Sorui, *Jpn. J. Phycol.* 30: 122, fig. 3 (1982).

II. Genus *Thorea* Bory de Saint-Vincent

Another member of the Philippine freshwater red algal flora has recently been reported and identified tentatively as Thorea violacea Bory de Saint Vincent by Liao and Young (2000). This species was first described based on materials from the Reunion Island in the Indian Ocean located about 600 km east of Madagascar. Species of this genus, like those of *Kumanoa*, are predominantly tropical to subtropical species (Traichaiyaporn et al., 2008) and fairly well represented in East and Southeast Asia. Peerapornpisal et. al. (2006) reported three unidentified species from Thailand, with one of them

(*Thorea* sp. 1 from Krabi province) recently described as a new species, *T. siamensis* Kumano et Traichaiyaporn ex Traichaiyaporn et al. (2008) based on type materials from Kanchanaburi province.

Sheath et al. (1993) synonymized six previously described species under *T. violacea* and emending the circumscription of the latter in order to better accommodate these six entities. However, the synonymy proposal has not received much acceptance among taxonomists, with all of them reinstated back as independently recognized taxa (Kumano, 2000; Guiry and Guiry, 2010).

T. violacea and *T. gaudichaudii* C. Agardh (type locality: Guam in the Mariana Islands) indeed exhibit some similar features although the taxonomic divide between them that is based on morphological characters is more pronounced.

Morphological features such as number of cells in spore-bearing branches, the nature of branching patterns, etc. have set the two taxa as independent species as suggested by Liao and Young (2000).

The materials from southwestern Cebu exhibited many morphological characters that put them closer to *T. gaudichaudii* such as their more proliferous branching patterns (Liao and Young, 2000, figs. 1A, 1B), and 2-celled spore-bearing branches as opposed to 1-celled spore-bearing branches in authentic *T. violacea* (Liao and Young, 2000, fig. 2D). Furthermore, *T. violacea* has only been recorded with certainty from two spring-fed streams in Texas (Sherwood and Sheath, 1999), a site along the Hudson River in New York (Müller et al., 2002), a habitat along the Rio Santa Catarina in Nuevo Leon, central Mexico (Sheath et al., 1993: 232) and a saline spring habitat in Spain, aside from its type locality (Egidos and Aboal, 2003).

A collection from Kikuchi River in Kumamoto, southern Japan identified as *T. violacea* by Sheath et al. (1993) has been confirmed to be a representative of *T. okadae* Yamada by Higa et al. (2007).

T. gaudichaudii has, on the other hand, been reported from various sites throughout the Ryukyu Islands, the tropical islands of southwestern Japan (Yamada, 1949), in subtropical water temperatures of 18-22°C as well as on Guam Island (type locality) and the Caroline Islands (Lobban et al., 1990) with stream water temperatures ranging from 25.2 to 28°C (Kumano, 2000: 291), comparable to the conditions found in the Philippine habitat.

A report of *T. violacea* from Fiji (authority erroneously indicated as (Thore) Desvaux by Sheath and Cole, 1996: 49, fig. 17) may prove to be a representative of *T. gaudichaudii* based on the multicellular spore-bearing branches illustrated therein.

On the basis of these morphological and phytogeographical considerations, the Philippine plants should therefore be treated as *T. gaudichaudii*.

ACKNOWLEDGMENTS

The author is most grateful to Professor Shu-Lian Xie (Shanxi University, Taiyuan, China), Dr. Thanitsara Inthasotti (Chiang Mai University, Thailand) and the staff at Hiroshima University Central Library for providing access to important taxonomic literature. The critical comments and suggestions of two anonymous reviewers helped improve the format and language.

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