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Distribution and ecological habitat of *Scenedesmus* and related genera in some freshwater resources of Northern and North-Eastern Thailand

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Abstract. *Phinyo K, Pekkoh J, Peerapornpisal Y. 2017. Distribution and ecological habitat of* Scenedesmus *and related genera in some freshwater resources of Northern and North-Eastern Thailand. Biodiversitas 18: 1092-1099.* The family Scenedesmaceae is made up of freshwater green microalgae that are commonly found in bodies of freshwater, particularly in water of moderate to polluted water quality. However, as of yet, there have not been any studies on the diversity of this family in Thailand and in similar regions of tropical areas. Therefore, this research study aims to investigate the richness, distribution and ecological conditions of the species of the *Scenedesmus* and related genera through the assessment of water quality. The assessment of water quality was based on the physical and chemical parameters at 50 sampling sites. A total of 35 taxa were identified that were composed of six genera, i.e. *Acutodesmus*, *Comasiella, Desmodesmus*, *Pectinodesmus*, *Scenedesmus* and *Verrucodesmus.* Eleven taxa were newly recorded in Thailand. The taxa were found in the oligo-mesotrophic to the eutrophic status. The major study sites were influenced by the nutrients identified in the water resources. The dominant species were *Desmodesmus communis* (E. Hegewald) E. Hegewald, *D. armatus* var. *bicaudatus* (Guglielmetti) E. Hegewald, *D. armatus* (Chodat) E. Hegewald and *D. serratus* (Corda) S. S. An, Friedl & E. Hegewald. This study has produced revised material on *Scenedesmus* and related genera in Thailand that is considered important information with regard to the classification of microalgae in Thailand.

Keywords: Biodiversity, microalgae, phytoplankton, trophic status and tropical areas

INTRODUCTION

Scenedesmus and related genera belong to Phylum Chlorophyta, Class Chlorophyceae, Order Sphaeropleales, Family Scenedesmaceae and, 639 taxa have been reported on the algaebase website (Guiry and Guiry 2014). The dominant characteristics of the family are: elliptical to spindle-shaped cells and the cell groups or coenobia are usually present in 2, 4, 8 or 32 in numbers in one to three rows of cells. The cell walls are smooth or appear as submicroscopic structures with a hemicellulosic and sporopollenic layer. The chloroplasts appear single and parietal with a single pyrenoid. The major taxonomic characteristics used for the morphological identification of the species of this family include: (i) cells being arranged in colonies, (ii) the size of the cell and colony, and (iii) the presence of an ornament or spine in the cell wall (Hegewald 1997). Several genera were separated from *Scenedesmus* by their morphological and molecular characteristics. Accordingly, the genus *Desmodesmus* displays certain structures on the cell wall such as teeth, rosettes, warts and spines, while the species *Scenedesmus* possesses a smooth, non-ornamented cell wall. The cells of the genus *Acutodesmus* appear to be more or less ellipsoidal, spindle-shaped and show longitudinal ridges under the TEM. The genus *Pectinodesmus* reveal a cell shaped similar to that of the genus *Acutodesmus* but differ in terms of molecular phylogeny. The genus *Comasiella* is distinguished by elongated and curved cells with obtuse cell poles and the coenobia are surrounded by mucilage. Eventually, *Verrucodesmus* will display ovate to obtuse elongated cells, while many granules will appear on the cell wall and coenobia will be embedded in the mucilage (Hegewald et al. 2010, Krienitz and Bock 2012 and Hegewald et al. 2013).

Scenedesmus are commonly found in fresh and brackish waters, particularly under conditions that are considered nutrient-rich (An et al. 1999). They can grow in highly polluted water and are typically used as pollution indicators In temperate zones, there have been extensive studies on the diversity and taxonomy of the members of this genera, while water quality assessment has also been deeply studied (Brettum and Andersen 2005 and Shubert et al. 2014). The sampling sites of certain countries that are located in tropical zones, such as those of Peru, India and Brazil, have been studied by a number of researchers (Hegewald and Schnepf 1978, Mousumi and Jai 2015, Godinho et al. 2010, Hentschke and Torgan 2010, Torgan and Hentschke 2011 and Ramos et al. 2015). However, there have not been any studies on the diversity and classification of this group of algae in Thailand. The main objective of this study is to investigate the richness and ecological conditions that are relavent to this species and the potential for using the species of the Scenedesmaceae family in the assessment of water quality of the water resources of Thailand.

MATERIALS AND METHODS

Study areas

Algal specimens were collected from June 2014 to March 2015 from various standing freshwater resources such as lakes, reservoirs, ponds, ditches and pools that were located in northern and north-eastern Thailand (Figure 1). Fifty sampling sites in 22 provinces were investigated in this study. There were 16 and 34 sampling sites located in the northern and north-eastern regions of Thailand, respectively. The ecological data of each sampling site such as catchment areas, agricultural areas or community areas were recorded and the utilization of the sampling sites was assessed.

Procedure

The algae were collected by filtering 10 L of water from each sampling site with a 10-µm pore size plankton net. The samples were preserved by adding 0.7 mL of Lugol's solution to 100 mL of the samples (Eaton et al. 2005). Samples were observed under a microscope and photographed using an Olympus Normaski microscope. The specimens were identified according to relevant literature, e.g.; Philipose (1967), Presscott (1970), Huber-Pestalozzi (1983), Hindák (1990), Croasdale et al. (1994), John et al. (2011) Krienitz and Bock (2012) and Hegewald et al. (2013). Cell enumeration was assessed by the Lackey drop method, which is a simple method that is used to obtain results when studying a dense plankton population (Greenberg et al. 1992). The importance value (IV) for each species was estimated as the sum of relative frequency and relative density (Williams-Linera et al. 2005), which were calculated by using the method of Mueller-Dombois and Ellenberg (1974) as follows: (i) Relative density (%R_D) = (number of individuals of species / total number of individuals) x 100, (ii) Relative frequency (%R_F) = (frequency of a species / sum frequency of all species) x 100, (iii) Importance value (IV) = Relative density + Relative frequency.

Water samples were collected at a depth of 30 cm from the surface of each water resource using polyethylene bottles for nutrient analysis, as well as for the analysis of certain physico-chemical properties. The bottles containing the water samples were kept in a cool box (5-7 ^{o}C) for later analysis in the laboratory. Measurements made of the physio-chemical parameters at the sampling sites included water and air temperature, light intensity, transparency, conductivity, pH and dissolved oxygen (DO) (Eaton et al. 2005).

Certain physico-chemical parameters (turbidity, alkalinity, biochemical oxygen demand (BOD), chlorophyll *a*) and certain nutrients (nitrate nitrogen, ammonium nitrogen and soluble reactive phosphorus) were analyzed in the laboratory, according to the method of Eaton et al. (2005). The trophic status of the water was classified according to the method of Peerapornpisal et al. (2004), which was based on Wetzel (2001), Lorraine and Vollenweider (1981).

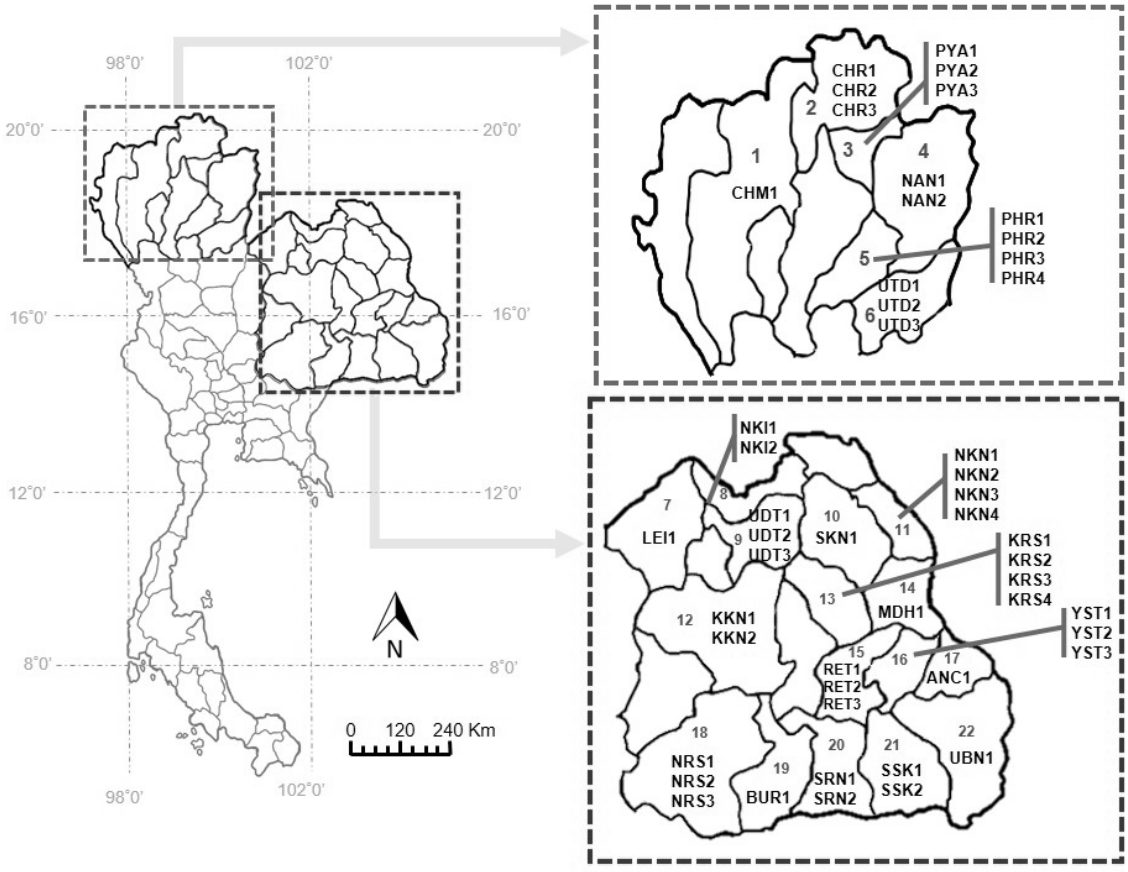

Figure 1. Map of Thailand showing 50 sampling sites in 22 provinces

RESULTS AND DISCUSSION

Sampling sites and water quality

The 50 sampling sites located in the water resources were comprised of a range of sizes and were classified as small (S) medium (M) and large (L) according to the capacity of the reservoir and/or the surface area of the reservoir. There were 30 sites that were classified as small, 17 sites that were classified as medium and three sites that were classified as large water bodies (Figure 2 (1)). Water samples were taken from the water resources at locations that were made up of various features including earthen ponds, artificial ponds, swamps, moats, reservoirs, oxidation ponds, canals, lakes, and ditches. The occurrence of *Scenedesmus* and related genera at each feature of the sampling sites is shown in Figure 2 (2). The water quality of the sampling sites was divided into four levels of status, i.e. oligo-mesotrophic, mesotrophic, meso-eutrophic and eutrophic statuses. There were 12 sites that were classified as oligo-mesotrophic status, 23 sites of mesotrophic status, 13 sites of meso-eutrophic status and two sites of eutrophic status. The results showed that the species of *Scenedesmus* and related genera had been found at twenty-nine sampling sites out of a total of fifty sites. The taxa could be found in the water of oligo-mesotrophic to eutrophic status; however, the presence of the group tended to be found in the water of mesotrophic and meso-eutrophic status (Figure 2 (3)). The rate of occurrence of the taxa was highest at NRS3, followed by the NKN4 and CHM1, which were comprised of small and medium size water bodies that were classified as having mesotrophic to meso-eutrophic water quality. The environmental characteristics of NRS3, NKN4 and CHM1 that resembled those of artificial constructions and nutrients were easily received by these water bodies through their surroundings, such as with those found within residential communities or agricultural areas (Table 1).

Diversity of *Scenedesmus* and related genera

A total of 35 taxa comprised of six genera, three species of *Acutodesmus,* one species of *Comasiella*, twenty-two species of *Desmodesmus,* two species of *Pectinodesmus,* five species of *Scenedesmus* and two species of *Verrucodesmus* were found (Table 2). Eleven taxa were newly recorded within Thailand (Figure 3) and the morphological and metric features of each taxa are presented in Table 3. The taxa were found in water quality of oligo-mesotrophic to eutrophic status. The species frequency was recorded and is presented as follows: *D. armatus* (Chodat) E.Hegewald, *D. armatus* var. *bicaudatus* (Guglielmetti) E.Hegewald and *A. dimorphus* (Turpin) P.M.T Sarenko. These were collected from 18, 16 and 15 sampling sites, respectively. The top dominant species that *bicaudatus* (Guglielmetti) E. Hegewald, *D. armatus* (Chodat) were determined by importance value were *D. communis* (E. Hegewald) E. Hegewald followed by *D. armatus* var. E. Hegewald and *D. serratus* (Corda) S.S.An, Friedl & E. Hegewald (Table 2). The percentage of relative abundance was determined by how common or rare each species was found to be with regard to the trophic status as is shown in Table 2.

Table 1. Characteristics of each sampling site and the appearance of *Scenedesmus* and related genera

Code of sampling site	*Size	Feature	**Status of water	% Occur-rence	***Species occur-rence
UTD1	S	Earthen Pond	EU	0.83	++
UTD2	S	Artificial Pond	MS	7.11	++++
UTD3	M	Swamp	MS	0.63	++
PHR1	S	Earthen Pond	MS	0	0
PHR2	S	Artificial Pond	MS	0	0
PHR3	M	Moat	ME	0.38	++
PHR4	L	Reservoir	MS	0	0
CHR1	M	Moat	ME	1.1	++
CHR2	M	Earthen Pond	OM	0	0
CHR3	L	Artificial Pond	OM	0	0
PYA1	M	Reservoir	MS	0.34	++
PYA2	S	Earthen Pond	ME	0.15	+
PYA3	M	Moat	MS	1.98	+++
NAN1	S	Earthen Pond	MS	0	0
NAN2	S	Oxidation Pond	ME	0.13	+
CHM1	M	Moat	ME	10.63	++++
NRS1	S	Artificial Pond	ME	0.46	++
NRS2	S	Artificial Pond	MS	0.23	++
NRS3	M	Moat	MS	27.8	+++++
KRS1	M	Artificial Pond	OM	0	0
KRS2	S	Swamp	ME	0	0
KRS3	S	Pond	MS	0	0
KRS4	M	Earthen Pond	MS	0.08	+
KKN1	L	Earthen Pond	MS	0.02	+
KKN2	S	Concrete pond	OM	0.1	+
NKN1	S	Earthen Pond	OM	0	0
NKN2	S	Earthen Pond	OM	0	0
NKN3	S	Artificial Pond	OM	5.53	++++
NKN4	S	Artificial Pond	MS	20.06	+++++
MDH1	S	Artificial Pond	OM	0.57	++
YST1	S	Earthen Pond	MS	0.3	++
YST2	S	Earthen Pond	MS	0.65	++
YST3	S	Canal	OM	0	0
RET1	M	Earthen Pond	OM	0	0
RET2	M	Lake	MS	0	0
RET3	M	Moat	ME	0.95	++
SSK1	M	Ditch	OM	1.17	++
SSK2	S	Earthen Pond	OM	0	0
SKN1	S	Oxidation Pond	ME	0.52	++
SRN1	S	Earthen Pond	ME	1.7	+++
SRN2	S	Artificial Pond	MS	2.71	+++
NKI1	M	Earthen Pond	ME	0	0
NKI2	S	Artificial Pond	MS	0.06	+
ANC1	S	Moat	MS	7.16	++++
UBN1	S	Earthen pond	MS	6.64	++++
UDT1	S	Earthen Pond	ME	0	0
UDT2	M	Swamp	MS	0	0
UDT3	M	Earthen Pond	EU	0	0
BUR1	S	Artificial Pond	MS	0	0
LEI1	S	Earthen Pond	ME	0	0

Note: *Size of reservoir was characterized by its capacity: S = capacity of reservoir<1 million m^3 and/or surface area of reservoir < 1 km^2, M = capacity of reservoir>1 million m^3 and<100 million m3 and/or surface area of reservoir > 1km^2 and <15 km^2, L = capacity of reservoir ≥100 million m^3 and/or surface area of reservoir >15 km^2. **Status of water; OM = Oligotrophic-mesotrophic status, MS = Mesotrophic status, ME = Mesotrophic-eutrophic status and EU = Eutrophic status. ***Species occurrence; 0 = No appearance of *Scenedesmus* and related genera, + = % Occurrence during 0.01-0.20, ++ = % Occurrence during 0.20-1.50, +++ = % Occurrence during 1.50-5.00, ++++ = % Occurrence during 5.00-20.00 and +++++ = % Occurrence during > 20.00

Discussion

Sampling sites and water quality

The abundance of *Scenedesmus* and related genera was highest at NRS3, which also had the highest percentage of occurrence (Table 1). With regard to quantitative measurements, higher values of the occurrence of the species were found at the NKN4 and CHM1 sites, which were secondary to those of NRS3. This sampling site was comprised of the moats located in NRS3 and CHM1 and the shallow pond in NKN4. According to the results, *Scenedesmus* and related genera were found in the moat category of the sampling sites (NRS3, CHM1, PHR3, CHR1, PYA3, RET3 and ANC1 (Figure 2 (2))), wherein the water quality was within the range of the mesotrophic to meso-eutrophic status. Most of the moats were located in the city and were surrounded by either residential communities, restaurants, and markets whose activities influenced the level of nutrients entering the water and could lead to the promotion of the growth of phytoplankton, including *Scenedesmus* and related genera (Prasertsin and Peerapornpisal 2015). Most of the sampling sites where the *Scenedesmus* and related genera were found were classified as being small and/or medium in size. In agreement with our results, Mrutyunjay and Siba (2007) found *Desmodesmus* and *Scenedesmus* in a small garden tank, a pond (0.5-2.0 hectare), a drain and a temporary water pool that were quite small when compared with other sites.

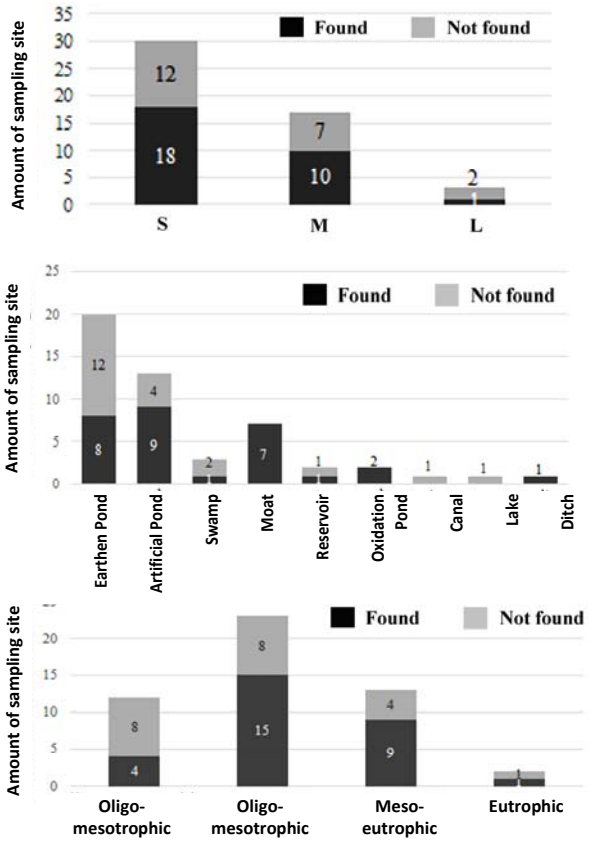

Figure 2. A. The number of sampling sites according to size (S, M, L). Note: See Table 1 for S, M, L. B. Features and the trophic status are displayed. C. The numbers presented either in the boxes or over them indicate the presence (found) and absence (not found) of *Scenedesmus* and related genera

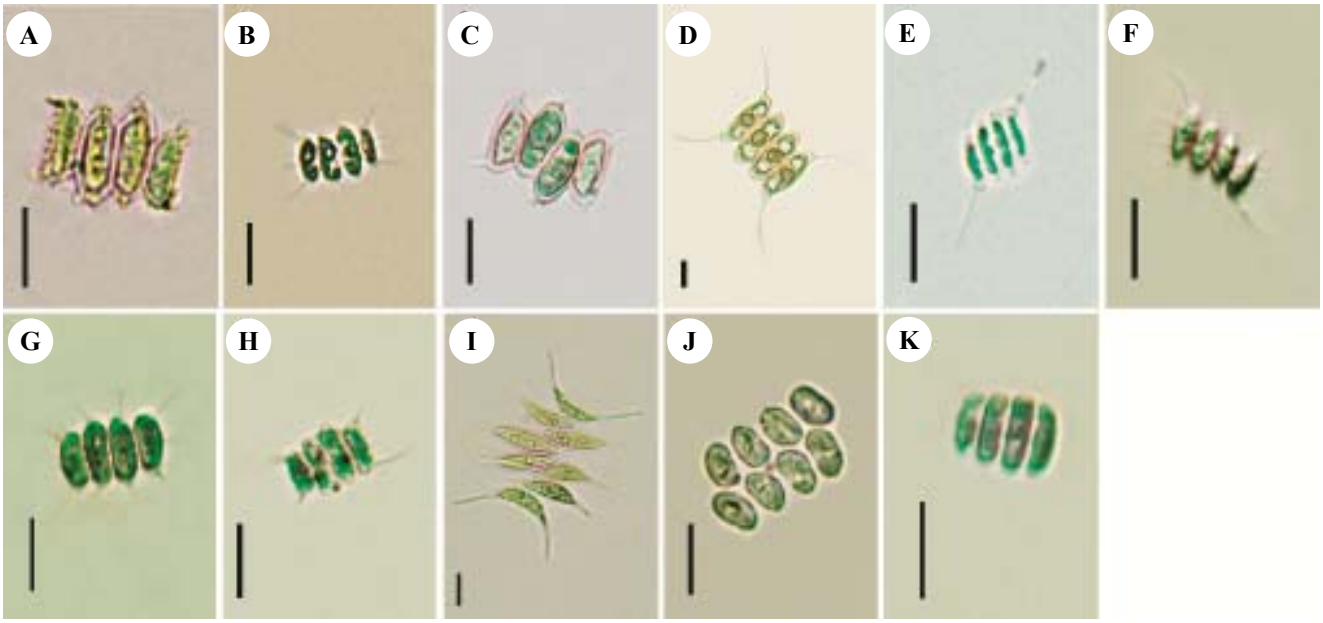

Figure 3. Eleven species were newly recorded for Thailand: **A.** *Desmodesmus. serratus* (Corda) S. S. An, Friedl & E. Hegewald, B. *D. subspicatus* (Chodat) E.Hegewald & A. Schmidt, C. *D. dispar* (Brébisson) E. Hegewald, D. *D. maximus* (West & G.S. West) Hegewald E. *D. intermedius* var. *acutispinus* (Roll) E. Hegewald, F. *D. baconii* M. Fawley, K. Fawley & E. Hegewald, G. *D. pleiomorphus* (F.Hindák) E. Hegewald, H. *D. lefevrei* (Deflandre) S.S. An, T. Friedl & E. H. Hegewald, I. *Pectinodesmus pectinatus* (Meyen) E. Hegewald, M. Wolf, Al. Keller, Friedl & Krienitz, J. *Comasiella arcuata* var. *platydisca* (G. M. Smith) E. Hegewald & M.Wolf, K. *Scenedesmus acunae* Comas. (scale bar = 10 µm)

Table 2. List of species with its frequency, abundance and the trophic status of the sampling sites

Species	Frequency at sites	$\%R_D$	$\%R_F$	IV	% Relative abundance of each trophic status			
					OM	ME	MS	EU
Genus *Acutodesmus*								
A. acuminatus (Lagerheim) P.M.Tsarenko	7	0.44	3.26	3.69	0.27	0.70	0.90	0.00
A. dimorphus (Turpin) P.M.Tsarenko	15	2.32	6.98	9.29	0.00	0.68	9.55	0.00
A. obliquus (Turpin) Hegewald & Hanagata	6	0.22	2.79	3.01	0.13	0.05	1.02	0.00
Genus *Comasiella*								
C. arcuata var. *platydisca* (G.M.Smith) E.Hegewald & M.Wolf	4	2.06	1.86	3.92	0.00	2.66	0.24	0.00
Genus *Desmodesmus*								
D. abundans (Kirchner) E.Hegewald	2	0.96	0.93	1.89	0.00	1.27	0.00	0.00
D. aculeolatus (Reinsch) P.M.Tsarenko	2	0.29	0.93	1.22	0.00	0.04	1.62	0.00
D. armatus (Chodat) E.Hegewald	18	6.74	8.37	15.11	5.20	7.81	2.69	0.00
D. armatus var. *bicaudatus* (Guglielmetti) E.Hegewald	16	10.21	7.44	17.66	12.27	8.27	18.46	9.52
D. asymmetricus (Schröder) E.Hegewald	1	0.03	0.47	0.49	0.00	0.04	0.00	0.00
D. baconii M.Fawley, K.Fawley & E.Hegewald	3	0.21	1.40	1.61	0.00	0.24	0.18	0.00
D. brasiliensis (Bohlin) E.Hegewald	7	0.52	3.26	3.78	2.27	0.40	0.12	4.76
D. communis (E.Hegewald) E.Hegewald	14	26.84	6.51	33.36	34.13	26.88	24.65	0.00
D. denticulatus (Lagerheim) S.S.An, T.Friedl & E.Hegewald	9	1.46	4.19	5.64	3.73	0.13	6.72	0.00
D. dispar (Brébisson) E.Hegewald	3	2.10	1.40	3.50	0.27	2.72	0.12	0.00
D. intermedius (Chodat) E.Hegewald	8	4.51	3.72	8.23	9.87	1.82	14.79	0.00
D. intermedius var. *acutispinus* (Roll) E.Hegewald	2	0.16	0.93	1.09	0.40	0.20	0.00	0.00
D. lefevrei (Deflandre) S.S.An, T.Friedl & E.H.Hegewald	1	0.04	0.47	0.50	0.00	0.05	0.00	0.00
D. maximus (West & G.S.West) Hegewald	3	7.00	1.40	8.40	0.00	8.89	1.62	0.00
D. opoliensis (P.G.Richter) E.Hegewald	14	3.44	6.51	9.95	5.47	2.55	4.62	47.62
D. opoliensis var. *carinatus* (Lemmermann) E.Hegewald	10	3.27	4.65	7.92	2.53	3.82	1.14	0.00
D. pannonicus (Hortobágyi) E.Hegewald	1	2.32	0.47	2.78	0.00	3.06	0.00	0.00
D. perforatus (Lemmermann) E.Hegewald	4	0.93	1.86	2.79	1.33	1.10	0.00	0.00
D. pleiomorphus (F.Hindák) E.Hegewald	1	0.16	0.47	0.62	0.00	0.20	0.00	0.00
D. serratus (Corda) S.S.An, Friedl & E.Hegewald	9	10.17	4.19	14.36	0.00	13.40	0.06	0.00
D. spinosus (Chodat) E.Hegewald	4	0.65	1.86	2.51	5.33	0.27	0.36	0.00
D. subspicatus (Chodat) E.Hegewald & A.Schmidt	7	1.68	3.26	4.93	7.33	1.46	0.24	0.00
Genus *Pectinodesmus*								
P. javanensis (Chodat) E.Hegewald, C.Bock & Krienitz	1	0.06	0.47	0.52	0.80	0.00	0.00	0.00
P. pectinatus (Meyen) E.Hegewald, M.Wolf, Al.Keller, Friedl & Krienitz	9	1.49	4.19	5.67	0.40	0.54	4.69	38.10
Genus *Scenedesmus*								
S. acunae Comas	2	0.23	0.93	1.16	0.00	0.28	0.12	0.00
S. ecornis (Ehrenberg) Chodat	2	0.55	0.93	1.48	6.40	0.12	0.00	0.00
S. indicus Philipose	3	5.10	1.40	6.50	0.00	6.73	0.00	0.00
S. obtusus Meyen	12	1.76	5.58	7.34	0.00	1.93	1.80	0.00
S. parisiensis Chodat	1	0.08	0.47	0.54	1.07	0.00	0.00	0.00
Genus *Verrucodesmus*								
V. parvus (G.M.Smith) E.Hegewald	2	0.27	0.93	1.20	0.00	0.01	1.62	0.00
V. verrucosus (Y.V.Roll) E.Hegewald	12	1.75	5.58	7.33	0.80	1.66	2.65	0.00

Note: Trophic status of water: OM = Oligotrophic-mesotrophic status, MS = Mesotrophic status, ME = Mesotrophic-eutrophic status and EU = Eutrophic status

Richness of the Scenedesmus and related genera

Scenedesmus and related genera were found to be present in every status of water quality and were confirmed by the relative abundance value of each trophic status (Table 2). Some species were found to be common such as *D. communis*, *D. armatus*, *D. armatus* var. *bicaudatus*, *D. opoliensis* and *D. Intermedius,* which displayed a high level of abundance in all sites of a trophic status (eutrophic status was apprently not identified because there were only a few sampling sites). Scenedesmaceae taxa were found in 35 taxa from 29 sampling sites, all of which reported a higher number of taxa than were found in other research studies of Thailand. Previously, the studies conducted in Thailand did not specifically focus on *Scenedesmus* and the related

Table 3. The morphogical and metric characteristics of newly recorded species in Thailand

Species	Cell length (µm)	Cell width (µm)	Coenobia arrangement	Cell shape	Ornament on cell wall
Desmodesmus serratus	10 (12.5)-17.5	2.5-7.5	2,4 cell linear	Elongate-ovoid	Teeth on the cell margin
D. subspicatus	5 (7.50)-8.75	1.8-2.5	2,4 cells linear	Elongate-ovoid to cylindrical	Main spines on apices and 2-3 lateral spines (shorter than main spines) of terminal cells; polar additional spines of inner cells
D. dispar	7.5 (10)-12.5	3.75-6.25	2,4 cells linear to slight alternating	Elongate-ovoid to cylindrical, round or polygonal apices	Terminal cells with a spine at one pole and a shorter spine at the opposite pole, inner cells with a short spine at one pole
D. maximus	22.5-25	7.5-8.75	2,4 cells linear	Cylindrical, round apices	Massive spines on apices of terminal cells
D. intermedius var. *acutispinus*	6.25 (7.5)-10	2.187 (2.5)-3.75	4 cells linear	Narrow cylindrical	2 spines arising in opposite directions on terminal cell apices
D. baconii	7.5-10	3.75-4.375	2,4 cells linear	Elongate ovoid	Large spines at one end and lateral row of spines at terminal cells, short spines on apices of inner cells
D. pleiomorphus	7.5	3.75	4 cells linear	Broad ovoid	Long spines at poles and median part of cells
D. lefevrei	7.5	3.75	4 cells linear	Cylindrical, slight curve in lateral cells	Terminal cells with 2 spines at each pole, one larger and another smaller arising in opposite directions on apices, a row of short spines at lateral at terminal cells
Pectinodesmus pectinatus	12.5-25	2-3.75	4, 8 cells alternate arrangement	Cells spindle-like, lunate shape with terminal cells, cell length to cell width 6:1	Not observed by light microscope
Comasiella arcuata var. *platydisca*	5-7.5	2.5-5	4,8 cells double series arrangement, small space between cells	Elongate-ovoid to cylindrical-ovoid, slight curve	Smooth cell walls, mucilaginous envelope
Scenedesmus. acunae	7.5-10	2.8-4.375	4 cells linear	Cylindrical of inner cells, convex outer cell, round apices	Smooth cell walls

genera as most of the research studies were focused on the species of phytoplankton. The process of identification at the species level of this algae group requires a significant amount of knowledge and many details. The first report of this the group in Thailand appeared in 1901 by W. West, while G. S. West surveyed the plants and algae at Koh Chang (Trat Province, Thailand). This study identified four species of *Scenedesmus* (*S. bijugatus, S. denticulatus* var. *linearis, S. acutiformis* var. *spinuliferum* and *S. quadricauda)*. Therefore, many reports have reported on the generic level of a species or focused on providing evidence of a given species. Notably, Prasertsin and Peerapornoisal (2015) studied the diversity of phytoplankton and water quality in certain freshwater resources in Thailand. In the above-mentioned study, 4 species of *Acutodesmus*, six species of *Desmodesmus* and two species of *Scenedesmus* (five taxa could not be identified by species) were found. Pongsawat and others (2004) reported on the presence of three species of *Scenedesmus*; *S. acuminatus* (Lagerh.) Choda. var. *acuminatus*, *S. armatus* (Chod.) G. M. Smith and *S. opoliensis* P. Richter, all of which were found in Rama IX Lake at Pathumthani Province. In another report, *Scenedesmus* and related genera were discovered and identified at the genus level (Angsupanich and Rakkheaw 1997 and Tookwinas and Songsangjinda 1999). Summarily, previous reports on *Scenedesmus* and related genera in Thailand reported on the presence of around 53 species and most of them were classified into the genus *Scenedesmus* (Lewmanomont et al. 1995). Furthermore, the high number and various systems associated with the sampling sites included in this study resulted in a high volume of *Scenedesmus* and related genera taxa. In addition, there are more research studies, publications and textbooks available that were related to identification than before, which resulted in more descriptions related to the classification of these algae groups. As a result, this research study identified far more specimens of taxa of *Scenedesmus* and related genera than the previous research studies that had been conducted in Thailand.

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