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Communication

A freshwater red alga, *Thorea clavata* Seto et Ratnasabapathy, from Thailand with special reference to sexual reproductive organs

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Abstract: *Thorea clavata* is reported for the first time in Thailand. Prior to this discovery it was known only from the type locality in Malaysia. The Thai collection was from the sub-district of Huay Khayeng, Thong Pha-phum district, Kanchanaburi province, south-western Thailand. The thalli were fertile and the spermatangia, carpogonia and carposporangia are described and illustrated.

Keywords: freshwater red algae, *Thorea clavata*, algal sexual reproductive organs

INTRODUCTION

The Taxa of *Thorea* show worldwide distribution but tend to be more common in tropical and subtropical regions as well as warmer waters in temperate regions [1]. From the western Pacific region, *T. gaudichaudii* was first discovered on Guam in the Marianas Islands [2] and subsequently reported from Okinawa in Japan [3] and Gagil-Tamil in the Caroline Islands [4]. *T. okadae* was described from Sendai River, Kagoshima prefecture on the island of Kyusyu in Japan [3]. *T. hispida* (as *T. ramosissima*) was reported from China [3]. *T. clavata* was described from Sungai Gombak in Selangor State and *T. prowsei* from Pahang State in the Malaysian peninsula without any description of the sexual reproductive organs [5]. The taxonomy and distribution of the taxa of Thoreaceae in the Western Pacific region were reviewed by Seto [6]. These new species were included in a review of morphological and phylogenetic features by Kumano et al. [7], who

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recognised five distinct taxa in the Asia-Pacific region: *T. hispida, T.okadae, T. guadichaudii, T. clavata* and *T. siamensis*. The last taxon was described as a new species [8].

In this paper *T. clavata* is reported for the first time in Thailand with a description of sexual reproductive organs.

MATERIALS AND METHODS

Specimens Examined

(1) Specimen from Sungai Gombak, Selangor State, Malaysia, coll. Ratnasabapathy (Herbarium of National Science Museum, Tsubuka, Japan, TNS-AL-157043, isotype).

(2) Specimen from Huay Khayeng sub-district, Thong Pha-phum district, Kanchabnaburi province, Thailand, coll. Traichaiyaporn et al. 8,11 (Herbaium of Department of Biology, Faculty of Science, Chiang Mai University, CMU).

Methods

Pieces of the herbarium specimens were well moistened with distilled water and removed for examination in a similar manner to fresh specimens from the field. Photomicrographs of specimens were taken by means of an Olympus BU-2 microscope, an adapter Olympus U-PMTVC, a CAMEDIA C0304-ADL digital camera and a TV-monitor.

For each specimen, some taxonomic parameters previously used to distinguish infrageneric taxa were measured. Since some type specimens were preserved and often fragmented, the sizes of gametophytes measured did not show exact values. Vegetative structures, e.g. length of gametophyte, cell number, and size and shape of assimilatory filament, were measured. Characteristics of sexual reproductive organs, e.g. size of spermatangia, carpogonia with trichogyne and asexual one such as carposporangia, were determined.

Using data of such parameters, calculation of average standard deviations was made by an `Excel` 2003 for Windows.

TOPOGRAPHY AND ENVIRONMENTS IN THAILAND

Thorea clavata is a new record of a freshwater red alga in Thailand, which is the second locality known for this species. It was found in a stream flowing through a mixed deciduous forest at about 205 m above mean sea level (UTM 0453312, 1617355 (N,S)), in Huay Khayeng sub-district, Thong Pha-phum district, Kanchanaburi province (Figure 1). It attached itself to rocks (Figure 2A) in slow-flowing water. The stream was 2.50-3.50 m wide with medium to high light intensity. Physico-chemical water qualities recorded in November 2003 and January 2004 were as follows: colour crystal clear, depth 0.20-1.00 m, velocity 0.09-0.31 m sec^{-1}, temperature 23.7-24.9°C, pH 7.4-7.5, conductivity 344-347 µS cm^{-1}, hardness 66.3-152.7 mg L^{-1} as $CaCO_3$, nitrate-nitrogen < 0.001-1.200 mg L^{-1}, nitrite-nitrogen < 0.001-0.006 mg L^{-1}, orthophosphate phosphorus 0.09-0. 20 mg L^{-1}, and silica 9.1-9.2 mg L^{-1}.

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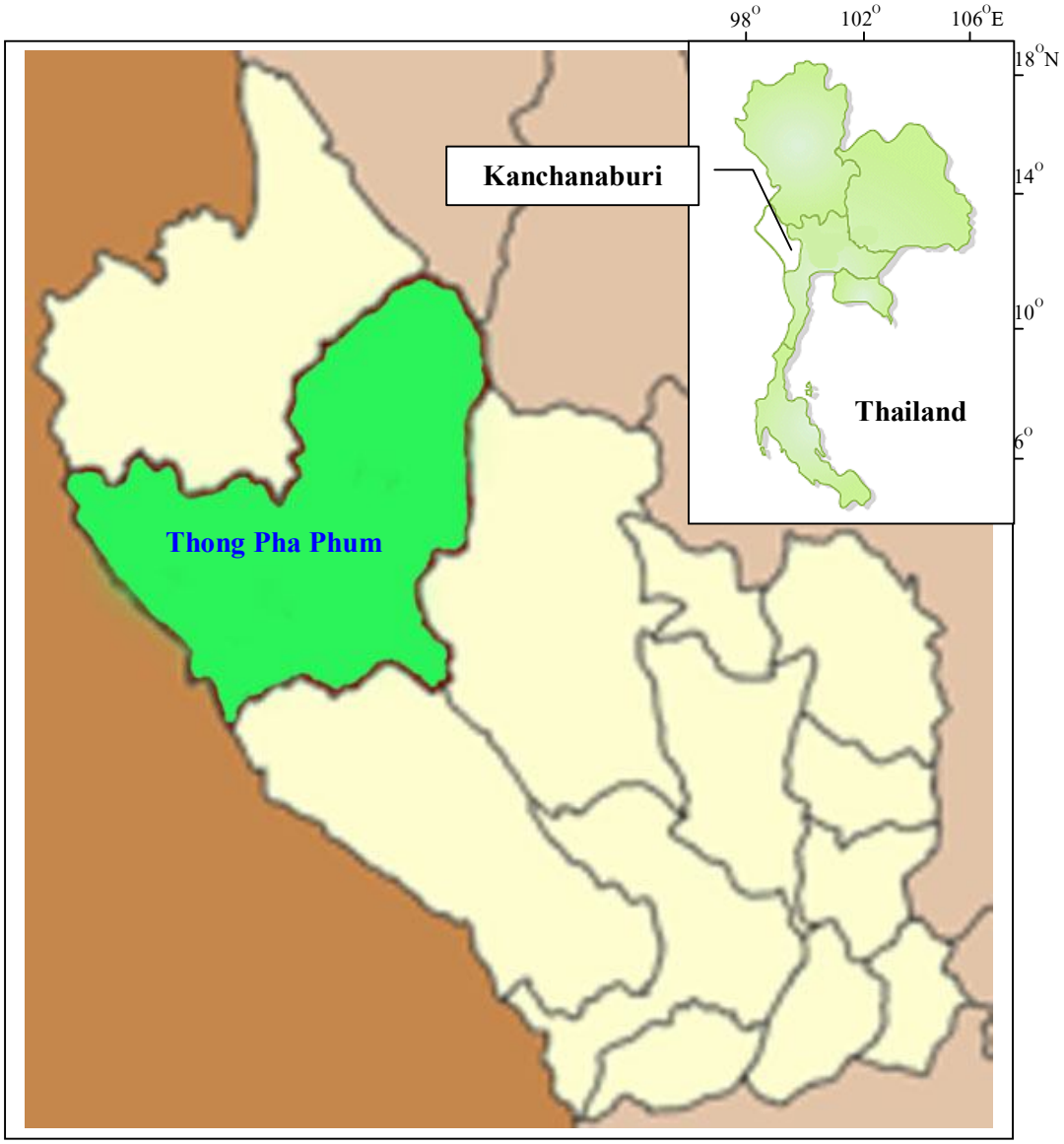

Figure 1. Map of Thailand showing the location of Thong Pha-phum district, Kanchanaburi province

DESCRIPTION OF THE THAI SPECIMEN

Thallus rather slender, tufted, highly mucilaginous, 500-600 µm in diameter, 4-12 cm in length, dark green, abundantly branched, multiaxial, consisting of medullar filaments and cortical assimilatory filaments, attached to substrata with discoid holdfasts. Medullar portion 200-400 µm in diameter (Figures 2B-2C). Assimilatory filaments 203 (170-310) µm in length, consisting of 12.5 (11-14) cells; apical cells clavate with rounded apices (Figure 2D). Distal portion of assimilatory filaments unbranched or sparsely branched, clavate, gradually tapered from apex toward proximal portion (Figure 3A).

Spermatangia terminal in small clusters on short assimilatory branches, elongated ovoid (with diameter/length ratio 1.79), 4.4 (4.3-5.7) µm in diameter and 7.8 (7.2-10) µm in length (Figures 3A-4A).

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Carpogonia elongated ovoid (with diameter/length ratio 1.9), 3.7 (2.9-4.3) µm in diameter at the base, 7.2 (7.2) µm in length, trichogyne straight or slightly curved, elongated club-shaped, 1.3 (0.7-4.3) µm in diameter and 95.8 (18-216) µm in length (Figure 4B).

Carposporangia solitary or in clusters terminated on gonimoblast filaments, elongated ovoid, (with diameter/length ratio 1.96), 7.7 (5.7-8.6) µm in diameter, 15.2 (12.9-17.2) µm in length (Figures 3B, 3C).

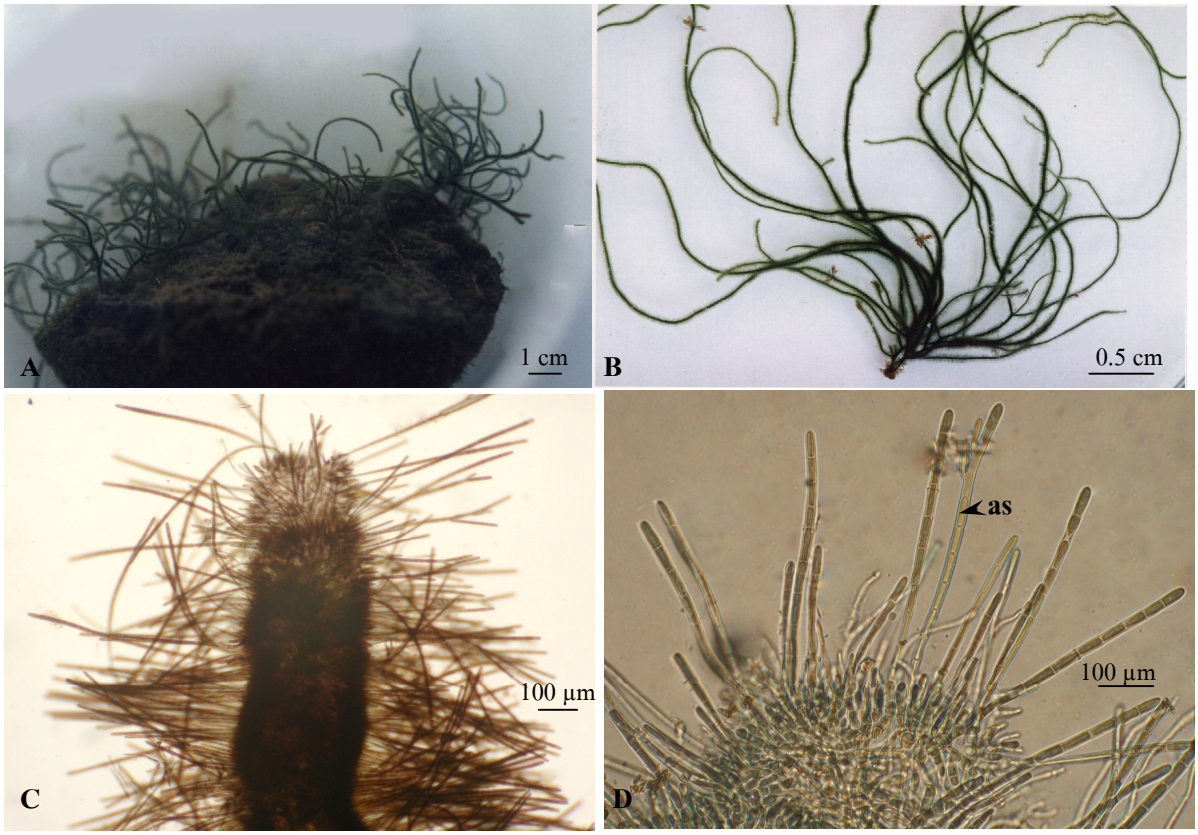

Figure 2. *Thorea clavata* Seto et Ratnasabapathy: (A) plant attaching on rock; (B) whole plant; (C) thallus; (D) assimilaroty filaments (as)

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Figure 3. *Thorea clavata* Seto et Ratnasabapathy: (A) assimilatory filaments (as) gradually tapered from apex towards proximal portion; (B) spermatangia (sm) and clusters of carposporangia (cr); (C) clusters of carposporangia (cr)

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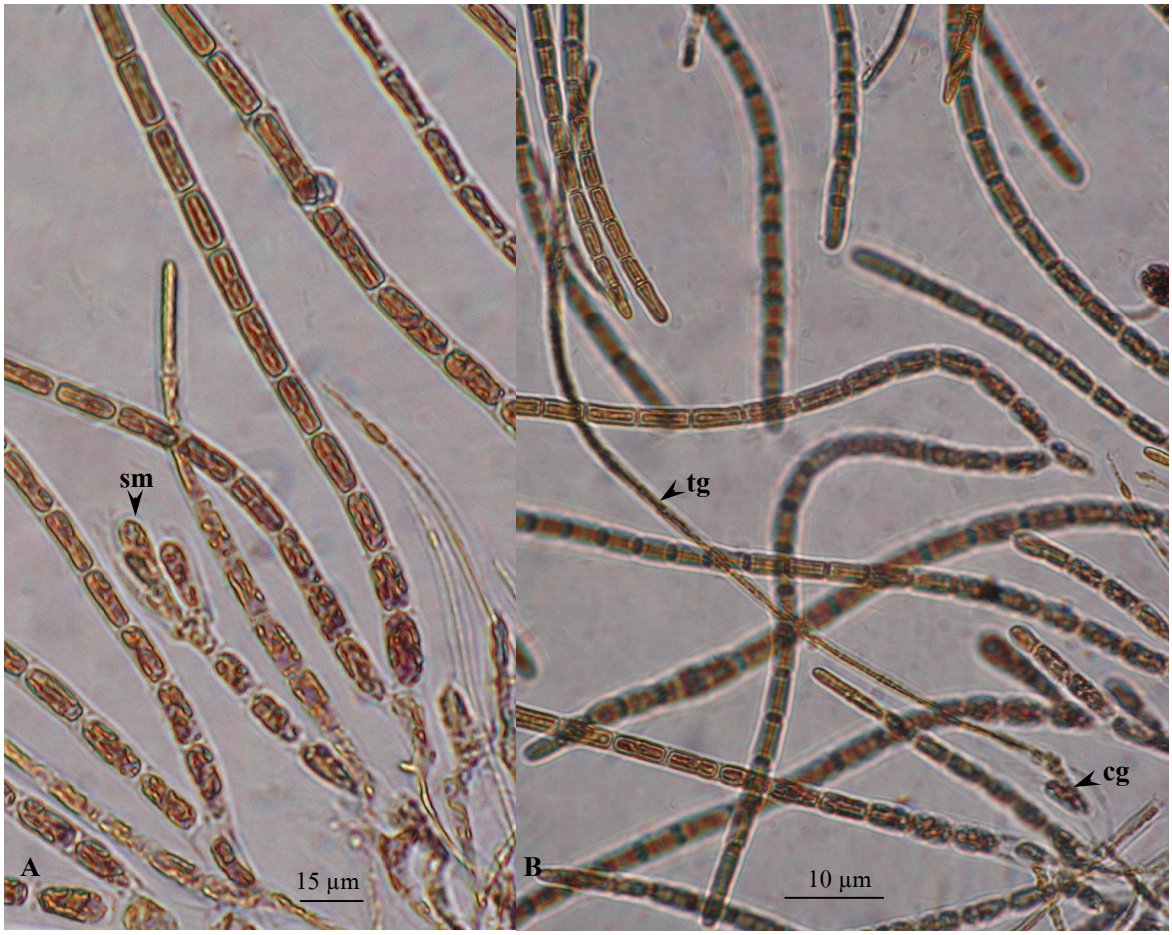

Figure 4. *Thorea clavata* Seto et Ratnasabapathy: (A) spermatangia (sm); (B) carpogonium (cg) with trichogyne (tg)

TAXONOMIC NOTE

The morphological and phylogenetic analyses of taxa of *Thorea* [7] are shown as follows.

Based on shape of assimilatory filaments, two groups of the taxa of genus *Thorea* may be distinguished: *Thorea clavata* with clavate assimilatory filaments and other taxa without clavate assimilatory filaments.

T. clavata was previously reported from Malaysia (type specimen, Ratnasabapathy & Seto 1981) [5].

Phylogenetic analyses based on the *rbc*L and *tuf*A genes show two clades [7]: 1) *T. clavata* from Thailand, *T. violacea* from USA, *T. hispida* from Japan and UK, and *T. okadae* from Japan; and 2) *T. gaudichaudii* from Japan and Philippines, *T. violacea* and *T. riekei* from USA and *T. siamense* from Thailand.

The conclusions are as follows: 1) *T. hispida* and *T. okadae* are sisters in the second clade; 2) the taxa from Japan are regarded as three distinct phylogenetic groups: *T. hispida* group, *T. okadae* phylogenetic group and *T. gaudichaudii* phylogenetic group; 3) *T. clavata* from Thailand is

at a basal position in the first clade, closely related to *T. violacea*, *T. hispida* and *T. okadae*; and 4) *T. siamense* from Thailand forms a well-supported subclade as a sister group of *T. gaudichaudii.*

IDENTIFICATION

Rantasabapathy and Seto [5] described *T. clavata* as a new species from Gombak River, Selangor State in Malaysia and mentioned that assimilatory filaments were 130-840 µm in length consisting of 8-40 cells, the distal portion of assimilatory filaments being unbranched or sparsely branched, clavate, gradually tapered from apex towards the proximal portion.

In the present study, the isotype specimen (TNS-AL-157043) gave the following observation: assimilatory filaments 290 (200-400) µm in length consisting of 13.3 (11-16) cells, distal portion of assimilatory filaments unbranched or sparsely branched, clavate, gradually tapered from apex towards proximal portion.

The specimens from Thailand showed the following: assimilatory filaments 203 (170-310) µm in length consisting of 12.5 (11-14) cells, apical cells clavate with rounded apices. Distal portion of assimilatory filaments unbranched or sparsely branched, clavate, gradually tapered from apex towards proximal portion.

Comparing measurements for the three specimens above, the lengths of assimilatory filaments are somewhat different: they are largest for the original description, intermediate for the isotype specimen and smallest for the Thai specimen, with those of the last two being similar to each other. However, based on the common features of the clavata assimilatory filaments, the Thai specimen was identified as *T. clavata*.

HABITAT

In Gombak River, the Malay specimen grew on downstream or upper surface of granitic rocks, 5-40 cm below the surface of clear, unpolluted, fresh, relatively fast or slow stream water flowing through a primary hill country forest with overhanging riverine vegetation. The stream at the site of collection was 2-3 m wide with occasional wide breaks in the vegatation admitting much sunlight. The water temperature at the time of collection (9:30-10:30 am) was 22-22.1°C and the pH was 6.6.

In Kanchanaburi, the Thai specimen was found growing in a small stream, attached on plants and rocks at half-shaded places with medium to high light intensity, in a crystal-clear, shallow small stream 20-40 cm deep, 2.50-3.50 m wide, running through a tropical mixed deciduous forest at an altitude of about 205 m.

TYPE LOCALITY: Gombak River, Selangor, Malaysia.

HOLOTYPE: Herb. Ratnasabapathy, RS 490, Seto, 6/V 1978.

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