Phytoplankton Composition and Distribution in the Coastal Area of Bachok, Kelantan.

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ABSTRACT A study on the biodiversity of phytoplankton was carried out at Bachok, Kelantan from 14th to 18th June 2008. The objective of the study was to document the phytoplankton biodiversity of this scientifically little known area. Twenty genera and 54 species from two major divisions, Bacillariophyta (diatom) and Pyrrophyta (dinoflagellate) were recorded. Diatoms were richest and most diverse, with 51 species from 18 genera. The dominant diatoms were *Chaetoceros constrictum, Rhizosolenia alata, Rhizosolenia bergonii* and *Rhizosolenia hebatata.* Recorded salinities ranged from 14.44ppt to 33.6ppt, and pH from 7.17 to 8.07.

ABSTRAK Kajian mengenai biodiversiti fitoplankton telah dijalankan di Bachok, Kelantan bermula dari 14 hingga 18 Jun 2008. Objektif kajian ini adalah untuk mendokumentasikan biodiversiti fitoplankton dalam kawasan yang kurang maklumat saintifiknya. Dua puluh genus dan 54 spesies dari dua divisi utama, Bacillariophyta (diatom) dan Pyrrophyta (dinoflagelat) telah direkodkan. Diatom paling banyak ditemui dengan taburan tertinggi dengan 51 spesies dari 18 genus. Dominan diatom adalah *Chaetoceros constrictum*, *Rhizosolenia alata, Rhizosolenia bergonii* dan *Rhizosolenia hebatata*. Kepekatan saliniti direkodkan dari 14.44ppt hingga 33.6ppt, dan pH dari 7.17 hingga 8.07.

(**Keywords:** phytoplankton, biodiversity, Bachok, IOES)

INTRODUCTION

Marine phytoplankton research in Malaysia has been largely patchy over the years. Quantitative study of plankton in Malacca Straits was first conducted in 1933 by Sewell [1], followed by Wickstead [2], Pathansali, [3], Chua & Chong [4] and Shamsudin *et al.* [5]. Marine phytoplankton research was also conducted in the west Malaysian waters by Salleh *et al.* in Langkawi [6] and around the offshore islands of Pulau Jarak, Pulau Perak and Pulau Sembilan during the first Scientific Expedition to the Seas of Malaysia (SESMA)[7]. Phytoplankton research in South China Sea (Malaysian waters) has however received little attention except the works of Chua [8] and Shamsudin [9].

Diatoms were the most conspicuous and widespread microplankton of the coastal marine waters of Johor, Kelantan and Terengganu [10]. Communities of diatoms (class Bacillariophyceae) can be extremely diverse in marine waters.

The purpose of the present study was to document the phytoplankton biodiversity within the vicinity of the Institute of Ocean and Earth Sciences (IOES) marine station at Bachok, Kelantan. The marine station has been designated as University of Malaya's focal point for marine research in the South China Sea.

MATERIAL AND METHODS

A total of 12 sampling stations were established; these included the river mouth at Kuala Kemasin – S1 (6°7'48.41"N, 102°22'14.09"E), the beach at Kuala Kemasin – S2 (6°7'29.15"N, 102°22'36.42"E), Sg. Rekang – S3 (6 ° 0 '20. 90 "N, 102 °25'39.87"E), Sg. Dua (I) – S4 (5°59 '52 . 23" N, 102 °25 '58.26"E), Sg. Dua (II) – S5 (5 °59 '46 .83 "N, 102 °26'0.63 "E), Sg. Dua (III) – S6 (5°59'43.41"N, 102°26'4.73"E), Tok Bali (I) – S7 (5°53'38.34"N, 102°29'32.98"E), Tok Bali (II) – S8 (5°53'24.57"N, 102°28'32.11"E), Tok Bali (III) - S9 (5°52'38.93"N, 102°28'55.83"E), Sg. Semerak – S10 (5°51'42.26"N, 102°30'9.21"E) and the river mouth of Sg. Semerak - S11 (5°51'50.17"N, 102°30'47.64"E). Figure 1 showed the locations of the 11 sampling stations.

Samples were collected using standard plankton net of 30 µm-mesh aperture. The samples were preserved in formalin (4%) and subsequently prepared for species identification using light microscope. Light microscopy was performed using Olympus BX 51. The morphological structures of the specimens were then examined using the scanning electron

microscopy (SEM). Several reference books and journals were used to identify most of the species [10, 11, 12, 13].

Water samples were collected using 500 ml polythene bottles by dipping the bottle under the surface of the water. Chemical analyses of nitrate, phosphate and silica concentration were conducted in laboratory. Measurement of physical factors such as light intensity, water temperature, pH, salinity, dissolved oxygen and water conductivity were recorded *in-situ* at the sampling sites.

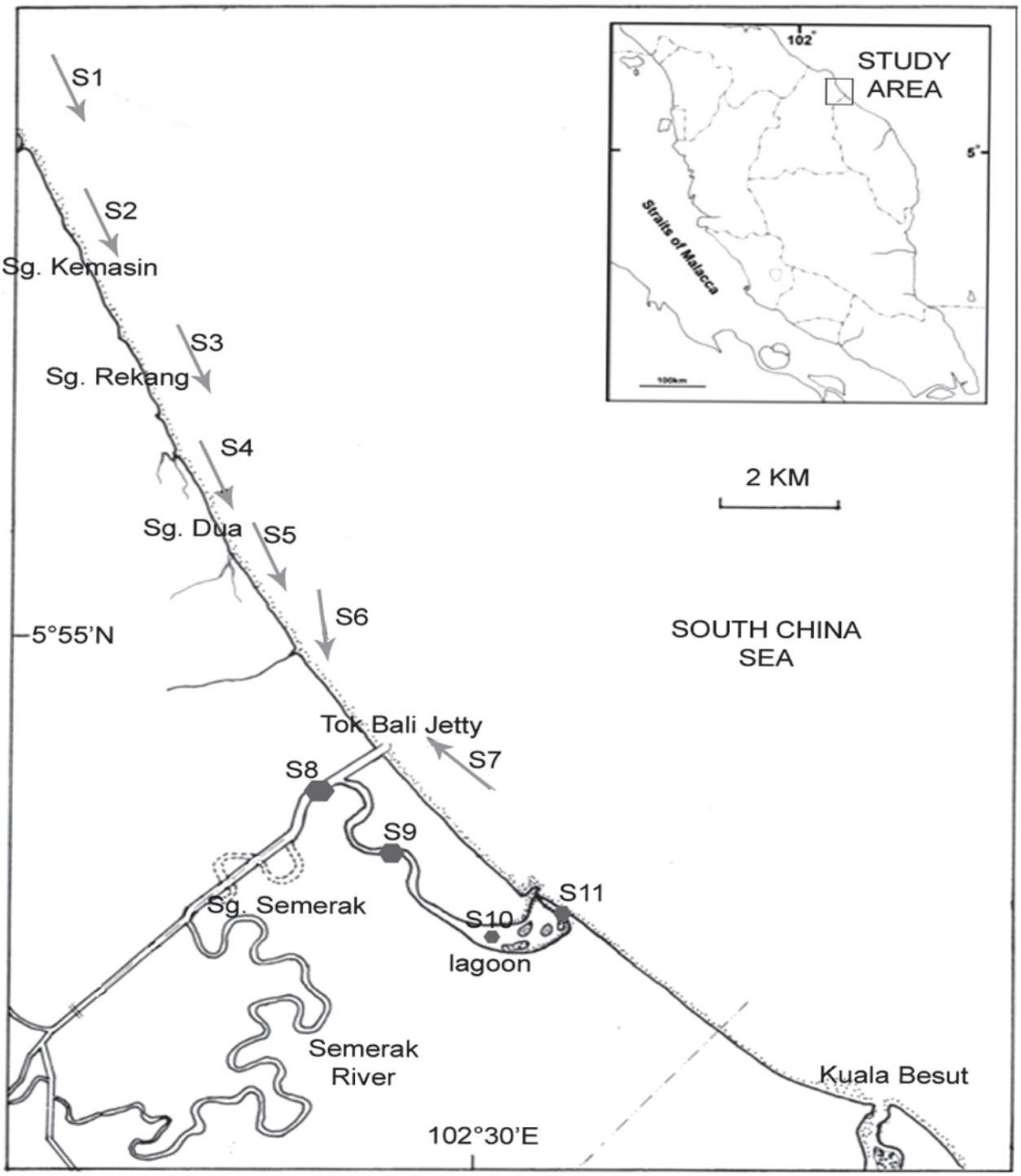

Figure 1. Location of the sampling sites.

RESULTS AND DISCUSSION

The range of recorded salinities during the study was high; 33.60 ppt at Tok Bali station and 14.46 ppt at Sg. Semerak station.

A total of 54 species and 20 genera from two main divisions of phytoplankton were recorded (Table 1). The most abundant species were Bacillariophyta (diatoms) with 51 species, followed by Pyrrophyta (dinoflagellate) with three species. The diatoms that were recorded as abundant along the coastal area of Bachok were species belonging to the genera of *Rhizosolenia, Chaetoceros, Thalassiothrix* and *Bacteriastrum.* These species were also recorded as dominant in Malacca Straits [7].

Diatoms were abundant at the Kuala Kemasin estuary where *Rhizosolenia* spp. was the most abundant as blooms. The plankton blooms attributable to most species from the Bacillariophyta are not hazardous to humans [14].

Diatoms are good indicators of the environmental condition of rivers and streams because they respond directly and sensitively to the physical, chemical and biological changes of these ecosystems, particularly temperature and nutrient concentrations [15, 16, 17]. Compared to the other stations (S4, S5, S6, S7, S8, and S9), the most dominant diatoms recorded from S1 and S11 were *Coscinodiscus, Ditylum, Biddulphia* and some dinoflagellates (Pyrrophyta) including *Ceratium* and *Protoperidinium.* Shallow waters (S5, S6) recorded high abundance of *Biddulphia* spp. This genus was the most common in shallow waters near the coast [10].

The diversity and distribution of the phytoplankton are related to their physiological requirements such as dissolved oxygen, pH, and nutrient content which can have a profound impact on the overall health or ecological state of the water. Eutrophication refers to the over-enrichment of the water by nutrients, particularly nitrogen and phosphorus, which increase phytoplankton growth. These nutrients are transported into the sea by rivers in solution or attached to sediments, thus increasing the nutrient loadings of coastal waters. Nitrate and phosphate are of special importance in that they often determine the productivity of water [18].

The nitrate concentrations (Table 2) at all stations were within 0.1 to 0.6 mg/L, while phosphorus concentration ranged from 0.01 to 1.43 mg/L. The highest silicate content occurred at station 10 with 0.39 mg/L, whereas the lowest was at station 7 (0.07mg/l). Silica is required by diatoms which were the dominant phytoplankton in the study sites [19, 20]. Silica may limit growth as well as the thickness of the cell wall [21].

Temperature, pH and dissolved oxygen are important factors used to verify either the oligotrophic or eutrophic status of water. Oligotrophic freshwater refers to very clean water with high drinking-water quality compared to the eutrophic condition which is due to excessive nutrients resulting in poor water quality. Eutrophication may cause harmful algal blooms as reported in Sabah [22] and Malacca Straits [23].

Dissolved oxygen in water can act as a pollution indicator [24, 25]. The present study shows a range of dissolved oxygen that ranged between 3.96 to 8.30 mg/L. It was found that high values of dissolved oxygen occurred at the surface where dissolved oxygen tends to equilibrate with atmospheric oxygen. The lowest dissolved oxygen concentration of 3.96 mg/L was recorded at S11, while S6 showed the highest concentration of dissolved oxygen at 8.30 mg/L. The low nutrient (N and P) concentrations and high dissolved oxygen content indicate that the marine water across the coastal area of Bachok was generally oligotrophic.

CONCLUSIONS

Fifty-four species of phytoplankton were recorded from Bachok coastal waters. The phytoplankton at Bachok coastal waters were diverse but dominated by diatoms and dinoflagellates.

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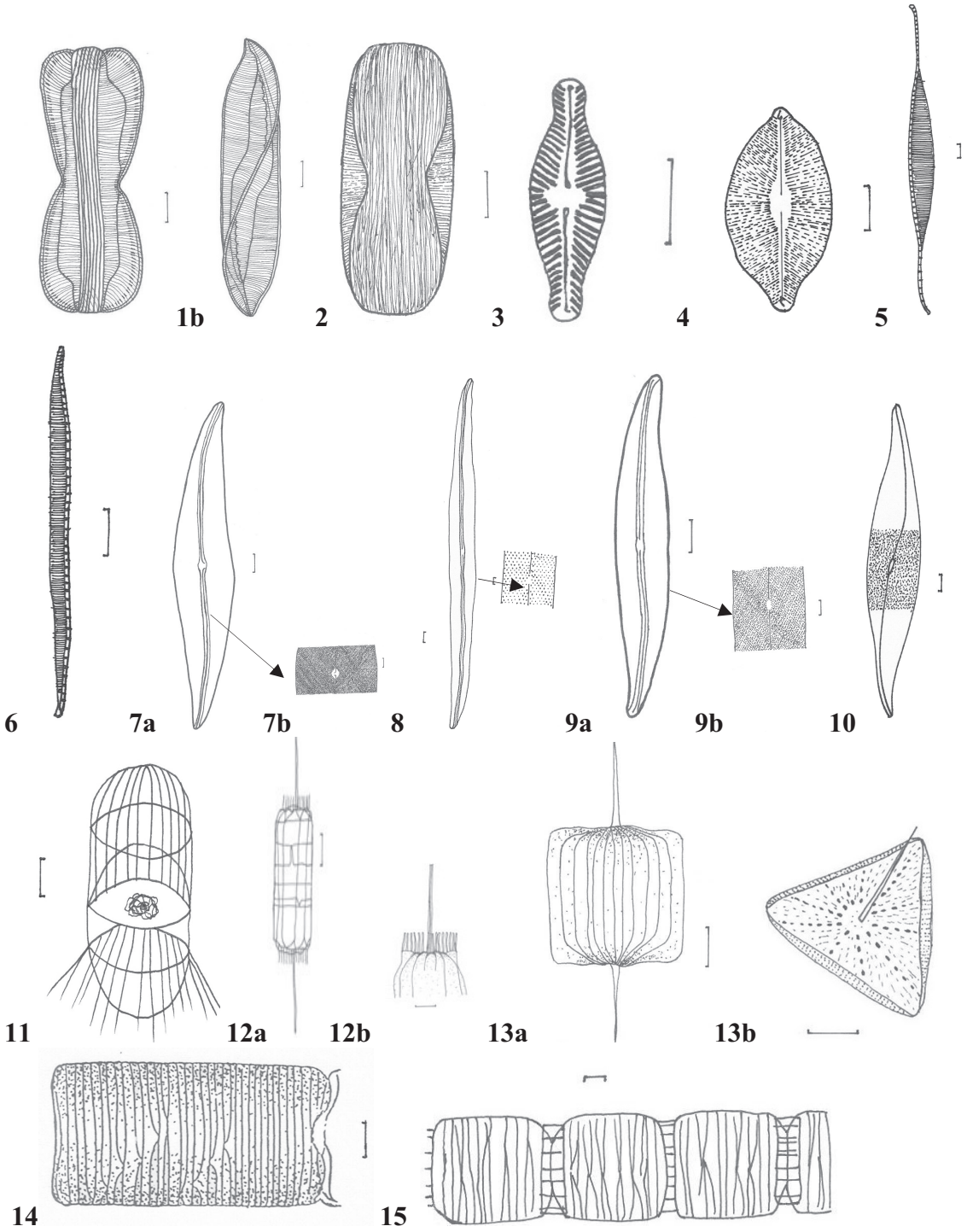

Plate 1. 1. *Amphiprora alata;* **a** valve view; **b** girdle view **2.** *Amphora quadrata* **3.** *Navicula hustedii* **4.** *Navicula pusilla* **5.** *Nitzchia longissima* **6.** *Nitzchia sigma* **7a,b** *Pleurosigma angulatum* **8** *Pleurosigma elongatum* **9a,b** *Pleurosigma salinarum* **10.** *Pleurosigma pelagicum* **11.** *Corethron pelagicum* **12** *Ditylum brightwellii*; **a, b** girdle view **13.** *Ditylum sol* **14.** *Guinardia flaccida* **15.** *Lauderia annulata*

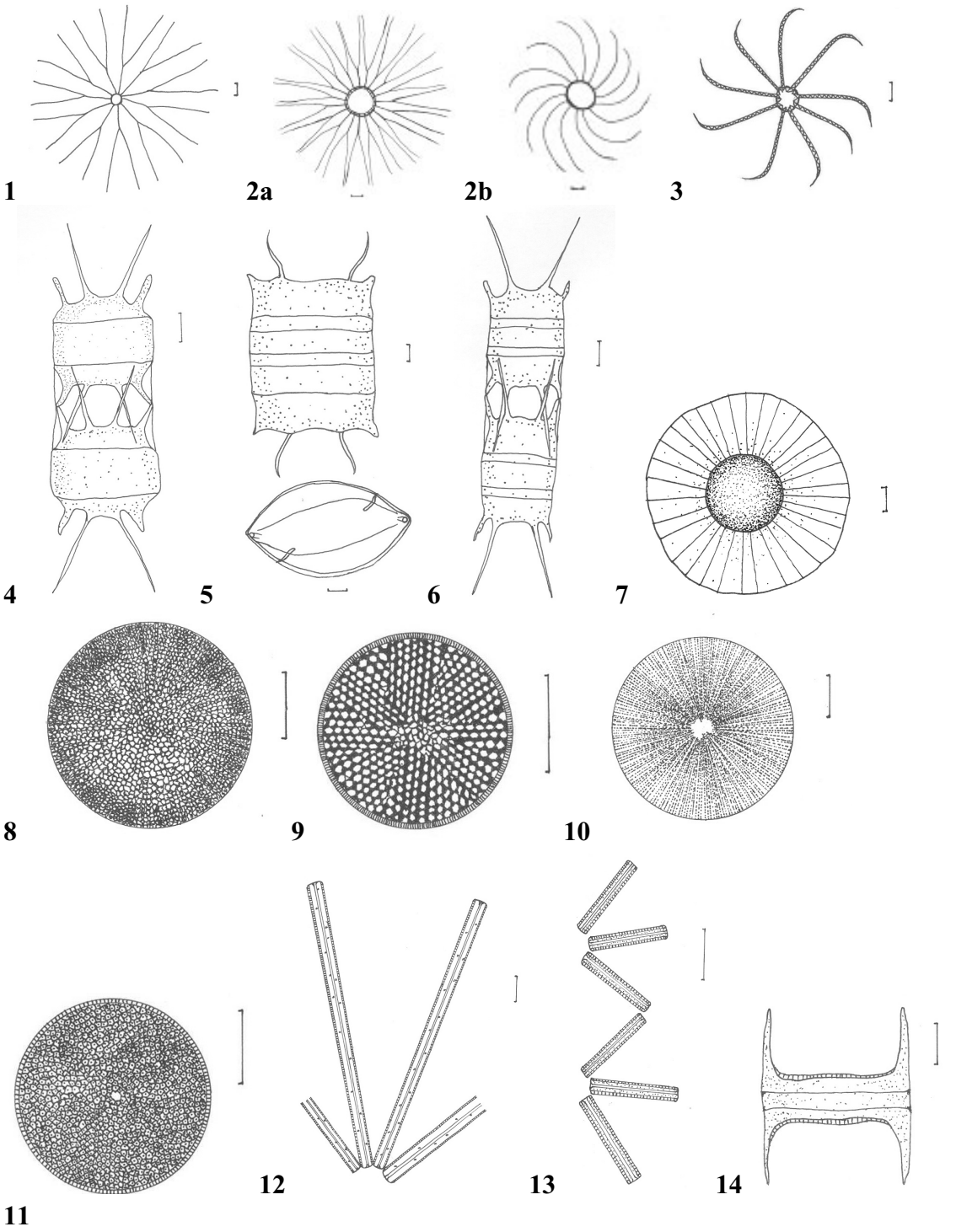

Plate 2. 1. *Bacteriastrum delicatum* **2.** *Bacteriastrum hyalinum* **3.** *Bacteriastrum varians* **4.** *Biddulphia mobiliensis;* girdle view **5.** *Biddulphia regia* **6.** *Biddulphia sinensis; girdle view* **7.** *Planktoniella sol* **8.** *Coscinodiscus asteromphalus* **9.** *Coscinodiscus centralis* **10.** *Coscinodiscus concinnus* **11.** *Coscinodiscus radiatus* **12.** *Thalassiothrix frauenfeldii* **13.** *Thalassionema nitzschioides* **14.** *Hemianulus sinensis*

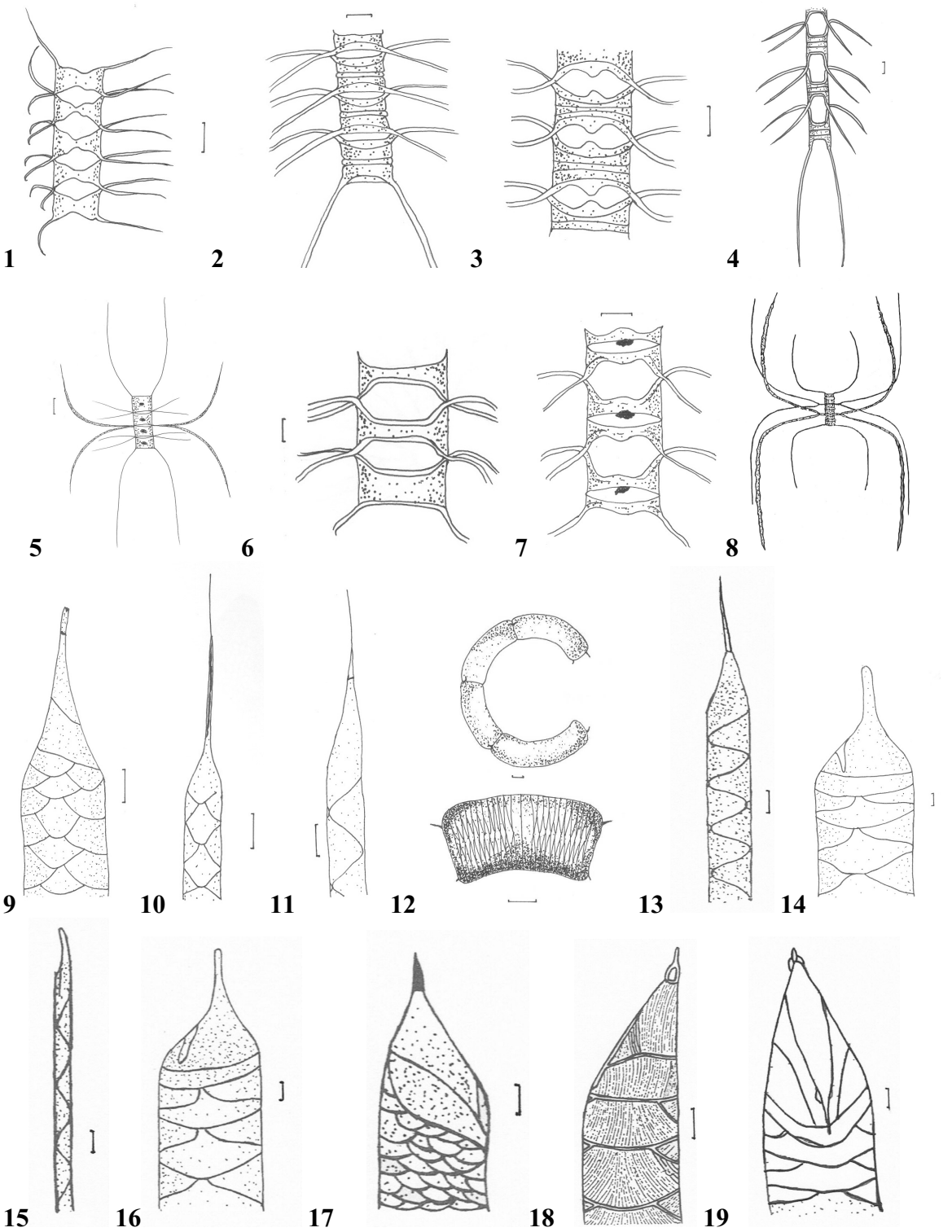

Plate 3. 1. *Chaetoceros cursivetus* **2.** *Chaetoceros constrictum* **3.** *Chaetoceros didymum* **4.** *Chaetoceros distans* **5.** *Chaetoceros diversum* **6.** *Chaetoceros decipiens* **7.** *Chaetoceros lorenzianum* **8.** *Chaetoceros leave* **9.** *Rhizosolenia bergonii* **10.** *Rhizosolenia setigera* **11.** *Rhizosolenia hebetata* **12** *Rhizosolenia stolterforthii* **13.** *Rhizosolenia calcar-avis* **14.** *Rhizosolenia alata* **15.** *Rhizosolenia alata var gracilima* **16.** *Rhizosolenia alata var indica* **17.** *Rhizosolenia acuminata* **18.** *Rhizosolenia imbricata* **19.** *Rhizosolenia styliformis*

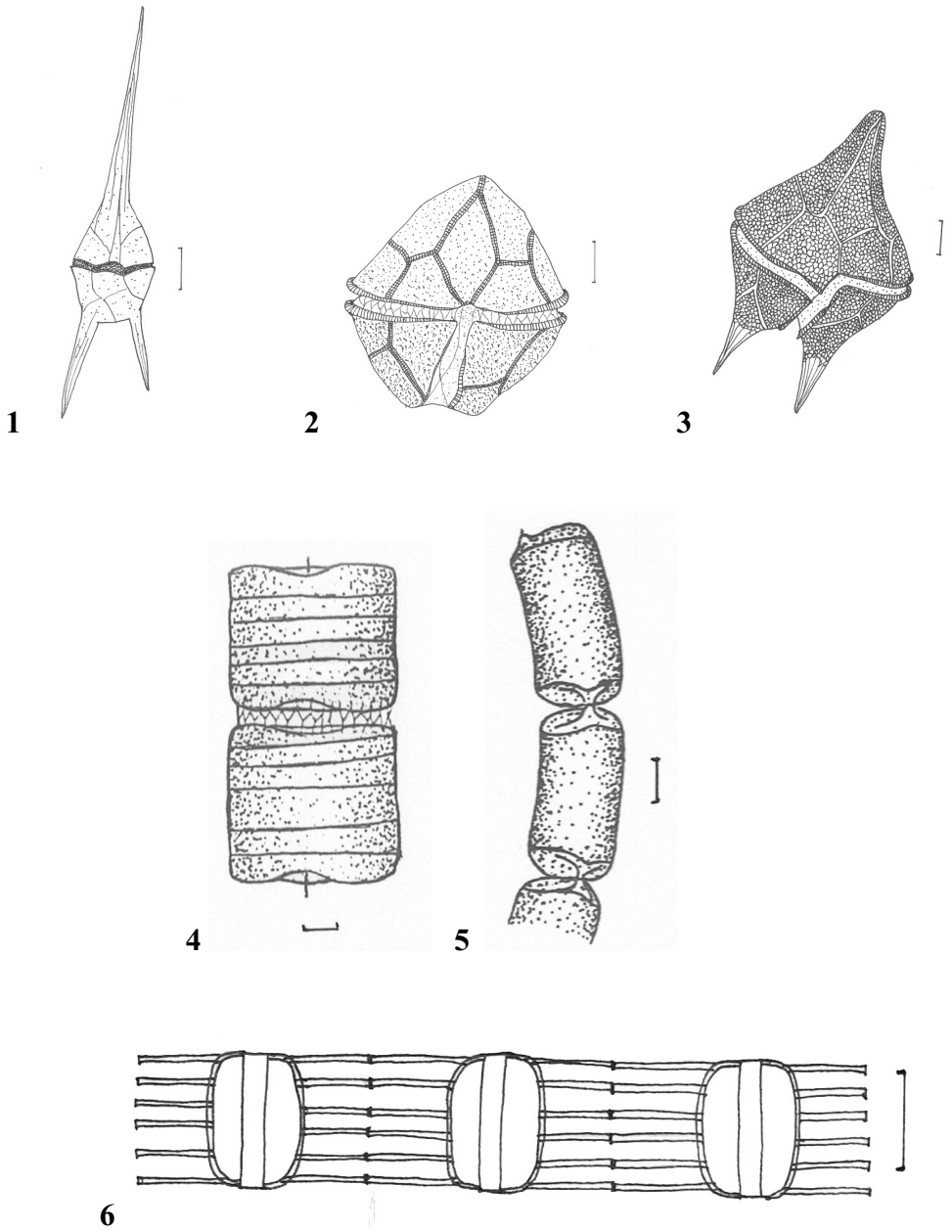

Plate 4. 1. *Ceratium lineatum* **2.** *Protoperidinium punctulatum* **3.** *Protoperidinium oblongum* **4.** *Schroderella schroderi* **5.** *Cerataulina bergonii* **6.** *Skletonema costatum.*

Table 1. List of phytoplankton species in Bachok, Kelantan (symbol '+' and '-' refer to present and absent respectively).

	Stations										
Species	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**
Bacillariophyta (Diatom)											
Amphiproraceae											
1. Amphiprora alata Kutzing	-	-	+	+	-	-	-	-	-	-	-
Catenulaceae											
2. Amphora quadrata Breb	-	-	-	+	-	-	-	+	+	-	-
Chaetocerotaceae											
3. Bacteriastrum delicatulum Cleve	-	+	-	+	-	-	+	-	+	-	-
4. Bacteriastrum hyalinum Lauder	+	+	-	+	-	-	-	+	+	-	-
5. Bacteriastrum varians Lauder	+	+	-	+	+	-	-	-	-	+	-
6. Biddulphia mobiliensis (Bailey) Grunow	-	-	-	-	-	-	+	-	+	-	-
7. Biddulphia regia Ostenfeld	-	-	-	-	-	+	-	-	-	-	-
8. Biddulphia sinensis Greville	-	-	-	-	-	+	+	-	-	-	-
9. Chaetoceros curvisetus Mangin	+	-	-	-	-	-	-	-	-	-	-
10. Chaetoceros constrictum Gran	-	-	-	+	-	-	-	-	-	-	-
11. Chaetoceros didymium Ehr.	-	-	-	-	-	-	-	-	-	+	+
12. Chaetoceros distans Gran	+	-	-	-	-	+	+	+	-	+	+
13. Chaetoceros diversum Cleve	-	-	-	-	-	+	-	+	-	-	-
14. Chaetoceros decipiens Cleve	-	-	-	+	+	-	-	+	-	-	+
15. Chaetoceros leave Cleve	-	+	-	-	-	-	-	-	-	-	+
16. Chaetoceros lorenzianum Grunow	+	-	-	-	-	-	-	-	-	-	-
Corethraceae											
17. Corethron pelagicum Castracane (Brun)	+	-	-	-	-	-	-	-	-	+	-
Coscinodiscaceae											
18. Coscinodiscus asteromphalus Ehr	-	-	-	-	-	+	-	-	-	-	-
19. Coscinodiscus centralis (Ehr.) A. Schmidt	-	-	-	-	-	-	-	-	-	+	-
20. Coscinodiscus concinnus W. Smith	+	-	-	-	-	-	-	-	-	-	-
21. Coscinodiscus radiatus Ehr.	+	+	-	-	+	-	-	+	-	-	-
Lithodesmiaceae											
22. Ditylum brightwellii Grunow	+	+	-	-	-	-	+	+	+	+	-
23. Ditylum sol Grunow	+	+	-	-	-	-	+	-	+	+	-
Hemiauliceae											
24. Hemiaulus sinensis Greville	+	+	+	+	+	-	-	+	-	+	+
25. Cerataulina bergonii H. Perag	+	-	-	+	-	-	-	-	-	-	-
Lauderiaceae											
26. Lauderia annulata Cleve	-	-	+	-	+	-	-	+	-	-	-
Naviculaceae											
27. Navicula hustedii Krasske	-	-	+	+	-	-	-	-	+	-	-
28. Navicula pusilla W. Sm	-	+	-	-	-	-	-	-	-	-	-

Table 1. Continued

	Stations										
Species	**S1**	**S2**	**S3**	**S4**	**S5**	**S6**	**S7**	**S8**	**S9**	**S10**	**S11**
Bacillariaceae											
29. Nitzchia longissima (Berb.) Ralf	+	-	-	+	-	-	-	-	-	-	-
30. Nitzchia sigma W. Sm	+	-	-	-	-	-	-	-	-	-	+
Thalassiosiraceae											
31. Planktoniella sol (Wallic) Schutt	-	-	-	-	+	-	+	+	+	-	+
Pleurosigmataceae											
32. Pleurosigma angulatum (Quek.) W. Sm.	-	-	-	-	+	+	-	-	-	-	-
33. Pleurosigma elongatum W. Sm	-	+	-	+	-	-	-	-	+	+	+
34. Pleurosigma salinarum Grunow	-	-	-	+	-	-	-	-	+	-	-
35. Pleurosigma pelagicum Perag.	-	-	-	+	-	-	-	-	-	-	-
Rhizosoleniaceae											
36. Rhizosolenia alata Brightwell	+	+	+	+	+	+	+	-	-	-	+
37. Rhizosolenia alata var gracilima	+	+	+		+	+	+	-	-	+	-
38. Rhizosolenia alata var indica	+	+	+	+	+	+	+	-	-	-	-
39. Rhizosolenia acuminata Gran.	+	+	+	+	+	+	+	-	-	+	-
40. Rhizosolenia bergonii Perag.	+	+	+	+	+	+	+	-	+	+	+
41. Rhizosolenia calcar-avis M. Schultze	+	+	+	-	-	-	+	-	-	+	+
42. Rhizosolenia setigera Brightwell	+	+	+	-	-	-	-	-	-	-	+
43. Rhizosolenia hebatata Bailey	+	+	+	+	+	+	+	-	+	+	-
44. Rhizosolenia imbricata Brightwell	+	+	+	+	+	+	+	-	+	+	-
45. Rhizosolenia stolterforthii Perag.	+	+	+	+	+	+	+	-	-	-	+
46. Rhizosolenia styliformis Brightwell	+	+	+	+	+	+	-	-	-	+	-
47. Guinardia flaccida (Castr.) Perag.	+	+	+	+	-	-	-	+	+	-	-
48. Schroderella schroderi (Bergon)	-	-	-	-	+	-	-	+	-	+	+
Skeletonemataceae											
49. Skeletonema costatum Greville	-	-	-	-	+	-	+	+	-	+	+
Thalassionemataceae											
50. Thalassiothrix frauenfeldii Grunow	-	-	-	-	+	-	+	+	-	-	-
51. Thalassionema nitzschioides Grunow	+	-	-	-	+	-	-	-	-	-	-
Division : Pyrrophyta (Dinoflagellate)											
Ceratiaceae											
52. Ceratium lineatum (Ehr) Cleve	+	-	-	-	-	-	-	+	-	+	-
Protoperidiniaceae											
53. Protoperidinium punctulatum Paulsen (Balech)	-	-	-	-	-	+	-	-	-	-	-
54. Protoperidinium oblongum	+	+	-	-	-	-	-	-	-	-	-

References: S1 - River mouth of Kuala Kemasin; S2 - Beach at Kuala Kemasin; S3 - Sg. Rekang; S4 - Sg. Dua (I); S5 - Sg. Dua (II); S6 - Sg. Dua (III); S7 - Tok Bali (I); S8 - Tok Bali (II); S9 - Tok Bali (III); S10 - Sg. Semarak; S11- River mouth of Sg. Semerak.

Table 2. Nutrient concentration and physical parameters analyzed from sampling locations at Bachok, Kelantan.

Parameters	**Results (range)**
Nitrate (mg/L)	0.1 - 0.6
Phosphate (mg/L)	0.01 - 1.43
Silica (mg/L)	0.07 - 0.39
Water temperature (°C)	30.84 - 32.22 ± 0.5
pH	7.17 - 8.07 ± 0.05
DO (mg/L)	3.92 - 8.30 ± 0.05
TDS (g/L)	15.63 - 33.43
Conductivity (mS/cm)	27.00 - 57.89
Salinity (ppt)	14.46 - 33.60

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