

SOME PHYTOPLANKTON OF TAMSUI RIVER FROM KUANTU (關渡) TO SHETZU (社子)

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The Tamsui River is the largest river in northern Taiwan. It opens by a small mouth at Tamsui into the Taiwan Strait and pours wastes from sewage, industry and the street water of Taipei City, along with the sandy waters from upper mountainous areas into the sea. Salt water during high tide reaches the edge of Taipei City. At this time, marine plankton is easily mixed with the freshwater biome. In order to know which algal species have invaded into the estuary region of the Tamsui River, the author made a short cruise from Kuantu to Shetzu on the afternoon of July 18th, 1965 around 3:00 P. M. at the time when the tide from the sea was rising. In this collection, a small plankton-net was towed by a small vane-boat horizontally just beneath the surface, at that time a breeze was coming in from the sea. The small boat moved very slowly in the same direction that the tide was entering but in the opposite to the freshwater coming from the mountains, therefore, the collection contained plenty of both marine and freshwater algae. The zooplankton has being studied in a series of projects carried out by the Institute of Fishery Biology of the Ministry of Economic Affairs (Liaw 1965, and Tan 1967), but the algal plankton has not been carefully studied, so the author has undertaken a detailed study of the samples collected.

The samples were preserved in 5% formalin solution. Under microscopic observations, only a few filamentous algae, such as *Zygnema* sp., *Spirogyra* sp., *Hydrodictyon reticulatum*, and some of the *Oscillatoriaceae* were observed. Spherical or unicellular algae were more abundant than the filamentous ones. There were lots of diatoms, desmids and other green cells (especially some of *Euglenophyta*, *Scenedesmus*, *Crucigenia*, *Pediastrum*, together with some other small green colonies).

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A list of recorded species including keys and descriptions follows:

PHYLLA EUGLENOPHYTA, CHLOROPHYTA, PYRRROPHYTA

Key to Kuantu genera

1. Plant unicellular..... 2

1. Plant colonial.....	9
2. Cells motile.....	3
2. Cells nonmotile.....	5
3. Cell with a tail-piece, without hard test.....	4
3. Cell without tail-piece, with hard test.....	3. <i>Trachelomonas</i>
4. Body-form linear-lanceolate.....	1. <i>Euglena</i>
4. Body-form ovate.....	2. <i>Phacus</i>
5. Cell linear, lanceolate or lunate.....	7
5. Cell nearly rounded.....	6
6. Setae at poles.....	19. <i>Chodatella</i>
6. Setae none.....	20
7. Body-form linear-lanceolate or lence-shaped.....	8
7. Body-form lunate.....	12. <i>Closterium</i>
8. Median portion swollen to be lence-shaped.....	20. <i>Characium</i>
8. Median portion slender or parallel sided.....	14. <i>Schroederia</i>
9. Colony filamentous.....	10
9. Colony non-filamentous.....	13
10. Filaments branching; rounded cells having theca.....	21. <i>Dinobryon</i>
10. Filaments straight; cylindrical cells having no theca.....	11
11. Filaments connected with each other becoming net-like.....	15. <i>Hydrodictyon</i>
11. Filaments not connected, always single, free.....	12
12. Chloroplast single, axile.....	18. <i>Mougeotia</i>
12. Chloroplasts two, disc-like.....	16. <i>Pleurodiscus</i>
13. Colony motile.....	4. <i>Pandorina</i>
13. Colony non-motile.....	14
14. Colony almost two or four-celled groups, in one plate.....	15
14. Colony always more than eight-celled in only one group.....	18
15. Cells always in one series.....	9. <i>Scenedesmus</i>
15. Cells not in one series.....	16
16. Cells rounded.....	17
16. Cells not rounded, nearly triangular.....	8. <i>Crucigenia</i>
17. Cells with setae.....	7. <i>Tetraedron</i>
17. Cells without setae.....	5. <i>Westella</i>
18. Cellular shapes rod-like or lunate.....	19
18. Cellular shapes polygonal or lobed as H-shaped.....	10. <i>Pediastrum</i>
19. Shape rod-like.....	6. <i>Actinastrum</i>
19. Shape lunate.....	13. <i>Selenastrum</i>
20. Flagella none; sinus and isthmus present; cell symmetric.....	11. <i>Cosmarium</i>
20. Flagella two; sinus and isthmus none; cell asymmetric.....	20. <i>Gymnodinium</i>

1. *Euglena*

Key to Kuantu species and variety.

1. Cell more than 100 μ in length; paramylum bodies always two, large, rod-like.....(1) *E. ascus*
1. Cell less than 70 μ in length; paramylum always two, flattened, ring-like bodies.....(2) *E. oxyuris* var. *minor*
- (1) ***Euglena ascus* Ehrenberg** (Pl. I, fig. 11)
Cells elongate spindle-shaped, produced posteriorly into a long, fine tapering point, narrowed at the anterior end; chloroplasts numerous; paramylon bodies two to several long rod-like; cells 12-16 μ in diameter, 100-180 μ long. Common.
Freshwater. This had been recorded from Mt. A-li and Chitou.
- (2) ***Euglena oxyuris* var. *minor* Prescott** (Pl. I, fig. 12)
Cells elongate-cylindric, tapering posteriorly to form a short caudus; chloroplasts numerous; paramylon two large, flattened ring-like bodies; cells 15-18 \times 77-85 μ (sample 12 μ in diameter, 68 μ long). Scarce.
Freshwater. New to Taiwan.

2. *Phacus*

Key to Kuantu species.

1. Caudus straight, long.....(4) *P. longicauda*
1. Caudus obliquely bent, short.....2
 2. Paramylon body single.....(5) *P. pleuronectus*
 2. Paramylon bodies always two.....3
3. One of paramylon bodies is found beside the other.....(3) *P. curvicauda*
3. One of paramylon bodies is beyond the other.....(6) *P. swirenkoi*
- (3) ***Phacus curvicauda* Swirenko** (Pl. I, fig. 5)
Cells broadly ovoid in outline, extended posteriorly into a caudus bent obliquely to the left; paramylon two large bodies; chloroplasts numerous; cells 25-30 μ long, 28-30 μ in diameter. Scarce.
Freshwater. New to Taiwan.
- (4) ***Phacus longicauda* (Ehr.) Dujardin** (Pl. I, fig. 6)
Cells broadly ovoid, 45-70 μ (sample 35-45 μ in diameter, 80-100 μ long), tapering very gradually posteriorly to form a long, straight, sharply caudus, paramylon usually a single large, circular body; chloroplasts numerous, disc-like.
Freshwater. This had been recorded from Mt. A-li.
- (5) ***Phacus pleuronectus* (Müller) Dujardin** (Pl. I, fig. 7)
Cell broadly ovoid. (sample 45 \times 70 μ); posterior caudus short, 16 μ long,

obliquely curved; paramylon usually single, large body; chloroplasts numerous, disc-like. Scarce.

Freshwater. New to Taiwan.

- (6) **Phacus Swirenkoi** Skvortzow (Pl. I, fig. 8)

Cells broadly ovoid, (sample $26 \times 35 \mu$, less broad in diameter than that in literature), with an obliquely curved caudus; paramylon single or two plates. Scarce.

Freshwater. New to Taiwan.

3. *Trachelomonas*

Key to Kuantu species and variety.

1. Test broadly jar-like (10) *T. schewiakoffii*
1. Test rounded or slightly elliptic 2
2. Spines none (8) *T. volvocina* var. *derephora*
2. Spines few or many 3
3. The wall beset with three radiating spines (7) *T. aculata*
3. The wall beset with numerous spines (9) *T. hispida*
- (7) ***Trachelomonas aculata*** Dolgoff (Pl. I, fig. 1)
- Test 32μ long, 30μ in diameter, ball-like, with three, 10–15 μ , spines radiating from the posterior part. Scarce.
- Freshwater. New to Taiwan.
- (8) ***Trachelomonas volvocina*** var. *derephora* Conrad (Pl. I, fig. 2)
- Test slightly ellipsoid, $28 \times 35 \mu$; flagellum aperture in a short, slightly expanded collar at the outer rim; shell reddish-brown. Scarce.
- Freshwater. New to Taiwan.
- (9) ***Trachelomonas hispida*** (Perty) Stein & Deflandre (Pl. I, fig. 3)
- Test ovate, $18 \times 24 \mu$; the wall evenly beset with numerous short spines; flagellum aperture with a slight thickening. Scarce.
- Freshwater. New to Taiwan.
- (10) ***Trachelomonas schewiakoffii*** Skvortzow (Pl. I, fig. 4)
- Test broadly spindle-shaped, tapering at two poles; flagellum aperture expanded out like a vase-mouth; 26μ in diameter, 40μ long. Scarce.
- Freshwater. New to Taiwan.

4. *Pandorina*

Only one species was found on this cruise.

- (11) ***Pandorina morum*** (Müller) Bory
 4–32 celled colonies, 15–35 μ in diameter. Common.
 Freshwater. This has been recorded from Mt. A-li.

5. *Westella*

Only one species was found on this cruise.

- (12) *Westella botryoides* (W. West) de Wildeman (Pl. I, fig. 29)
Colony always composed of 4 groups of spherical cells, each group 4 celled, connected loosely by the persistent remains of mother cell walls. Cells 3-5 μ in diameter. Rare.
Freshwater. This had been recorded from Mt. A-li and Hualien.

6. *Actinastrum*

Key to Kuantu species. and variety.

1. Far pole of cell pointed.....(14) *A. hantzschii* var. *fluviatile*
1. Far pole of cell flattened(13) *A. gracilimum*
(13) *Actinastrum gracilimum* G. S Smith (Pl. I, fig. 22)
Cells slenderly rod-like, 20 \times 24 μ , forming a radiating colony. Rare
Freshwater. This has been recorded from Tainan.
(14) *Actinastrum hantzschii* var. *fluviatile* Schroeder (Pl. I, fig. 26)
Cells slenderly spindle-shaped, 2.0-3.0 \times 15-18 μ , with pointed apices, forming a radiating colony. Rare.
Freshwater. New to Taiwan.

7. *Tetraedron*

Only one species was found on this cruise.

- (15) *Tetraedron elegans* Playhair (Pl. I, fig. 10)
Cells nearly spherical, 4-5 μ in diameter, each with a long, straight spine, 12-18 μ long; composed of four-celled; with an angle of ninety degree between two spines. Rare.
Freshwater. New to Taiwan.

8. *Crucigenia*

Key to Kuantu species.

1. Cells kidney-like.....(17) *C. lauterbornei*
1. Cells nearly triangular.....2
2. Colony consisting of trapezoidal cells, with a central space.....(16) *C. fenestrata*
2. Colony consisting of four right-triangular cells, without central space(18) *C. tetrapedia*
(16) *Crucigenia fenestrata* Schmidle
Colony square, consisting of four trapezoidal cells, always forming multiple colonies. Rare.
Freshwater. New to Taiwan.

- (17) **Crucigenia Lauterbornei** Schmidle (Pl. I, fig. 18)
Cells 4.5-5.5×6-10 μ ; four-celled coenobia, only contacted at the apices of cells; always forming multiple colonies. Rare.
Freshwater. New to Taiwan.
- (18) **Crucigenia tetapedia** (Kirch.) West & West (Pl. I, fig. 19)
Colony square, consisting of four triangular cells, always forming multiple colonies. Rare.
Freshwater. This had been recorded from Tainan.

9. Scenedesmus

Key to Kuantu species.

1. Outer cells having long spines.....2
 1. Outer cells having no spines.....(20) *S. incrassatus*
 2. Spine single at one pole of each outer cell only.....(19) *S. diagonalis*
 2. Spine two at two poles of each outer cell.....3
 3. Outer cells with straight spines.....(21) *S. opoliensis*
 3. Outer cells with curved spines.....(22) *S. quadricauda*
- (19) **Scenedesmus diagonalis** S. Fang (Pl. I, fig. 23)
Colony composed of (2)-4-8 fusiform cells arranged in one series; outer cells with obliquely bent spines, inner cells none. Cells 3-5×14-20 μ . Scarce.
Freshwater. This had been recorded from Tainan.
- (20) **Scenedesmus incrassatus** Bohlin (Pl. I, fig. 24)
Colony always composed of four fusiform, subacute cells, arranged in one alternating series; cells 5-6×13.15 μ (shorter form than that in the literatures). Scarce.
Freshwater. New to Taiwan.
- (21) **Scenedesmus opoliensis** P. Richter (Pl. I, fig. 25)
Colony always composed of four elliptic cells arranged in single series, with two long spines at each outer cell; inner cells with a very short spines at one pole only; cells 6-6.5×18-22 μ , with 16-20 μ long spines. Scarce.
Freshwater. This had been recorded from Tainan and Chitou.
- (22) **Scenedesmus quadricauda** (Turp.) de Brébisson
Colony composed of 2-4-8 fusiform cells, arranged in one series; outer cells with a long curved spine at each pole; inner cells without spines; cells 3-6×16-18 μ . Common.
Freshwater. This had been recorded from Hualien.

10. Pediatrum

Key to Kuantu species and varieties.

1. Outer half of marginal cells with only one

- projection.....(26) *P. simplex* var. *duodenarium*
1. Outer half of marginal cells with two projections2
 2. Cells U-shaped.....(2) *P. tetras*
 2. Cells H-shaped-(at least marginal cells).....3
 3. Cells compacted together (at least the inner cells).....(23) *P. boryanum* var. *perforatum*
 3. Cells arranged orderly with lobial connections, with net-eyed spaces.....4
 4. Cells broadly H-shaped.....(24) *P. duplex*
 4. Cells slenderly H-shaped.....(25) *P. duplex* var. *gracillimum*
- (23) ***Pediastrum boryanum* var. *perforatum* Racib.**
Coenobia always more than 30 compacted cells; marginal cells with two short projections. Common.
Freshwater. New to Taiwan.
- (24) ***Pediastrum duplex* Meyer** (Pl. I, fig. 15)
Cells 10–20 μ in diameter, with smooth walls, broadly constricted at median portions; outer half of marginal cells with two short projections. Common.
Freshwater. This had been recorded from Mt. A-li and Hualien.
- (25) ***Pediastrum duplex* var. *gracillimum* W. & G. S. West** (Pl. I, fig. 16)
Cells nearly H-shaped and connected each other with the topes of cellular lobes. Scarce.
Freshwater. New to Taiwan.
- (26) ***Pediastrum simplex* var. *duodenarium* (Bailey) Rabh.** (Pl. I, fig. 21)
Outer half of marginal cells only one projection; cells triangular; 16-celled coenobia, 90 μ in diameter in the sample. Scarce.
Freshwater. This had been recorded from Mt. A-li and Chitou.
- (27) ***Pediastrum tetras* (Ehr.) Ralfs** (Pl. I, fig. 14)
Colony entire with one inner cell; all cells with one margin deeply incised like U-shaped; colony 35 μ in diameter, cells 10–12 μ long in the sample. Scarce.
Freshwater. This had been recorded from Botel Tobago and Chitou.

11. *Cosmarium*

Only one species was found on this cruise.

- (28) ***Cosmarium decedens* (Reinsch) Racib** (Pl. I, fig. 13)
Cells long-rectangular, moderately constricted, sinus slightly opened; semicells subrectangular, lateral margin concave and basal margin also concave; chloroplast one, axile and with one central pyrenoid per semicell. Rare.
Freshwater. This had been recorded in Taiwan spas (Chang 1965).

12. *Closterium*

Key to Kuantu species.

1. Cell actually lunate.....2
 1. Cells straight except at the polar apices.....(29) *C. gracile* var. *striolatum*
 2. Pyrenoids numerous, scattered.....(30) *C. lunula*
 2. Pyrenoids less than ten in one downward series.....3
 3. Inner margin inflated in the middle.....(31) *C. moniliferum*
 3. Inner margin straight.....(32) *C. pritchardianum*
- (29) ***Closterium gracile* var. *striolatum* Krieg.**
 Cell $4 \times 210 \mu$ ($130-206 \mu$ long in literatures), straight, long; with acute, 45 degree obliquely bent poles. Rare.
 Freshwater. New to Taiwan.
- (30) ***Closterium lunula* (Müller) Nitzsch**
 Cells spindle-shaped; inner margin straight, outer margin 20-50 degree of arc; pyrenoids numerous, scattered. Common.
 Freshwater. New to Taiwan.
- (31) ***Closterium moniliferum* (Bory) Ehrenberg**
 Cells $32-35 \times 200-250 \mu$ ($30-68 \times 188-420 \mu$ in literatures), inner margin inflated in the middle, narrowed to apices; outer margin 100-130 degree of arc; pyrenoids 6-7 in a median series. Scarce.
 Freshwater. This has been recorded from Mt. A-li.
- (32) ***Closterium pritchardianum* Archer**
 Cells $45-58 \times 500-580 \mu$ ($28-55 \times 350-670 \mu$ in literatures), slightly curved, outer margin 20-45 degree (24-43 degree in literatures) of arc, inner margin almost straight; pyrenoids 7-8 in a median series. Common.
 Freshwater. New to Taiwan.

13. *Selenastrum*

Only one species was found on this cruise.

- (33) ***Selenastrum minutum* Collins** (Pl. I, fig. 27)
 Cells often solitary, paired or in small families, irregularly arranged, crescent-shaped; cells $2-3 \mu$ in diameter, $7-10 \mu$ between two apices. Rare.
 Freshwater. New to Taiwan.

14. *Schroederia*

Only one species was found on this cruise.

- (34) ***Schroederia setigera* (Schroed.) Lemm.** (Pl. I, fig. 9)
 Cells solitary, acicular, $3-4 \times 35-42 \mu$ ($2.5-10.0 \times 22.5-52.5 \mu$ in literatures), with spines. Common.
 Freshwater. New to Taiwan.

15. *Hydrodictyon*

Only one species was found on this cruise.

- (35) *Hydrodictyon reticulatum* (L.) Lagerheim

Plant forms a cylindrical colony with 5-or 6-sides. Rare.

This had been recorded from Mt' A-li.

16. *Pleurodiscus*

Only one kind of young filaments was found on this cruise.

- (36). *Pleurodiscus purpureus* (Wolle) Lagerh. (Pl. I, fig. 30)

Cells cylindric, with two free or slightly connected chloroplasts. Scarce.

New to Taiwan.

17. *Spirogyra*

Two kinds of vegetative cells were found on this cruise. {They could not be identified because of lack of conjugation structures.

Key to Kuantu species.

1. Cell cylindrical with loosely spiral-bands of chloroplast... (37) *Spirogyra* sp. 1.

1. Cell cylindrical with compressed bands of chloroplast (38) *Spirogyra* sp. 2.

- (37) *Spirogyra* sp 1. Common. (Pl. I, fig. 31)

- (38) *Spirogyra* sp 2. Common. (Pl. I, fig. 32)

18. *Mougeotia*

Only one kind of vegetative filaments was found on this cruise.

- (39) *Mougeotia* sp. (Pl. I, fig. 33)

Cell cylindrical, 6-15 μ in diameter, 60-120 μ long, with an axile, massive chloroplast. Common.

19. *Chodatella*

Only one species was found on this cruise.

- (40) *Chodatella subsalsa* Lemm.

Cells ovate, with four setae at poles. Rare.

Freshwater. New to Taiwan.

20. *Characium*

Only one species was found on this cruise.

- (41) *Characium ambiguum* Hermann (Pl. I, fig. 23)

Cell solitary, lence-shaped, 6 \times 30 μ (4-8 \times 25-30 μ in literatures). Rare.

Freshwater. New to Taiwan.

21. Dinobryon

Only small fragments were found on this cruise.

- (42) *Dinobryon* sp. (Pl. I, fig. 28)

Loricas widely opened, bell-like; protoplast with 1 plate-like, parietal chromatophore, and with two flagella. Scarce.

22. Gymnodinium

Only one kind of cells were found on this cruise.

- (43) *Gymnodinium* sp.

Cell nearly ball-like, $17 \times 20 \mu$; furrow in the middle and a half longitudinal branch. Rare.

CLASS BACILLARIOPHYCEAE

Key to the Kuantu genera.

1. Valve with radial ornamentation about at central point.....2
1. Valve with transverse ornamentation (sometimes longitudinal).....7
 2. Cells united into long filaments.....3
 2. Cells not united into long filaments.....5
3. Valves without spines.....23. *Melosira*
3. Valves with spines.....4
 4. Terminal cell with four spines only.....28. *Chaetoceros*
 4. Terminal cell with more than eight spines.....26. *Bacteriastrium*
5. Valve with spines.....27. *Biddulphia*
5. Valve without spines.....6
 6. Valve with net-eyed ornamentation.....24. *Coscinodiscus*
 6. Valve with radiating-line ornamentation.....25. *Cyclotella*
7. Valve longitudinal symmetric.....8
7. Valve longitudinal asymmetric.....14
 8. Valve-view sigmoid.....36. *Gyrosigma*
 8. Valve-view otherwise.....9
9. Valve with transverse costae.....39. *Surirella*
9. Valve without transverse costae.....10
 10. Valve transversely asymmetric.....34. *Gomphonema*
 10. Valve transversely symmetric.....11
11. Valve ellipsoid.....12
11. Valve naviculoid or rod-like.....13
 12. Cell rectangular in girdle view.....33. *Diploneis*
 12. Cell transversely curved in girdle view.....32. *Cocconeis*
13. Valve naviculoid.....37. *Navicula*
13. Valve long, rod-like.....29. *Synedra*

14. Raphe without a marginal keel15
 14. Raphe not within a marginal keel16
 15. Cells rectangular in cross-section (according to literature); constriction in the middle (in Kuantu sample).....31. *Hantzschia*
 15. Cells rhombic in cross-section (according to literature); no constriction in the middle of Kuantu species38. *Nitzschia*
 16. Valves with transverse costae.....30. *Rhopalodia*
 16. Valves without transverse costae.....35. *Cymbella*

23. *Melosira*

Key to Kuantu species.

1. Cells less than 7 μ ; girdles finely punctate.....(44) *M. italica*
 1. Cells more than 20 μ ; girdles smooth.....(45) *M. varians*
 (44) *Melosira italica* (Ehr.) Kützing
 Cells 6.0–6.5 \times 20–22 μ , sulcus and striations not observed in the sample. A filamentous diatom. common.
 Freshwater, brackish, coastally marine. New to Taiwan.
 (45) *Melosira varians* C. A. Ag. (Pl. II, fig. 13)
 Cells 22–24 \times 25–28 μ ; valves slightly concave; girdles nearly smooth. A filamentous diatom. Common.
 Freshwater, brackish, and coastally marine. This had been recorded from Taiwan spas (Chang 1965).

24. *Coscinodiscus*

Key to Kuantu species and variety.

1. Valve with a smooth central space.....(46) *C. gigas* var. *pratexta*
 1. Valve without any central space.....(47) *C. lacustris*
 (46) *Coscinodiscus gigas* var. *pratexta* (Janisch) Hustedt
 Only fragments were found on this cruise. Cells finely, radiately punctate, with a smooth central-space. Rare.
 A southern, warm-sea species. New to Taiwan.
 (47) *Coscinodiscus lacustris* Grunow
 Cells 30–46 μ in diameter. Rare.
 A coastal species, always found in estuaries and in freshwaters.
 New to Taiwan.

25. *Cyclotella*

Only one variety was found on this cruise.

- (48) *Cyclotella comata* var. *oligactis* (Ehr.) Grunow (Pl. II, fig. 1)
 Cells 15 μ in diameter; valve with marginally radiating striations, with a

large smooth-central-area, sometimes with several scattered dots; without spines. Rare.

Very common in freshwaters. New to Taiwan.

26. *Bacteriastrium*

Only one species was recorded on this cruise.

(49) *Bacteriastrium hyalinum* Lauder.

A straight, filamentous diatom; setae 15 or more on the terminal cells. Common.

The commonest species in the Atlantic, a very common one in the Pacific; they are found rather commonly in estuaries (Kokubo 1965, p. 162). New to Taiwan-flora, but they have been recorded from the Taiwan Straits.

27. *Biddulphia*

Only one species was recorded on this cruise.

(50) *Biddulphia sinensis* Greville

(Pl. II, fig. 11)

Cells free or united into a filamentous colony; cell cylindric, with four spines at the two poles. Common.

A warm-sea diatom. This has been recorded from the Taiwan Straits.

28. *Chaetoceros*

Key to Kuantu species.

1. Colonial chain bent or spirally curved; the space between two cells naviculoid.....(51) *C. curvisetus*
 1. Colonial chain straight; the space between two cells hexagonal.....(52) *C. lorenzianus*
- (51) *Chaetoceros curvisetus* Cleve (Pl. II, fig. 14)
 Cell 20 μ in diameter. Rare.
 A coastal species. New to Taiwan.
- (52) *Chaetoceros lorenzianus* Grunow (Pl. II, fig. 17)
 Cells 20-35 μ in diameter. Scarce.
 A coastal, warm-sea species. This has been recorded from the Taiwan Straits.

Order PENNALES

29. *Synedra*

Only one species was recorded on this cruise.

(53) *Synedra ulna* (Nitzsch) Ehrenberg

This type has many different forms. Common.

Freshwaters and marine. This has been recorded from Taiwan spas (Chang 1965.).

30. *Rhopalodia*

Key to Kuantu species.

1. Cells broadly linear with median inflation.....(54) *R. gibba*
1. Cells broadly ovate.....(55) *R. gibberula*
- (54) *Rhopalodia gibba* (Ehr.) Müller (Pl. II, fig. 9)
Cells broadly linear with median inflation and broadly rounded poles in girdle view. Common.
Freshwater. New to Taiwan.
- (55) *Rhopalodia gibberula* (Ehr.) Müller (Pl. II, fig. 10)
Cells broadly ovate, with distinct costae. Common.
Freshwater. This has been recorded from Taiwan spas (Chang 1965).

31. *Hantzschia*

Only one species was found on this cruise.

- (56) *Hantzschia amphioxys* (Ehr.) Grunow (Pl. II, fig. 3)
Cells $5-8 \times 50-56 \mu$; valve concave on one side and convex on the other.
Scarce.
Brackish, freshwater. New to Taiwan.

32. *Cocconeis*

Only one variety was found on this cruise.

- (57) *Cocconeis placentula* var. *klinoraphis* Geitler
Scarce. This has been recorded from the Taiwan spas (Chang 1965).
Freshwater, brackish waters.

33. *Diploneis*

Only one species was found on this cruise.

- (58) *Diploneis puella* (Schumann) Cleve
Scarce. This has been recorded from the Taiwan spas (Chang 1965).

34. *Gomphonema*

Only one species was found on this cruise.

- (59) *Gomphonema sphaerophorum* Ehrenberg (Pl. II, fig. 16)
Cell $10 \times 36 \mu$; valve elliptic-clavate, sharply tapering toward a round, capitate pole and with a knob-like apical-pole; striations 11-16 in 10μ . Rare.
Freshwater. New to Taiwan.

35. *Cymbella*

Only three species have been found on this cruise.

Key to Kuantu species.

1. Valve more than 200 μ in length.....(60) *C. lanceolata*
1. Valve less than 100 μ in length.....2
 2. Transverse striations tube-like.....(61) *C. turgida*
 2. Transverse striations just line-like.....(62) *C. ventricosa*
- (60) *Cymbella lanceolata* (Ehr.) Van Heurck.....(Pl. II, fig. 8)
Cells 24-34 \times 200-210 μ ; valve slightly naviculoid, dorsally convex, ventrally concave with a swollen middle; briefly transverse striation, punctate.
Common.
Brackish water. New to Taiwan.
- (61) *Cymbella turgida* Gregory.....(Pl. II, fig. 5)
Common. This has been recorded from the Taiwan spas (Chang 1965).
- (62) *Cymbella ventricosa* Kützinger.....(Pl. II, fig. 4)
Valve slightly naviculoid, with median inflation on ventral margin.
Common. New to Taiwan.

36. Gyrosigma

Key to Kuantu species.

1. Valve with more acute poles, more than 100 μ long.....(63) *G. kuetzingii*
1. Valve with rounded poles, less than 80 μ in length.....(64) *G. scalproides*
- (63) *Gyrosigma kuetzingii* (Grunow) Cleve.....(Pl. II, fig. 7)
Cells 12-15 \times 80-120 μ (sample: 12 \times 100 μ); valve S-formed, sharply tapering to rounded poles. Scarce.
Freshwater, brackish, marine. New to Taiwan.
- (64) *Gyrosigma scalproides* (Rabh.) Cleve.....(Pl. II, fig. 6)
Valve S-shaped, with very gradually tapering toward rounded poles. Rare.
Freshwater, brackish. New to Taiwan.

37. Navicula

Only one species was found on this cruise.

- (65) *Navicula cryptocephala* Kützinger
Scarce. This has been recorded from the Taiwan spas (Chang 1965).

38. Nitzschia

Key to Kuantu species and variety.

1. Valve linear, straight.....2
1. Valve slightly sigmoid, with curved poles.....(66) *N. longissima* var. *reversa*
 2. Colony plate-like.....(67) *N. paradisa*
 2. Colony chain-like.....(68) *N. seriata*

- (66) *Nitzschia longissima* var. *reversa* W. Smith (Pl. II, fig. 2)
Needle-like valve with swollen middle and with obliquely curved poles; cells 60–80 μ in length, smaller forms (115–200 μ in literatures). Common.
Brackish, freshwater. New to Taiwan.
- (67) *Nitzschia paradoxa* Gmelin (Pl. II, fig. 12)
Cells connected with their valves into a plate-like colony; each can move forward or backward, changing the colonial form. Scarce.
Marine, brackish, freshwater. New to Taiwan.
- (68) *Nitzschia seriata* Cleve (Pl. II, fig. 14)
Cells connected at polar portions to form a chain-colony; valve linear-lanceolate with acute poles. Scarce.
Marine. They have been recorded from Taiwan Strait.

39. *Surirella*

Key to *Kuantu* species and variety.

1. Cell isopolar.....(69) *S. linearis*
1. Cell not isopolar.....(70) *S. robusta* var. *splendida*
- (69) *Surirella linearis* W. Smith (Pl. II, fig. 18)
Cells lateral symmetric, isopolar, 9–25 \times 20–215 μ (sample: 30 \times 120 μ); valve linear with parallel sides and roundedly tapering to cuncate poles; costae 2–5 (sample: 2–3) in 10 μ . Scarce.
Freshwater, brackish. New to Taiwan.
- (70) *Surirella robusta* var. *splendida* (Ehr.) Van Heurck (Pl. II, fig. 15)
Cells lateral symmetric, not isopolar; 40–60 \times 75–250 μ (sample: 66 \times 180 μ), with ovate to elliptic valves with broadly rounded poles; costae 0.7–1.5 (sample: 0.5–1.0) in 10 μ . Scarce.
Freshwater, brackish. This has been recorded from the Taiwan spas (Chang 1965).

Division CYANOPHYTA

Key to *Kuantu* species and variety of the blue-green algae.

1. Colony filamentous.....3
1. Colony made up of a mass of cells.....2
2. Cells in a colony of less than 50, always unicellular or in pairs.....(72) *Chroococcus turgidus*
2. Cells in a colony more than 50, forming a large mass of various shapes.....(71) *Microcystis flos-aquae*
3. Filaments spiral.....(82) *Spirulina nordstedti*
3. Filaments straight or only bent at polar portion.....4

4. Filaments less than 2.5μ in diameter; septa not visible5
4. Filaments more than 3.0μ in diameter; septae granulate.....6
5. Sheath visible; trichome more or less entangled about
other algae.....(80) *Phormidium orientale*
5. Sheath not visible; trichome free.....(81) *Phormidium tenue*
6. Filaments terebriform at poles.....(79) *Oscillatoria terebriformis*
6. Filaments straight or obliquely bent at the poles.....7
7. Filament distinctly constricted at the cross-walls8
7. Filament not constricted (or very slightly constricted).....9
8. Heterocysts present..... (73) *Anabaena affinis*
8. Heterocysts none.....(76) *Oscillatoria constricta*
9. Septae granulate; cell contents finely granulate.....10
9. Septae finely granulate; cell contents coarsely granulate.....11
10. Cells less than 10μ in diameter.....(77) *Oscillatoria formosa*
10. Cells more than 15μ in diameter.....(78) *Oscillatoria limosa*
11. Cells with dark pseudovacuoles.....(74) *Oscillatoria tenuis* var. *tergestina*
11. Cells without pseudovacuoles.....(75) *Oscillatoria chalybea*

40. Microcystis

- (71) *Microcystis flos-aquae* (Witttr.) Kirchner
Cells $3-7 \mu$ in diameter. Common.
Freshwater, colonial. This has been recorded from Hualien.

41. Chroococcus

- (72) *Chroococcus turgidus* (Kützing) Nägeli
Cells solitary or 2-4-8 celled colonies, with sheath. Scarce.
Freshwater. This has been recorded from the Taiwan spas (Chang 1965).

42. Anabaena

- (73) *Anabaena affinis* Lemm. (Pl. I, fig. 38)
Filamentous trichomes; cells and heterocysts same sized, $5-6 \mu$ in diameter.
Rare.
Freshwater. New to Taiwan.

43. Oscillatoria

- (74) *Oscillatoria tenuis* var. *tergestina* (Kütz.) Rabh. (Pl. I, fig. 34)
Cells $4-6 \mu$ in diameter and $3-4 \mu$ long, coarsely granulate; trichomes
straight or slightly bent, not constricted at cross-walls, very gradually
tapering at the apex; and apical cells acute to rounded. Rare.
Freshwater. This has been recorded from the Taiwan spas (Chang 1965).

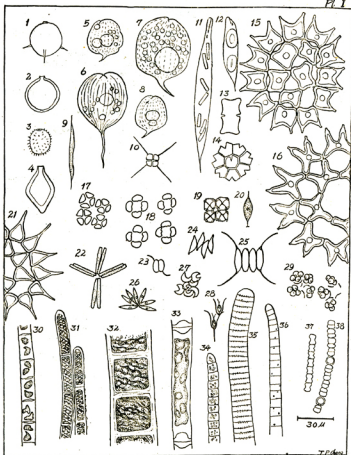
- (75) *Oscillatoria chalybea* Mertens (Pl. I, fig. 36)
Cells $8-10 \times 3-5 \mu$, finely granular with scattered refringent granules; trichomes straight but tapering at the apex; end cell bent and acute. Common. Freshwater, brackish. This has been recorded from Taiwan spas (Chang 1965).
- (76) *Oscillatoria constricta* Szafer (Pl. I, fig. 37)
Cell $4 \times 8 \mu$, constricted at the middle; trichomes straight or slightly bent, constricted at cross-walls. Rare, only a few fragments were found. Freshwater. This has been recorded from the Taiwan spas (Chang 1965).
- (77) *Oscillatoria formosa* Bory
Cells $8-10 \times 3-4 \mu$; trichomes straight, but bent and tapering at the apex, not constricted but granulated at cross-walls. Common. Freshwater, brackish. This has been recorded from the Taiwan spas (Chang 1965).
- (78) *Oscillatoria limosa* (Roth) C. A. Ag. (Pl. I, fig. 35)
Cells $14-15 \times 3.0-4.5 \mu$; trichomes straight but sometimes slightly bent at the apex. Some of our sample is more similar to *O. pernata* Skuja (in Desikachary, 1959, p. 205, pl. 41, f. 8, 9, 14), because of depressed hemispherical apical cells, calyptra absent, and trichome slightly constricted at cross-walls. Common. Freshwater, brackish. This has been recorded from the Taiwan spas (Chang 1965).
- (79) *Oscillatoria terebriformis* Ag.
Trichomes twisted spirally and tapered at the apex; end cell acute-conical, without calyptra; cells $3.0-6.5 \times 2.5-6 \mu$, not constricted at cross-walls. Scarce. Freshwater, brackish. This has been recorded from the Taiwan spas (Chang 1965).

44. Phormidium

- (80) *Phormidium orientale* G. S. West
Filaments more or less entangled about *Oscillatoria formosa* and *Spirogyra* spp.; sheath very thin, firm and transparent; trichomes $1.0-2.0 \mu$ broad; cells $2.5-4 \mu$ long. This sample should be compared with *P. nordgaardii*. Scarce. Freshwater. New to Taiwan.
- (81) *Phormidium tenue* (Menegh.) Gomont
Trichomes $1.5-3.0 \mu$ broad, straight or slight-bent, freely scattered among other *Oscillatoriaceae*. Cells up to 5μ long; cross-walls not commonly visible, not granulated; end cell acute-conical, calyptra absent. Scarce. Freshwater, brackish. This has been recorded from the Taiwan spas (Chang 1965).

Pl. I

Pl. I



Pl. II

Pl. II

