การประเมินคุณภาพน้ำในแหล่งน้ำนิ่งโดยใช้แพลงก์ตอนพืชชนิดเด่นด้วย AARL – PP Score

Assessment of Water Quality in Standing Water by Using Dominant Phytoplankton (AARL- PP Score)

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บทคัดย่อ

ห้องปฏิบัติการวิจัยสาหร่ายประยุกต์ (Applied Algal Research Laboratory: AARL) ภาควิชาชีววิทยา คณะวิทยาศาสตร์ มหาวิทยาลัยเชียงใหม่ ได้วิจัยเกี่ยวกับคุณภาพน้ำและความหลากหลายของแพลงก์ตอนพืช 35 เรื่อง ในเวลา 15 ปีที่ผ่านมา ซึ่งนำไปสู่การศึกษาคุณภาพน้ำในแหล่งน้ำนิ่งได้อย่างง่าย โดยใช้แพลงก์ตอนพืช เป็นวิธีการที่ไม่ใช้สารเคมี และยังบ่งชี้คุณภาพน้ำในอดีตได้ด้วย การประเมินคุณภาพน้ำด้วยวิธีนี้เรียกว่า AARL-PP Score ซึ่งประกอบด้วยคะแนนจาก 2 ส่วน ส่วนที่ 1 เป็นการสร้างคะแนนมาตรฐานคุณภาพน้ำโดยอิงระดับสารอาหาร ด้วยการแบ่งออกเป็น 6 ระดับ คือ คุณภาพดี (oligotrophic status), ดีถึงปานกลาง (oligotrophic - mesotrophic status), ปานกลาง (mesotrophic status), ปานกลางถึงไม่ดี (mesotrophic - eutrophic status),ไม่ดี (eutrophic status), และไม่ดีมาก (hypereutrophic status) โดยใช้คะแนน 1-10 แบ่งแต่ละระดับโดยใช้ประสบการณ์ที่มีมาก่อน ส่วนที่ 2 เป็นการให้คะแนนแพลงก์ตอนพืชชนิดเด่นที่ปรากฏในแหล่งน้ำซึ่งมีคุณภาพต่างกัน โดยให้คะแนน 1-10 คะแนนน้อยจะบ่งชี้คุณภาพน้ำดี ส่วนคะแนนมากจะบ่งชี้คุณภาพน้ำไม่ดี การศึกษาคุณภาพน้ำในแหล่งน้ำที่ศึกษา ทำได้โดย รวบรวมแพลงก์ตอนพืชมาวินิจฉัยและหาความมากน้อยของแต่ละจีนัส นำจีนัสเด่นซึ่งเรียงตามลำดับความมากน้อย 3-5 จีนัส ให้คะแนนระดับคุณภาพน้ำจากส่วนที่ 2 หาค่าเฉลี่ยแล้วนำ ไปเปรียบเทียบกับคะแนนมาตรฐานคุณภาพน้ำในส่วนที่ 1 จะสามารถหาคุณภาพน้ำได้ ได้มีการทดลองใช้ Score นี้ ในแหล่งน้ำ 50 แห่งในภาคเหนือ ส่วนภาคตะวันออกเฉียงเหนือ และภาคใต้ ภาคละ 20 แห่ง ผลปรากฏว่าให้ความถูกต้องมากกว่า 95% เมื่อเปรียบเทียบกับคุณภาพน้ำทางด้านกายภาพและเคมี

Abstract

The Applied Algal Research Laboratory (AARL), Department of Biology, Faculty of Science, Chiang Mai University, had done 35 research topics on the quality of water and phytoplankton diversity in the past 15 years. The new knowledge leading to the simplicity of standing water quality study. Besides, the chemical reagents are not required and could be used to indicate the water quality in its past history.

This water quality assessment is called “AARL- PP Score”. It is composed of 2 parts scoring system. The first part is the standard score of water quality base on trophic level status. The water quality was categorized into 6 status using 1-10 scores. Each status was divided by former research experience, i.e. clean (oligotrophic status), clean to moderate (oligotrophic-mesotrophic status), moderate (mesotrophic status), moderate to polluted (mesotrophic-eutrophic status), polluted (eutrophic status), and very polluted (hypereutrophic status). In the second part, the dominant genera of phytoplankton from different water quality resources were given 1-10 scores. The lower scores indicated clean water whereas the higher scores indicated polluted water. During the assessment of water quality, the phytoplankton were collected, identified and the quantity of each genus was determined. Three to five dominant genera of the phytoplankton were selected in accordance with their respective amount. The score of each genus following the water quality in the second part was averaged and compared with the standard score of water quality in the first part. The AARL-PP Score had been tested in 50 water resources in the North and 20 water resources each in Northeastern and Southern parts of Thailand, with more than 95% in agreement with physical and chemical water quality.

Introduction

The study of standing water quality, generally use physical and chemical methods. Most of them involved the examination of the colour, odor and taste of the water, pH, dissolved oxygen (DO), biochemical oxygen demand (BOD), electric conductivity (EC), chlorophyll *a* contents, the amount of nitrite, nitrate, ammonia and phosphate; the amount of total and fecal coliform bacteria including heavy metals and some insecticides.

These methods require the use of some expensive instruments and chemical reagents, the residues will be pollutants in the environments. Besides, the water quality base on physical and chemical analysis will only show the quality on the measuring day (Wetzel, 1983),it can not predict

the water quality in the past. Some aquatic entomologists, protozoologists, phycologists, limnologists and hydrologists have tried to creat bioindicators to assess water quality in some water resources. In the case of standing water quality, phytoplanktons were suitably used as bioindicator to assess the water quality. Applied Algal Research Laboratory (AARL), Microbiology Section, Department of Biology, Faculty of Science, Chiang Mai University, Thailand have carried out the research concerning the use of phytoplankton (PP) as bioindicator to assess standing water quality for more than 15 years. At present, members of AARL have been used “AARL-PP Score” to assess the standing water quality all over Thailand. The researchers hope that this score will be useful for students, local people and those who are interested in standing water quality.

Materials and Methods

AARL-PP Score is composed of 2 parts scoring system. The first part is the standard score of water quality base on trophic level. The water quality was categorized into 6 status using 1-10 score. Each status was divided by the data from the past survey (Table1).

Table 1 Water quality scores followed trophic level and general water quality

Score	Water quality by trophic level	General water quality
1.0-2.0	Oligotrophic status	Clean
2.1-3.5	Oligo-mesotrophic status	Clean- moderate
3.6-5.5	Mesotrophic status	Moderate
5.6-7.5	Meso-eutrophic status	Moderate- polluted
7.6-9.0	Eutrophic status	Polluted
9.1-10.0	Hypereutrophic status	Very polluted

The second part of AARL-PP Score is the dominant genera of phytoplankton score, it was given in 1-10. The lower score indicated clean water whereas the higher score indicated polluted water (Table 2). Morphological characters of phytoplankton genera used in AARL – PP Score were showed in Figure 1.

Table 2 Dominant genus scores

Genus	Score	Genus	Score
Actinastrum	5	*Gymnodinium*	6
Acanthoceras	5	*Gyrosigma*	7
Amphora	6	*Isthmochloron*	5
Anabaena	8	*Kirchneriella*	5
Ankistrodesmus	7	*Melosiera*	5
Aphanocapsa	5	*Merismopedia*	9
Aphanothece	5	*Micractinium*	7
Aulacoseira	6	*Micrasterias*	2
Bacillaria	7	*Microcystis*	8
Botryococcus	4	*Monoraphidium*	7
Centritractus	4	*Navicula*	5
Ceratium	4	*Nephrocytium*	5
Chlamydomonas	6	*Nitzschia*	9
Chlorella	6	*Oocystis*	6
Chroococcus	6	*Oscillatoria*	9
Closterium	6	*Pandorina*	6
Cocconeis	6	*Pediastrum*	7
Coelastrum	7	*Peridiniopsis*	6
Cosmarium	2	*Peridinium*	6
Crucigenia	7	*Phacus*	8
Crucigeniella	7	*Phormidium*	9
Cryptomonas	8	*Pinnularia*	5
Cyclotella	2	*Planktolyngbya*	7
Cylindrospermopsis	7	*Pseudanabaena*	7
Cymbella	5	*Rhizosolenia*	6
Dictyosphaerium	7	*Rhodomonas*	8
Dimorphococcus	7	*Rhopalodia*	5
Dinobryon	1	*Scenedesmus*	8
Encyonema	6	*Staurastrum*	3
Epithemia	6	*Staurodesmus*	3
Euastrum	3	*Stauroneis*	5
Eudorina	6	*Strombomonas*	8
Euglena	10	*Surirella*	6
Eunotia	2	*Synedra*	6
Fragilaria	5	*Synura*	8
Golenkinia	5	*Tetraedron*	6
Gomphonema	6	*Trachelomonas*	8
Gonium	6	*Volvox*	6

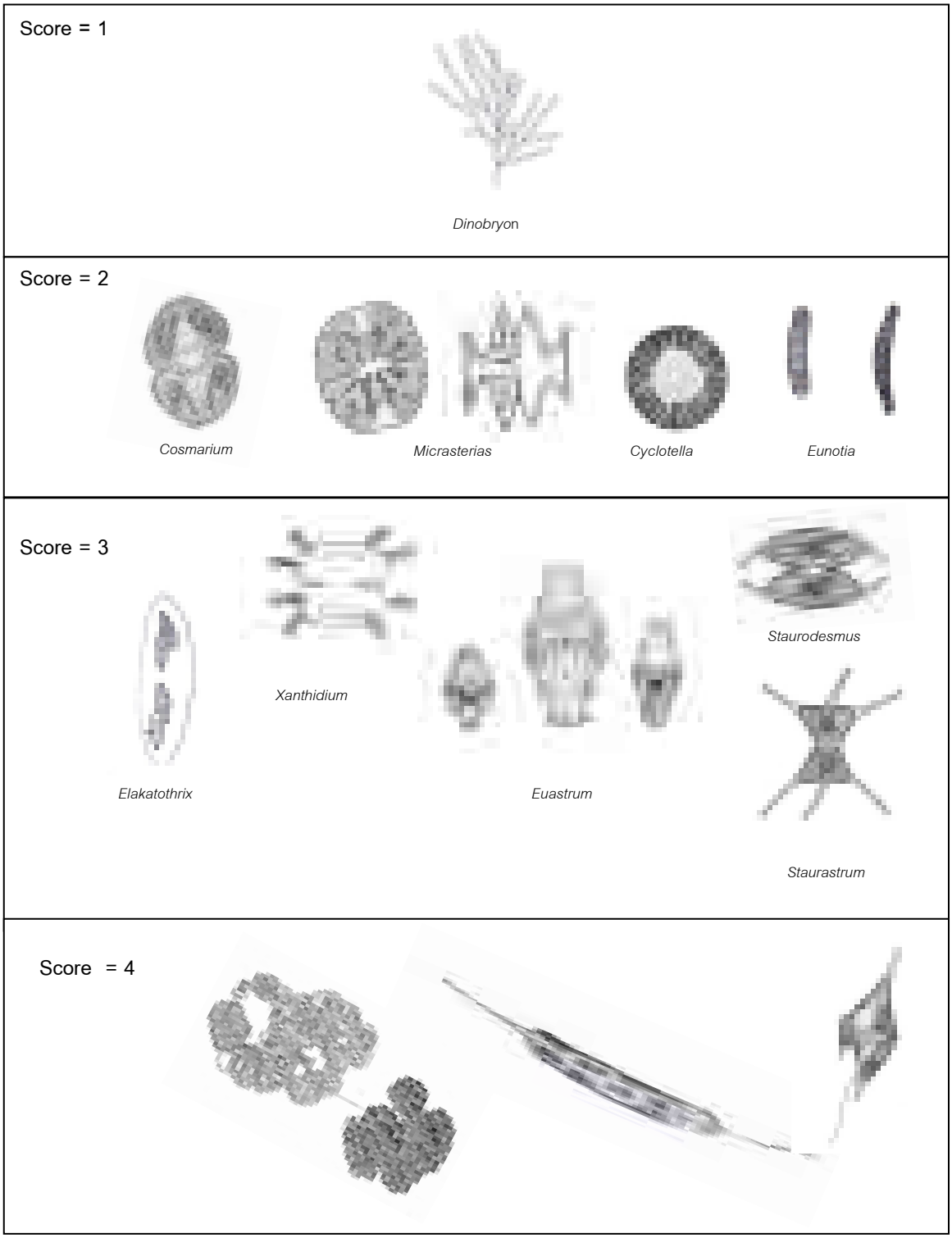

Figure 1 Dominant phytoplankton genus with the indicated score

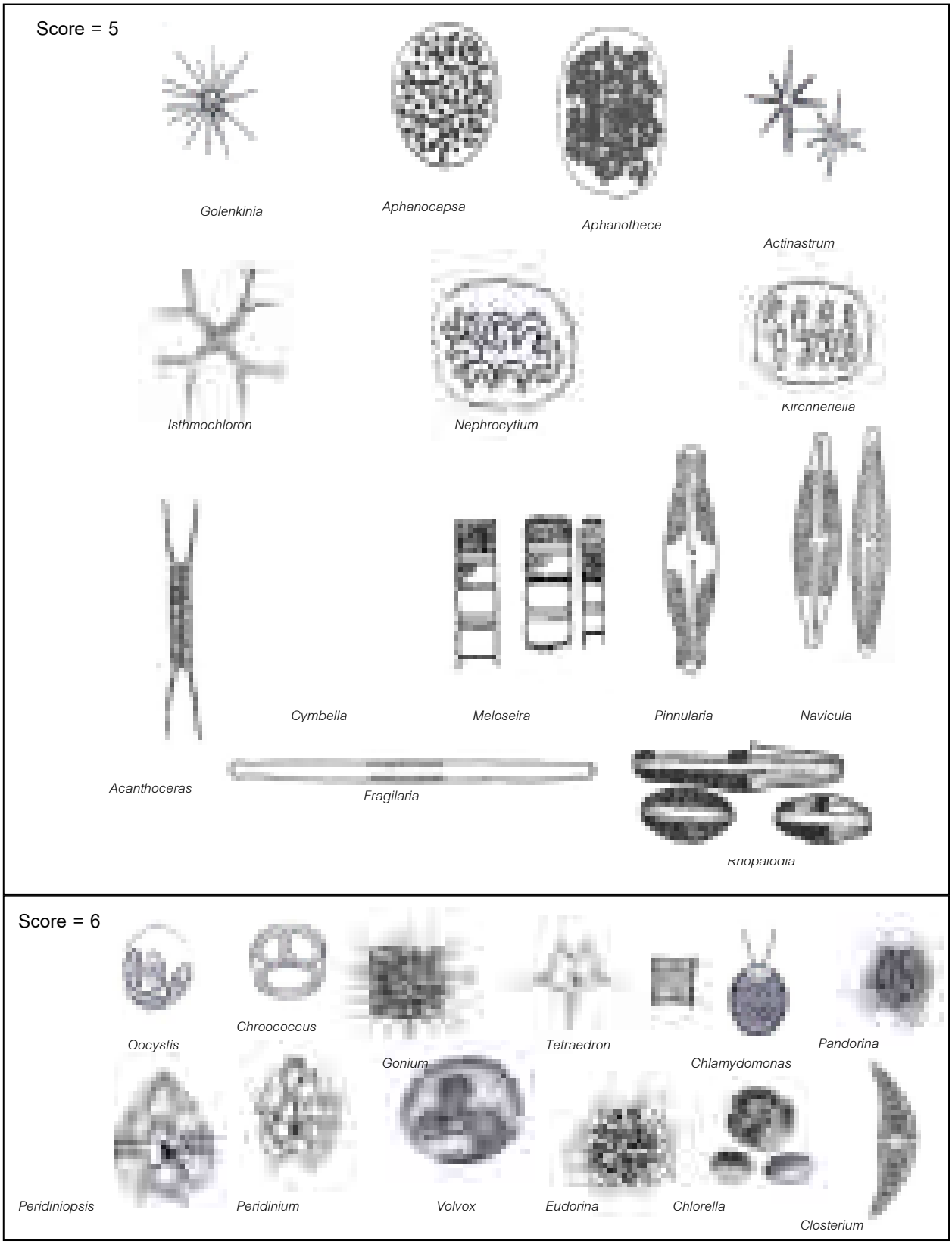

Figure 1 (continued 2)

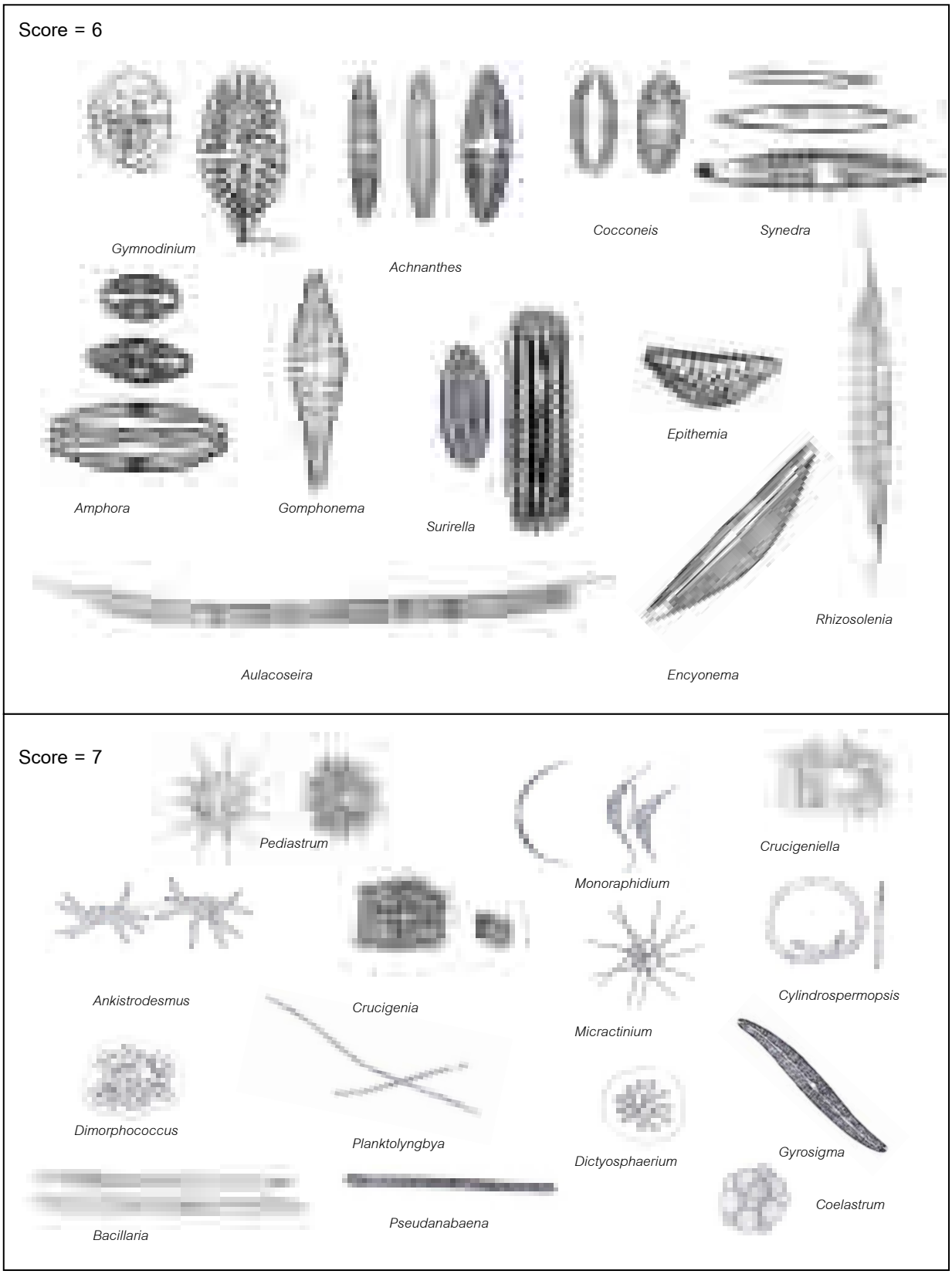

Figure 1 (continued 3)

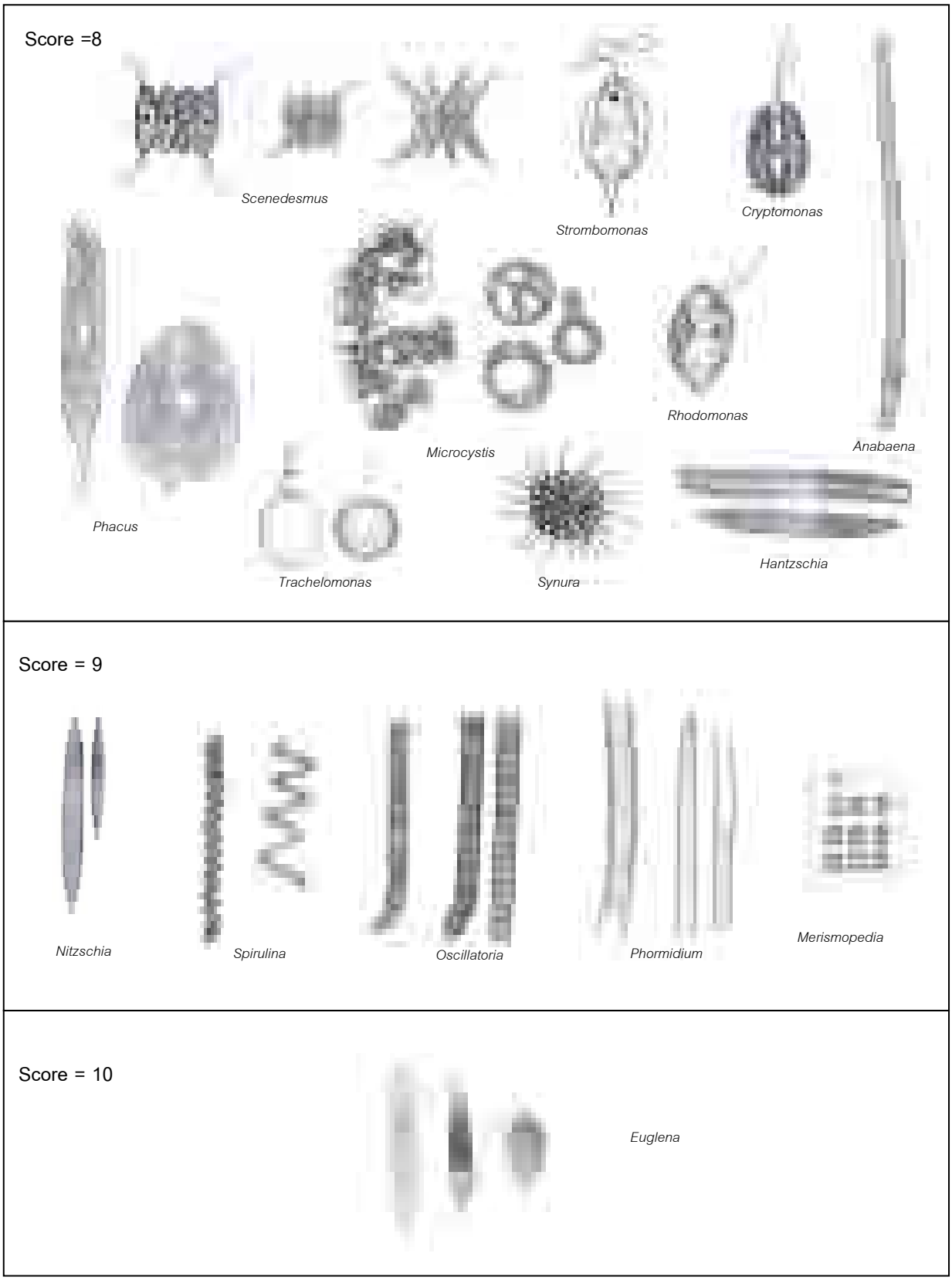

Figure 1 (continued 4)

During the assessment of water quality, the phytoplankton were collected, identified to genera and the quantity of each genus determined (John *et al.* ,2002 ; Peerapornpisal , 2005). Three to five dominant genera of the phytoplankton were selected according to their irrespective amount. The score of each selected genus following the water quality in the second part (Table 2) was averaged and compared with the standard water quality score in the first part (Table1).

In the present study, the physical and chemical properties of water i.e. colour and oder of water, pH, DO, BOD, EC, chlorophyll a contents, amount of nitrate nitrogen, ammonium nitrogen and soluble reactive phosphorous were also investigated (APHA, 1996). The physical and chemical properties of water were used in combination to evaluate the water quality (Lorraine and Vollenweider, 1981; Peerapornpisal *et al*., 2004). The results of water quality using AARL – PP Score will be compared with those obtained from physical and chemical methods.

Example

In Chiang Mai Moat, Chiang Mai, Thailand

3 genera were dominant : *Euglena* sp., *Trachelomonas* sp.and *Navicula* sp.

From Table 2: Scores of selected genera are:-

Euglena sp. = 10

Trachelomonas sp. = 8

Navicula sp. = 5

Total score = 10+8+5 = 23

Average score = 23/3 = 7.6

From Table 1: Score 7.6 is in **Eutrophic status** or **Polluted water quality** The water quality in Chiang Mai Moat is **Polluted**

Results and Discussion

The authors believe that AARL – PP Score can be used to assess the water quality in Thailand and tropical areas. However, the water quality scores followed tropic level and dominant genus scores of phytoplankton should be investigated in temperate and other regions before the application of AARL – PP Score as the value of water quality in each level and the species composition of phytoplankton may be different in different region (Lorraine and Vollenweider 1981; Wetzel,1983).

The AARL-PP Score had been done in 50 water resources in the North, 40 water resources in the Northeastern and Southern parts of Thailand with more than 95 % in agreement with physical

and chemical water quality. The water quality of some water resources in Thailand using AARL – PP Score were showed in Table 3.

Table 3 The water quality of some water resources in Thailand using AARL – PP Score

Water resources	Dominant phytoplankton	Phytoplankton score	Trophic level	General water quality
Mae Jok LuangReservoir, Chiang Mai (North)	*Dinobryon* *Staurodesmus* *Stauratrum*	1.66	Oligotrophic status	Clean
Maekuang Udomtara Reservoir , Chiang Mai (North)	*Staurodesmus* *Staurastrum* *Cosmarium*	2.66	Oligo-mesotrophic status	Clean- moderate
Ang Kaew Reservoir Chiang Mai University Chiang Mai (North)	*Peridinium* *Aulacoseira* *Ceratium*	5.66	Meso-eutrophic status	Moderate- polluted
Fish pond in Wat Umong Chiang Mai (North)	*Phacus* *Oscillatoria* *Pediastrum*	8	Eutrophic status	Polluted
Chiang Mai Moat Chiang Mai (North)	*Euglena* *Trachelomonas* *Phacus*	8.6	Eutrophic - status	Polluted
Bang Wad Reservoir Phuket (South)	*Cosmarium* *Staurastrum* *Dinobryon*	2	Oligotrophic status	Clean
Chiew Lan Reservoir Surat tani (South)	*Staurastrum* *Cosmarium* *Peridinium*	3.66	Mesotrophic status	Moderate
Talay Noi Phatthalung (South)	*Dictyosphaerium* *Pandorina* *Microcystis*	7	Meso-eutrophic status	Moderate- polluted
Lamtakhong Reservoir Nakhon Ratchasima (Northeast)	*Aulacoseira* *Fragilaria* *Staurastrum*	4.66	Mesotrophic status	Moderate
Ubonrath Reservoir Khon Kaen (Northeast)	*Aulacoserra* *Eudorina* *Fragilaria*	5.66	Meso-eutrophic status	Moderate- polluted

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