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RESEARCH

Pennate Diatoms in Talin Bay Lian, Batangas Province, Philippines

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The pennate diatoms from the five stations of Talin Bay, Lian, Batangas Province, Philippines were collected for a period of one year, preserved, identified and classified based on their gross morphology using scanning electron microscope and photomicroscope. Order Bacillariales was represented *by Cocconeis scutellum* Ehrenberg, *Bacillaria paxillifera* (O.F. Muller) Hendey, *Fragilariopsis oceanica* (Cleve) Hasle, *Nitzschia longissima* (Brebisson) Ralfs, *Asterionellopsis glacialis* (Castracane) Round, *Striatella unipunctata* (Lyngbye) Agardh, *Pleurosigma normanii* Ralfs, *Campylodiscus ralfsii* W. Smith, *Thalassionema nitzschioides* (Grunow) Mereschkowsky, *T. fraunfeldii* (Grunow) Hallegraeff and *Licmophora flabellata* (Carmichael) Agardh.

Key words: apical pore field, apical slit field, areola, fibula, foot pole (basal pole), head pole (apical pole), keel, sternum, valve mantle

Cordero (1972) pointed out that the work of Bailey and Harvey from 1853 to 1862 was the earliest recorded studies of Philippine diatoms. The author also pointed out that O' Meara in 1872 made an inclusive study of the genus *Navicula* (Diatomaceae) from Sulu archipelago and that Mann (1925) published a book on the marine diatoms of the Philippines.

The abundance of phytoplankton and zooplankton in the shallower and deeper portions of Manila Bay was reflected in a survey of plankton conducted by Tiews et al. (1976). A total of 61 genera of phytoplankton was found in Lake Bato, Camarines Sur by Perez (1969). Martinez and Pantastico (1976) showed the presence of green algae and diatoms in algal ponds and pools in Manila and vicinities. Diatoms and dinoflagellates were the dominant species found in the water samples collected from Northwestern Luzon by Relon (1985); Northeastern Iloilo by Escuadra (1983); Sorsogon Bay by Legasto and del Mundo (1976); Estancia, Northern Iloilo by Ganaden and Calvedo (1974), Cancabato Bay and Northwest San Pedro Bay, Leyte by Reyes (1973) and in Silut Bay, Cebu by Almase (1972).

The importance of phytoplankton in the production of basic food for fish and pennaeid larvaie was fully elucidated in the research activities. (see Table 1)

This work provides basic information related to the morphological characteristics of the representatives of Order Bacillariales in Talin Bay, Lian, Batangas Province using scanning electron microscope (SEM). It attempts to explore the ornamentations of the valves and other interesting characteristics using SEM, which hopes to be useful to the study of marine micro-algal flora in the five stations of Talin Bay, Lian, Batangas.

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Author	Year	Title of Research
Pantastico, JB, Perez R & Domingo T	1977	Diatom production for hatchery operations of *Pennaeus monodon* Fabr.
Pomoljinda T	1977	Identification and culture of common diatoms as possible feed forPennaeus monodon Fabr.
Juliano RO	1972	The role of aquaculture in increased fish production
Vicencio ZT	1964	Algal food habits of milkfish, Chanos chanos Forskal
Aligaen V	1961	The possibility of growing Gracilaria in bangus fishpond
Rabanal HR	1961	The growing of algae or "lumut" in bangus fishpond
Esguerra RS	1957	A general survey of algae growing in fishponds with special reference to algae used by bangus as food
	1948	Enumeration of algae in Philippine bangus fishponds and in the digestive tract of the fish with notes on conditions favorable for their growth
Villadolid DV	1954	Fertilization of bangus fishpond nurseries
Mejia TG	1952	Plankton as aquatic food resources
Villadolid DV & Villaluz DK	1950	Bangus cultivation and its relation to algal culture in the Philippines

Materials and Methods

Description of the Study Site

Talin Bay is a fishing village and a resort area which is approximately 200 km. south of Manila. It is situated on the southwestern part of Luzon, Philippines approximately 14°.1" N latitude, 120°.65" E longitude. This is bordered by hills and sugarcane fields. Mangroves likewise surround the bay. The climate is generally warm (27-37 °C) most especially from February to May. The water is clear with moderately strong water movements.

The study site consists of five stations namely: San Diego (station 1), Lumaniag (station 2), Reyna (station 3), Talin Pont (station 4) and Luyahan (station 5) (see Fig. 1).

Collection and Preservation of the Samples

Specimens were collected at the five stations of Talin Bay every second week of each collecting month starting from October 1997 to September 1998. A total of twelve collecting months were conducted at a monthly interval. A plankton net with 80 μm mesh size was utilized for collecting the phytoplankton using the scoop method. Two (1-L) plastic bottles were used as containers of the water samples which were fixed with ten drops of 3% glutaraldehyde. The diatoms were allowed to settle at the bottom of Imhoff tubes. The supernatant fluid was carefully siphoned off to get the desired final volume. The concentrated samples were stored in small, closed and labelled dark bottles.

The samples were then fixed with 3% glutaraldehyde plus 0.1M cocodylate buffer for 1-2 hours and washed 3 to 5 times in 0.1M cocodylate buffer for 30 minutes. Post fixation was done using 1% Osmium tetroxide (0s04) for 1 hour. The diatoms were washed again three to five times with 0.1M cocodylate buffer for 30 minutes. Dehydration series using absolute ethanol was made in 50%, 70%, 80%, 95% for 30 minutes and finally 100% for 1 hour which was done twice. This was followed by stub mounting using aluminum stub with double sided tape and placed in a dessicator overnight. Ion coating with gold and palladium was done for 2.5 minutes.

Viewing of the samples was conducted at De La Salle University, Taft Avenue, Manila using photomicroscope and at the National Institute of Molecular Biology and Biotechnology (BIOTECH) University of the Philippines, Los Baños, College,

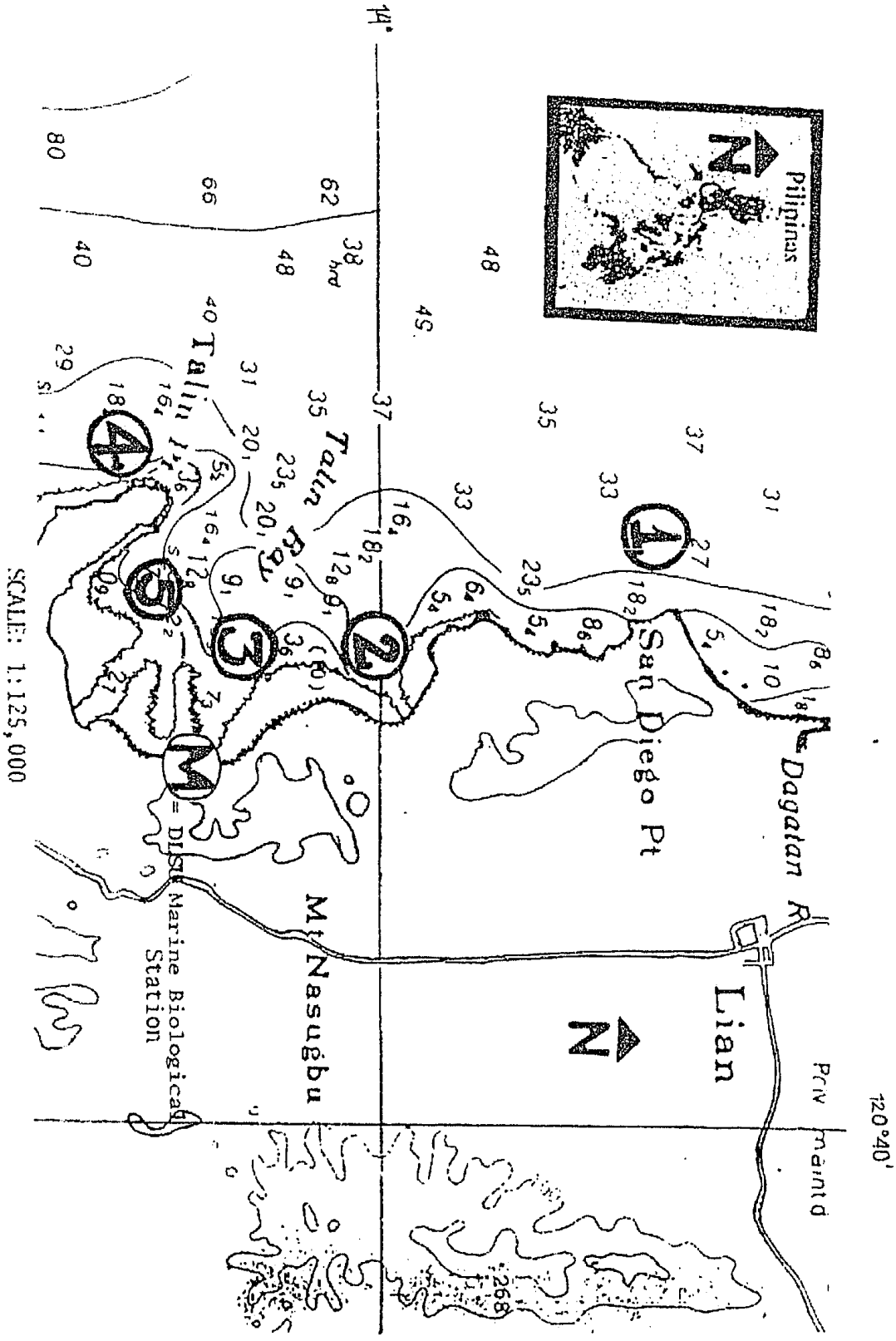


Figure 1. Map of the study site in Talin Bay, Lian, Batangas Province, Philippines.
Legend: Site 1. San Diego Point, 2. Lumaniag, 3. Reyna, 4. Talin Point, 5. Luyahan.

Laguna using SEM Hitachi S-510 at 25 kilovolts and photomicroscope. This was followed by film processing and micrograph printing (Trinidad 1992).

Identification and Classification

The collected diatoms were identified using the keys and/or illustrations published by Tomas (1997), Raymont (1980), McConnaughey (1978). Yamaji (1977), Bougis (1976), Hynes (1974), Tait (1972), Newell and Newell (1967), Wood and Lutes (1967), Shirota (1966), Van Heurck (1962), Chuang (1961) and Crosby and Wood (1958). Classification of the diatoms was based on the protocol of Tomas (1997). Descriptions of the taxa, most especially genera have been confined to specific characters.

Results

Taxonomy

This study includes 1 order, 7 families, 10 genera and 11 species.

Class Bacillariophyceae
Order Bacillariales
Key to Genera

1. Cells occurring singly in saddle-shaped, circular structures.....*Campylodiscus*

1. Cells occurring in ribbon-like chains.....2

    2. Cells flat united into long bands...*Fragilariopsis*

    2. Cells rod-like united into zigzag or star-like colonies.....3

3. Chain less stellate.....*Thalassionema*

3. Chain not as above..... 4

    4. Valve sigmoid..... *Pleurosigma*

    4. Valve cuneate or globular 5

5. Valve section club-shaped.....*Licmophora*

5. Valve section oval shaped.....6

    6. Valve surface reticulated...*Cocconeis*

    6. Valve surface areolated punctated.....7

7. Cells rectangular with slightly rounded corners.....*Striatella*

7. Cells spindle shaped.....8

    8. Cell solitary with central belly.....*Nitzschia*

    8. Cell not solitary but form a colony.....9

9. Cell formation resemble a pile of matches.....*Bacillaria*

9. Cell formation radial.....*Asterionella*

Order Bacillariales Genus *Cocconeis* Ehrenberg
***Cocconeis scutellum* Ehrenberg**

Plate X Fig. 1

The length of the cell ranges from 20-60um, width 12-40 um. The frustule in valve view is broadly elliptical. The valves are dissimilar. The upper valve has coarse radial puncta and marked pseudoraphe. It is finely punctate at margin with puncta in rows. The lower valve has median line, raphe and small central area. It is finely radiately striate with broad marginal loculiferous rim. It is oval-shaped in girdle view. Its vertical pseudocanal forms a straight line. The radiating linear crests mingle at right angle with the vertical linear crests and create reticulated patterns which become finer mesh at the edge of the border.(SEM).

The specimen is figured in Yamaji (1977), Pl. 26, no.1, Hynes (1974), Pl. 33, no. 61 and Shirota (1966) no. 871. This form occurs in Talin Point, Lian, Batangas province. Literature records suggest that this species can be found also in Japan and South Vietnam.

GENUS *Bacillaria* Gmelin
***Bacillaria paxillifera* (O.F. Muller) Hendey**
Synonym: *Bacillaria paradoxa* Gmelin

Plate X, Fig. 2

The valve length ranges from 156-246 um, width 5-6 um. The cells form a colony, the members of which can slide over one another. In girdle view, the cells are rectangular and transversely striated. In valve view, the cells are linear-lanceolate or spindle-shaped. The raphe system is slightly keeled. The raphe is continuous from pole to pole. The fibulae are strong (SEM). The valve surface has transverse parallel striae.

The identity of this species is confirmed further by the illustrations of Tomas (1997) Pl. 66, Yamaji (1977)

Plate X

Family Achnanthaceae

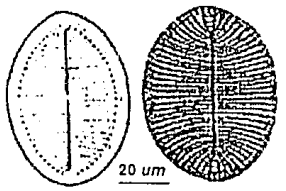
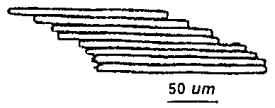


Figure 1. *Cocconeis scutellum* Ehrenberg



part of the chain girdle view

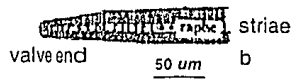


Figure 2. *Bacillaria paxillifera* (O.F. Muller) Hendey

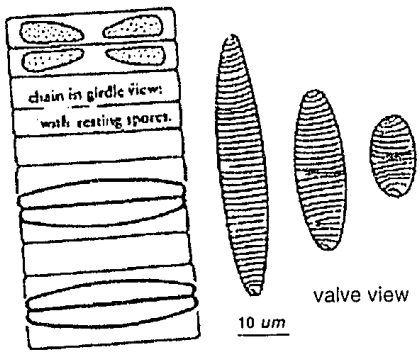


Figure 3. *Fragilariopsis oceanica* (Cleve) Hasle

Fig. 3

Family Bacillariaceae Ehrenberg

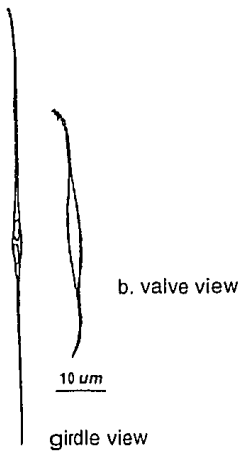


Figure 4. *Nitzschia longissima* (Brebisson) Ralfs

Pl. 29 and Newell and Newell (1967) Pl. VIII. This diatom from San Diego, Lian Batangas province can also be found in Japan, South Vietnam, Malaya, Singapore and California.

GENUS *Fragilariopsis* Hustedt
***Fragilariopsis oceanica* (Cleve) Hasle**
Basionym: *Fragilaria oceanica* Cleve

Plate X Fig. 3

The cell length ranges from 8-60 um, width 3-8 um. The valve (girdle view) is rectangular with round corners. It forms a belt-like, straight, thickly joined colony. It is elliptic-lanceolate in valve view. Both ends of the valve section are pointed. It has two pigmentation granules on either side of the cell nucleus. The interstriae on valve face are weakly

Plate XI

Family Fragilariaceae Greville

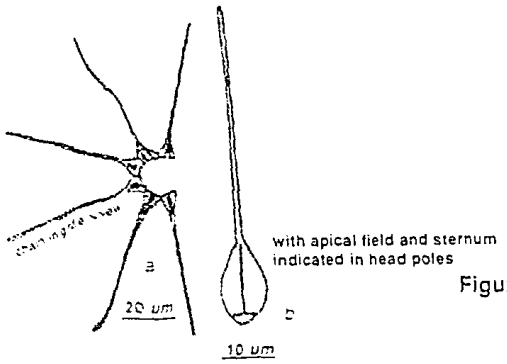


Figure 1. *Asterionellopsis glacialis* (Castracane) Round

Family Surirellaceae

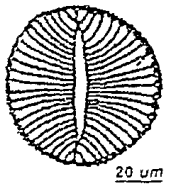


Figure 2. *Campylodiscus ralfsii* W. Smith

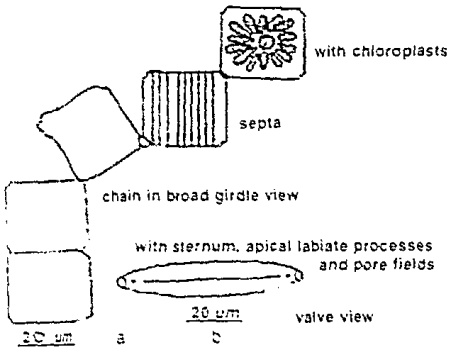


Figure 3. S. *unipunctata* (Lyngbye) Agardh

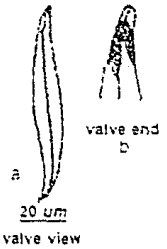


Figure 4. *Pleurosigma normani* Ralfs

silicified but they are more strongly silicified on valve mantle (SEM). The raphe is along the bend between the valve face and mantle or slightly displaced to the mantle. The central larger interspace is present. The resting spore valves are structured as vegetative valves but they are heavily silicified (SEM).

This species is figured in Tomas (1997) Pl. 67, Yamaji (1977) Pl. 24, Hynes (1974) Pl. 33 and Newell and Newell (1967) Pl. VII. It is considered as a consistent member of the diatom family in San Diego, Lumaniag and Luyahan Lian, Batangas as well as in Japan and South Vietnam.

GENUS *Nitzschia* Hasle
Nitzschia longissima (Brebisson) Ralfs

Plate X Fig. 4

The length of the cell is 253 um, width 6 um. The cell is solitary, motile and spindle-shaped with a central belly. The ends are long, straight and hair-like. The raphe has fibulae and central larger interspace distinct in mounted cleaned material. The external canal wall is poroid. The transverse striae and interstriae are hardly visible with light microscopy. *N. longissima* is coarsely silicified with fibulae connected with silicified strips running parallel to the raphe slit (SEM).

This species is figured and discussed by Tomas (1997), Yamaji (1977), Hynes (1974), Wood & Lutes (1967), Shirota (1966), Chuang (1961) and Cupp (1943); found in several stations of Lian, Batangas like San Diego, Talin Point and Luyahan and other countries like Japan, Rhode Island, South Vietnam, Malaya, Singapore and California.

GENUS *Asterionellopsis* Round
Asterionellopsis glacialis (Castracane) Round
Synonym: *Asterionella japonica* Cleve

Plate XI Fig. 1

The cell length ranges from 50-100 um. The cells form radial colonies. The basal part of the valve is swollen or enlarged then it abruptly thins out and becomes cylindrical up to the tip. The lines of the valve are remarkably thin and fine. The cells are united at corners of enlarged region. The chromatophores are present in the basal, enlarged part only. The foot poles are angular in girdle view and more or less rounded in valve view. The valve has apical pore or slit fields and sternum indicated in head pole (SEM).

Tomas (1997) figured *A. glacialis* in Pl. 50, Raymont (1980) in Fig. 4.18, McConnaughey (1978) in Fig. 6-5 and Shirota (1966) in Fig. 848. A drifter from San Diego and Reyna, Lian, Batangas, this species is also found in Japan, Rhode Island, South Vietnam and California.

GENUS *Striatella* Agardh
Striatella unipunctata (Lyngbye) Agardh

Plate XI, Fig. 3

The length of apical axis ranges from 50-78 um. The valve surface is areolated-punctated. The cells in girdle view are rectangular with slightly rounded corners. The intercalary bands are numerous. The valves are linear to elliptical-lanceolate with blunt rounded ends. The cells are united to form ribbons. Numerous open bands have narrow septa. The chloroplasts are granular to oblong and radially arranged. The cell in valve view is lanceolate with distinct apical pore fields, slightly sunk in and surrounded by a rim (SEM). One labiate process is present at each pole. The valve areolae are in three self-crossing vine systems. The sternum is narrow (SEM).

This rare species of San Diego, Lian, Batangas as well as Japan and California is figured in Pl. 50, 25 and Fig. 122 by Tomas (1997), Yamaji (1977) and cupp (1943) respectively.

GENUS *Pleurosigma* W. Smith
Pleurosigma normanii Ralfs

Plate XI, Fig. 4

The length of the apical axis ranges from 90-220 um. The valves are broadly lanceolate, slightly sigmoid, with subacute ends. The raphe is nearly central, sigmoid with single curvature. The central nodule is dilated transversely. The crossing angle of striae is greater at the center than lowward the valve apices (SEM).

This species is figured in Pl. 62, 28, 33, VII, 6 by Tomas (1997), Yamaji (1977), Hynes (1974), Newell and Newell (1967) and Van Heurck (1962) respectively and found in Reyna, Luyahan and San Diego, Lian, Batangas plus other countries like Japan, South Vietnam, Denmark and England.

GENUS *Campylodiscus* Ehrenberg
Campylodiscus ralfsii W. Smith

Plate XI Fig. 2

The cell diameter ranges from 80-100 um. The valve section is oval and curves like a saddle. The central portion has a long, fine, needle shaped vertical canal. Fine cut line designs are present on both sides somewhat coarsely lined up like veins and becoming thick at the edges and with short spine-like protrusions.

A rare diatom from San Diego, Lian, Batangas province, Philippines and Japan is illustrated in Pl. 29 by Yamaji (1977) and Fig. 869 by Van Heurck (1962).

GENUS *Thalassionema* (Grunow) ex Mereschkowsky
Thalassionema nitzschioides (Grunow) Mereschkowsky

Plate XII Fig. 1

Valve length ranges from 18-20 um, width 6-7 um. The rod shaped, straight, or slightly curved cells join end to end into a star-shaped or zigzag chains. The valves are linear or slightly lanceolate in valve view and rectangular in girdle view. Apical spine is present. The marginal structure is visible as ribs. The sternum is wide. The areolae are circular. The internal openings (foramina) of the areolae are smaller than the external openings (SEM). The external openings of areolae are crossed by a simple silicified bar or a pattern of crossing bars (SEM). The valve ends are similar.

This specimen is figured in Pl. 56 & 24, by Tomas (1997) and Yamaji (1977) respectively. It abounds in Talin Point and Luyahan, Lian, Batangas province, Philippines as well as Japan, Rhode Island, South Vietnam, Alaska, Malaya, Singapore and California.

GENUS *Thalassionema fraunfeldii* (Grunow) Hallegraeff
Synonym: *Thalassiothrix fraunfeldii* Grunow

Plate XII

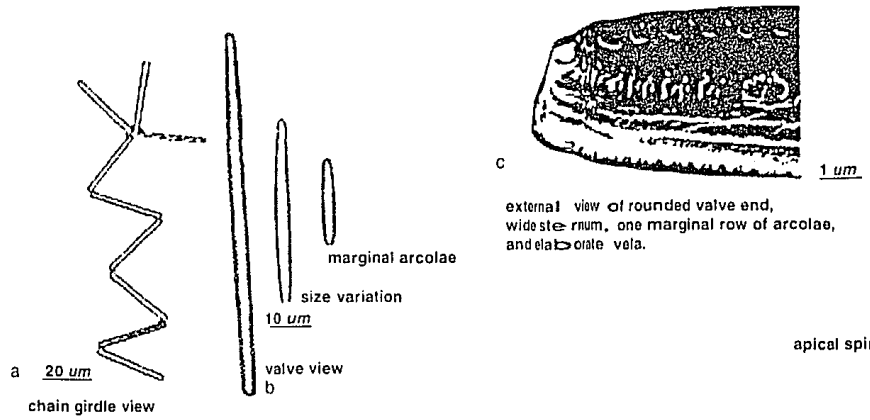


Figure 1. *Thalassionema nitzschioides* (Grunow) Mereschkowsky

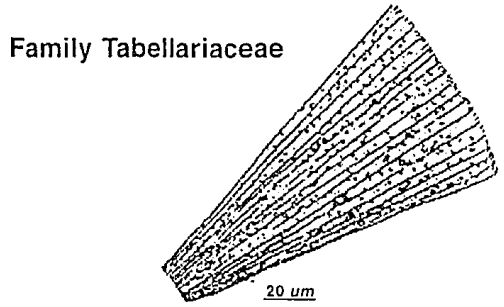


Figure 3. *Licmophora flabellata* (Carmichael) Agardh

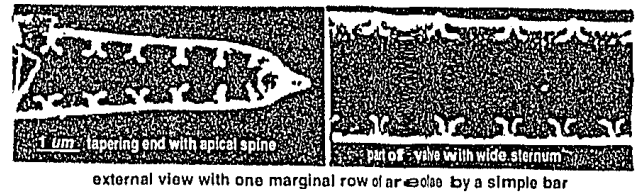


Figure 2. *T. fraunfeldii* (Grunow) Hallegraeff

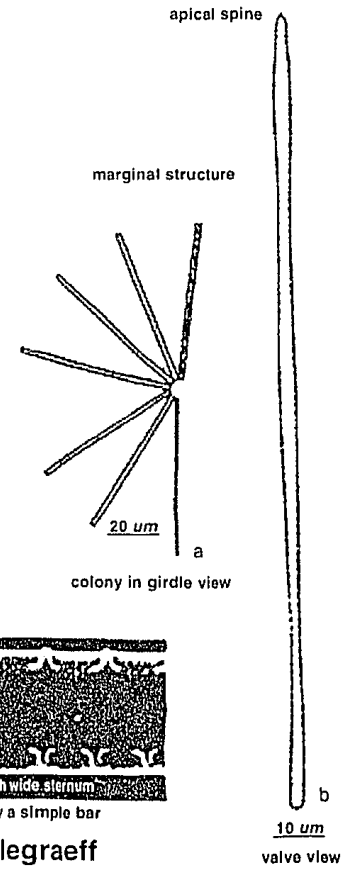


Plate XII Fig. 2

The length of the cell ranges from 90-100 um, width 2-4 um. The cells form stellar colonies. The valve (girdle view) is linear. The tips of the cell are slightly different, one end blunt rounded, the other wedge-shaped or tapering with a spine. Marginal spines are small but regularly occurring. The marginal rows of areolae are crossed by a simple strongly silicified bar (SEM).

This species is figured in Pl. 55, 24, 33 by Tomas (1997), Yamaji (1977) and Hynes (1974) respectively. This diatom from Lumaniag and Luyahan, Lian, Batangas province, Philippines abounds also in Japan, Rhode Island, South Vietnam and California.

GENUS *Licmophora* Agardh
***Licmophora flabellata* (Carmichael) Agardh**

Pl. XII Fig. 3

The length of the cell is 300 um. The frustule in valve view is excessively long and narrow, cuneate-lanceolate and attenuate towards the basal portion which is inflated and subcapitate. The girdle face is cuneate and very narrow with numerous septa penetrating from upper part of the cell (SEM). The chromatophores give a double-banded effect.

This rare species figured in Pl. 31 by Van Heurck (1962) abounds in San Diego, Reyna and Talin Point, Lian, Batangas province, Philippines and England.

Acknowledgement

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Appendix

Taxonomic Classification of Some Pennate Diatoms in Talin Bay, Lian, Batangas Province

CHRYSOPHYTA
Class Bacillariophyceae
Order Bacillariales
Family Achnanthaceae Kutzing
Genus *Cocconeis* Ehrenberg
C. scutellum Ehrenberg
Family Bacillariaceae Ehrenberg
Genus *Bacillaria* J.F. Gmelin
B. paxillifera (O. F. Muller) Hendey
Genus *Fragilariopsis* Hustedt
F. oceanica (Cleve) Hasle
Genus *Nitzschia* Hasle
N. longissima (Brebisson) Ralfs
Family Fragilariaceae Greville
Genus *Asterionellopsis* Round
A. glacialis (Castracane) Round
Genus *Striatella* C. A Agardh
S. unipunctata (Lyngbye)Agardh
Family Naviculaceae Kutzing
Genus *Pleurosigma* W. Smith
P. normanii Ralfs
Family Surirellaceae
Genus *Campylodiscus* Ehrenberg
C. ralfsii W. Smith
Family Thalassionemathaceae Round
Genus *Thalassionema* Grunow ex Mereschkowsky
T. nitzschioides (Grunow) Mereschkowsky
T. fraunfeldii (Grunow) Hallegraeff
Family Tabellariaceae
Genus *Licmophora* Agardh
L. flabellata (Carmichael) Agardh