

行政院國家科學委員會補助專題研究計畫成果報告
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臺灣西南部半鹽水濕地之矽藻生物多樣性研究
A Biodiversity Study of Brackish Water
Attached Diatom Assemblages in Wetlands, in
Southwestern Taiwan

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執行單位：嘉南藥理科技大學環境工程衛生系

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國科會專題研究計畫成果報告撰寫格式說明

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A Biodiversity Study of Brackish Water Attached Diatom Assemblages in
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計畫參與人員：蕭雅琪，葉展廷，蔡宏韋，張玉明

一、中文摘要

本研究主要調查臺灣西南部之半鹽水濕地之矽藻生物多樣性。研究結果已於臺南縣市之 42 個選定樣區，配合光學顯微鏡與掃描式電子顯微鏡之鏡檢與比對分析，已整理出 19 屬，69 種臺灣西南部半鹽水濕地之最主要的矽藻生物相之圖譜資料。本研究結果除明確的了解臺灣西南部半鹽水濕地之矽藻生物相外，對於將來繼續從事以本土性矽藻為水質污染之指標生物之研究將有極大之助益。

關鍵詞：生物多樣性,半鹽水,矽藻,

英文摘要

This study investigated the biodiversity of diatoms from the brackish water wetlands, in southwestern Taiwan. It had finished forty-one sampling plots around Tainan City. All native diatoms were identified under light microscope and scanning electron microscope and to be compared. A total of sixty-nine diatom species belong to nineteen genera were sorted by the SEM photographs. The results will good for doing the studies about bioindicators in the future.

Keywords: biodiversity, brackish, diatoms

二、緣由與目的

在河川、河口...等等水域環境中，藻類扮演一極端重要的角色。其中，大型藻(macroalgae)可以提供其它小型動物如蝦蟹等之棲息環境，微藻(microscopic algae)是浮游生物之重要組成成份，它可提供其它生物如貝類等之食物來源。微藻，尤其是矽藻，亦可以附著於底泥或其它植物上，故在生態上扮演一極重要的角色。

在臺灣，雖然與藻類相關的研究，有日益增加的趨勢，但以從事藻類生理特性之研究者較多。實際從事矽藻生物多樣性之研究者相當少，而即使有許多已出版的矽藻名錄之記載臺灣的矽藻分類群，卻極少有圖譜以供對照者。唯有早期黃民雄教授於嘉義師院發表的臺灣南部的矽藻(黃民雄 1982)，有許多珍貴的光學顯微鏡下的矽藻種的特徵，足以提供今日研究之參考與對照。然而，目前有許多矽藻屬之分類特徵，已因掃描式電子顯微鏡技術之進步，而逐漸被修正轉換其原先之屬的分類地位。黃教授所發表之光學顯微鏡下南部矽藻"種"之調查，事實上是今日繼續研究之一極佳之參考資料。足見本土生物多樣性之調查資料之不容忽視。

由於矽藻被認為是一極佳之指標生

物，足以反應一水域環境長期之水質狀況(Asai, K. & Watanabe, T.(1995)，故完整整理一套本土矽藻圖譜資料庫，對於繼續從事以本土性矽藻為水質污染之指標生物之研究將有極大之助益。

三、材料與方法

為進行臺灣西南部半鹽水濕地之矽藻生物多樣性研究，所有族群在採集時，同時測定其生長環境之鹽度，酸鹼度、電導度與水溫。所有樣品皆先觀察記錄與拍攝其新鮮樣品之形態特徵及運動特性，再將其族群培養於適當的培養條件中，照光，並逐日觀察其生長繁殖之特性。一部份新鮮樣品直接以酸處理，使其保留足供鑑定之細胞壁成份。經酸處理之細胞壁成份做適當的編號保存，以供鑑定及比較用。各樣品之矽藻細胞壁以兩種方式觀察其在光學顯微鏡下之特徵，一為直接以干擾相差鏡檢拍攝，另一以矽藻膠封片後再鏡檢拍攝。各樣品之矽藻細胞壁經光學顯微鏡鏡檢後，挑出有代表性之樣品進行掃描式電子顯微鏡之鏡檢與記錄。記錄經統計分析以探討不同鹽度、電導度及酸鹼度間所出現之矽藻之相關性與歸群特性。

四、結果與討論

本研究主要以分佈於N23°, E120°之臺灣西南部半鹽水濕地之41個採樣點為研究對象。經光學與掃描式電子顯微鏡之觀察結果，已整理出臺灣西南部半鹽水濕地之矽藻圖譜共69種。所有矽藻樣品除觀察新鮮樣品外，皆經硫酸及硝酸鉀處理成矽藻細胞壁以利保存，此外，所有樣區之矽藻皆製備以矽藻膠封片之矽藻標本，保存於嘉南藥理科技學環工系藻類研究室。觀察所鑑定之69種矽藻大多具有電子顯微鏡下之分類

特徵以供鑑定比對，而所有保存於研究室之電腦圖檔，皆記載其生態特徵，包括鹽度、酸鹼度及電導度範圍，並記錄其主要之分佈區域。主要分佈地區以八個主要之大範圍為記錄依，包括：(I)四鯤鯓紅樹林區 (S1-2)，(II)安平古堡區 (S3-10)，(III)億載金城 (S11)，(IV)曾文河口 (S17,18)，(V)七股紅樹林區 (S19-20,22-23)，(VI)四草鹽沼 (S12-15, 24-26,28)，(VII)四草紅樹林區 (S21,28-34)及(VIII)七股鹽田(S34-41) (Plates 1-69)等做為記錄之依據。研究結果亦發現臺灣西南部半鹽水溼地所整理之69種矽藻主要分屬於19屬，包括 *Achnanthes* , *Amphiprora* , *Amphora* , *Cocconeis* , *Caloneis*, *Cyclotella* , *Haslea* , *Mastogloia* , *Melosira* , *Navicula* , *Nitzschia* , *Pleurosigma* , *Gyrosigma* , *Fragilaria* , *Thalassiosira* , *Diploneis* , *Pinnularia* , *Surirella* , *Synedra* 等。其中，*Amphora* 為最普遍存在之附著性之矽藻屬，種類最多，在電子顯微鏡下共發現16種，在自然情況下其生長之方式為平貼於基質上，極易成長為優勢種。

此外，由於以臺灣西南部各沼澤溼地出現之矽藻群落以秋末最濃密，故為比較69種矽藻彼此間生長環境之相關性，乃比較各種矽藻，在秋末出現於不同採樣點之鹽度、酸鹼度及電導度範圍，以了解其主要之生態條件。所有矽藻依其出現之相對豐富度，將其轉換為優勢程度等級。再進一步以主成份分析彼此間之關聯。結果顯示69種矽藻依其於41個採樣站出現之優勢程度等級可分為16個主成份，累積變異百分比為90%。本研究結果所整理之圖譜資料，對於臺灣西南部半鹽水濕地之矽藻生物多樣性提供極有價值之生態資訊。

力於光學顯微鏡鏡檢及掃描式電子顯微鏡之比對，已獲得極好之影像資料對於繼續從事南部地區之指標生物之研究工作，將有極大之助益。

五、計畫成果自評

本計劃因計劃主持人花費相當多之心力於光學顯微鏡鏡檢及掃描式電子顯微鏡之比對，已獲得極好之影像資料對於繼續從事南部地區之指標生物之研究工作，將有極大之助益。

Plate 1-67.

Achnanthes brevipes C.Agardh, Plate 1.

Ecology: Brackish water, Epipellic or Epiphytic, pH (7.5-9.3), EC (16.4-49.6ms/cm²), and Salinity (3.3-0.8%)

Distributions: (I), (II), (III), (IV), (V), (VI), (VII).

Achnanthes exilis Kütz. Plate 2.

Ecology: Brackish water, Epiphytic, pH (7.5-9.3), EC (9.3-49.6 ms/cm²), and Salinity (0.1-3.3 %)

Distributions: (I), (II), (III), (IV), (V), (VI), (VII).

Amphiprora surirelloides Hendeby, Plate 3.

Ecology: Brackish water, Epiphytic or Planktonic, pH (7.5-9.3), EC(12.7-49.6ms/cm²), and Salinity (0.7-3.3%)

Distributions:(V),(VI),(VII),(VIII).

Amphiprora alata (Ehrenb.)Kütz., Plate 4.

Distributions: (V), (VI)(VII).

Ecology: Brackish water, Epiphytic or Planktonic, pH (7.5-8.7), EC(30.0-44.8 ms/cm²), and Salinity (2.0-2.9%)

Amphiprora sp3, Plate 5.

Distributions: (V), (VI).

Ecology: Brackish water, Epiphytic or Planktonic, pH (7.8-8.8), EC(16.4-42.0 ms/cm²), and Salinity (0.8-2.7 %)

Amphora granulata W.Greg., Plate 6.

Distributions: (I), (II), (III), (IV), (V), (VI),(VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(10.1-49.6ms/cm²), and Salinity (0.1-3.38%)

Amphora holsatica Hust., Plate 7.

Distributions: (I), (II),(IV), (V), (VI),(VII).

Amphora normanii Rabenh., Plate 8.

Distributions: (I), (V), (VI),(VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(12.7-42 ms/cm²), and Salinity (0.5-2.7%)

Amphora sp4, Plate 9.

Distributions: (IV), (V), (VI),(VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(29.8-42 ms/cm²), and Salinity (2-2.7%)

Amphora rhombica Kitton ex A.W.F.Schmidt var. *intermedia* Cleve, Plate 10.

2001, figs 5-6.

Distributions: (II), (IV), (V), (VI),(VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(10.1-49.6ms/cm²), and Salinity (0.1-3.3%)

Cocconeis placentula Ehrenb. var. *euglypta* (Ehrenb.)Cleve, Plate 11.

Distributions: (IV), (V).

Ecology: Brackish water, Epiphytic or Epipellic, pH (8.0-8.7), EC(16.4-49.6ms/cm²), and Salinity (0.6-3.3%).

Cocconeis scutellum Ehrenb., Plate 12.

Distributions: (I), (IV), (V), (VI),(VII).

Cyclotella meneghiniana Kütz., Plate 13.

Distributions: (I), (II), (V), (VI),(VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(9.7-42 ms/cm²), and Salinity (0.1-2.7%).

Haslea sp1., Plate 14.

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(16.4-35.5ms/cm²), and Salinity (0.8-2.5%).

Mastogloia exigua F.W.Lewis, Plate 15.

Distributions: (V), (VI), (VII), (VIII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(29.8-58.2ms/cm²), and Salinity (2.0-4.4%).

Melosira nummuloides (Dillwyn) C.Agardh, Plate 16.

Distributions: (IV), (V).

Ecology: Brackish water, Epiphytic, pH (8.1-8.7), EC(30.0-49.6ms/cm²), and Salinity (2.2-3.3%).

Navicula margalithii Lange-Bert., Plate 17.

Distributions: (V), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(29.8-44.8ms/cm²), and Salinity (2.0-2.9%).

Nitzschia amphibia Grunow, Plate 18.

Distributions: (I), (II), (III), (IV), (V), (VI), (VII).

Ecology: Freshwater or Brackish; Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(10.1-49.6ms/cm²), and Salinity (0.1-3.3%).

Nitzschia acuminata (W. Sm.)Grunow, Plate 19.

Distributions: (I), (V), (VII).

Nitzschia coatcrata Grunow, Plate 20.

Distributions: (IV), (VI).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(9.3-49.6ms/cm²), and Salinity (0.1-3.3%).

Nitzschia longissima (Bréb ex Kütz.)Grunow, Plate 21:

Distributions: (I), (II), (IV), (V), (VI), (VII)

Ecology: Marine or Brackish water, Epiphytic or Planktonic, pH (7.5-9.3), EC(16.4-49.6ms/cm²), and Salinity (0.1-3.3%).

Nitzschia punctata W. Sm., Plate 22.

Distributions: (V), (VI), (VII), (VIII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(29.8-41.1ms/cm²), and Salinity (2.2-2.5%).

Nitzschia sigma (Kütz.) W. Sm., Plate 23.

Distributions: (II), (III), (IV), (V), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(10.1-49.6ms/cm²), and Salinity (0.1-3.3%).

Pleurosigma normanii Ralfs, Plates 24.

Distributions: (IV), (V), (VIII).

Ecology: Brackish water, Epipellic, pH (7.6-8.7), EC(30.0-58.2.6ms/cm²), and Salinity (2.9-4.4%).

Synedra fasciculate (C.Agardh)Kütz., Plate 25.

Distributions: (I), (II), (III), (IV), (V), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(16.4-49.6ms/cm²), and Salinity (0.1-2.9%).

Pleurosigma angulatum (E.J. Quekett)W. Sm., Plate 26.

Distributions: (VI).

Ecology: Brackish water, Epipellic, pH (8.0-8.7), EC(41.1-44.8ms/cm2), and Salinity (2.6-2.9%).
Pleurosigma elongatum W. Sm., Platen 27.
Distributions: (VI), (VII).

Ecology: Brackish water, Epipellic, pH (7.8-8.7), EC(30.0-41.1ms/cm2), and Salinity (2.0-2.7)
Gyrosigma scalprodes (Rabenh) Cleve, Plate 28.
Distributions: (IV), (V), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(16.4-49.6ms/cm2), and Salinity (3.3-0.8%).
Fragilaria sp. ; Plate 29.
Distributions: (V), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(16.4-42.0ms/cm2), and Salinity (3.3-0.8%).
Thalassiosira Cl. *Thalassiosira quillardii* Hasle, Plate30.
Distributions: (III), (V).

Ecology: Brackish water, Planktonic, pH (8.0-8.7), EC(12.7-18.6ms/cm2), and Salinity (0.5-1.1%).
Navicula sp9, Plate31.
Distributions: (IV), (V), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(12.3-49.6ms/cm2), and Salinity (0.6-3.3%).
Navicula cryptocephala var. *veneta* (Kütz.)Rabenh., Plate 32.
Distributions: (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(29.8-44.8ms/cm2), and Salinity (2.0-2.9%).
Amphora sp6, Plate 33.
Distributions: (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(29.8-44.8ms/cm2), and Salinity (2.0-2.9%).
Amphora sp7, Plate 34.
Distributions:(VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(29.8-44.8ms/cm2), and Salinity (2.0-2.9%).
Amphora sp8; Plate 35.
Distributions: (I), (II), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(9.5-44.8ms/cm2), and Salinity (0.1-2.9%).
Amphora sp9; Plate 36.
Distributions: (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(2.98-44.8ms/cm2), and Salinity (2.0-2.9%).
Amphora sp10; Plate 37.
Distributions: (I), (II), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(9.5-44.8ms/cm2), and Salinity (0.1-2.9%).
Amphora sp11, Plate 38.
Distributions: (I),(VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(20.7-44.8ms/cm2), and Salinity (0.5-2.9%).
Cyclotella sp2, Plate 39.
Distributions: (VI), (VII).

Ecology: Brackish water, Planktonic, pH (7.5-9.3), EC(29.8-44.8ms/cm2), and Salinity (2.0-2.9%).
Cyclotella sp3; Plate 40.
Distributions: (VI), (VII).

Ecology: Brackish water, Planktonic, pH (7.5-9.3), EC(29.8-44.8ms/cm2), and Salinity (2.0-2.9%).
Amphora sp12; Plate 41.

Distributions: (I), (III).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.7-8.0), EC(18.4-20.7ms/cm2), and Salinity (0.4-0.5%).
Diploneis sp1, Plate 42.
Distributions: (I), (II), (III).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.7-8.0), EC(9.7-17.6ms/cm2), and Salinity (0.1-0.5%).
Nitzschia sp7, Plate 43.
Distributions: (I), (II), (III).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.7-8.0), EC(9.7-17.6ms/cm2), and Salinity (0.1-0.5%).
Nitzschia sp8, Plate 44.
Distributions: (I), (II), (III), (VI).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.7-8.8), EC(9.3-29.1ms/cm2), and Salinity (0.1-2.9%).
Amphora sp13; Plate 45.
Distributions: (I), (II), (VI).

Ecology: Brackish water, Epiphytic or Epipellic, pH (8.0-8.8), EC(10.1-29.1ms/cm2), and Salinity (0.1-1.9%).
Cyclotella sp4, Plate 46.
Distributions: (I), (II), (III).

Ecology: Brackish water, Planktonic, pH (7.7-8.7), EC(9.3-24.7ms/cm2), and Salinity (0.1-0.5%).
Navicula angusta Grunow, Plate 47.
Distributions: (I), (II), (IV), (V), (VI), (VII).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(12.3-29.4ms/cm2), and Salinity (0.1-3.3%).
Pinnularia sp1, Plate 48.
Distributions: (I), (II), (III).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.7-8.7), EC(9.7-24.7ms/cm2), and Salinity (0.1-0.5%).
Diatoma sp1, Plate 49.
Distributions: (III).

Ecology: Brackish water, Epiphytic or Epipellic, pH (8.3), EC(24.7ms/cm2), and Salinity (0.5%).
Amphora sp14, Plate 50.
Distributions: (I), (II), (III).

Ecology: Brackish water, Epiphytic or Epipellic, pH (7.7-8.7), EC(9.3-24.7ms/cm2), and Salinity (0.1-0.5%).
Navicula sp3, Plate 51.
Distributions: (IV), (V), (VI).

Ecology: Brackish water, Epiphytic or Epipellic, pH (8.0-8.7), EC(18.6-49.6ms/cm2), and Salinity (0.6-3.3%).
Navicula sp4, Plate 52.
Distributions: (VI).

Ecology: Brackish water, Epiphytic or Epipellic, pH (8.5-8.6), EC(28.1-29.4ms/cm2), and Salinity (1.6-1.9%).
Nitzschia sp9, Plate 53.
Distributions: (IV), (V).

Ecology: Brackish water, Epiphytic or Epipellic, pH (8.0-8.7), EC(18.6-49.6ms/cm2), and Salinity (0.6-3.3%).
Navicula sp5, Plate 54.
Distributions: (VIII).

Ecology: epipellic on higher salty concentration, pH (4.7-8.4), EC(97.1-209.0ms/cm2), and Salinity (8.0-21.6%).
Navicula sp6, Plate 55.
Distributions: (VIII).

Ecology: epipellic on higher salty concentration, pH (4.7-8.4), EC(97.1-209.0ms/cm2), and Salinity (8.0-21.6%).

- Navicula* sp7, Plate 56.
Distributions: (VIII).
Ecology: epipellic on higher salty concentration, pH (4.7-8.4), EC(97.1-209.0ms/cm²), and Salinity (8.0-21.6%).
- Navicula* sp8, Plate 57.
Distributions: (VIII).
Ecology: epipellic on higher salty concentration, pH (4.7-8.4), EC(97.1-209.0ms/cm²), and Salinity (8.0-21.6%).
- Nitzschia obtuse* var. *scalpelliformis* Grunow, Plate 58.
Distributions: (II), (VII), (VIII).
Ecology: Ecology: Brackish water, Epiphytic or Epipellic, pH (7.7-8.7), EC(9.5-167.1ms/cm²), and Salinity (0.1-14.2%).
- Nitzschia* sp11, Plate 59.
Distributions: (VIII).
Ecology: epipellic on higher salty concentration , pH (4-8.5), EC(56.5-209.0ms/cm²), and Salinity (4.2-21.6%).
- Surirella* sp1, Plate 60.
Distributions: (VIII).
Ecology: epipellic on higher salty concentration, pH (7.5-7.7), EC(56.5-58.2ms/cm²), and Salinity (4.2-4.4%).
- Navicula* sp10, Plate 61.
Distributions: (II).
Ecology: Brackish water, Epiphytic or Epipellic, pH (7.5-9.3), EC(9.5-17.6ms/cm²), and Salinity (0.1-0.5%).
- Amphora* sp15, Plate 62.
Distributions: (II), (VI).
Ecology: Brackish water, Epiphytic or Epipellic, pH (8.3-8.8), EC(12.3-29.4ms/cm²), and Salinity (0.1-0.5%).
- Cyclotella* sp6, Plate 63.
Distributions: (II).
Ecology: Brackish water, Epiphytic or Epipellic, pH (8.7), EC(17.6ms/cm²), and Salinity (0.5%).
- Caloneis* sp1, Plate 64.
Distributions: (I).
Ecology: Brackish water, Epiphytic or Epipellic, pH (8.0), EC(20.7ms/cm²), and Salinity (0.5%).
- Nitzschia* sp12, Plate 65.
Distributions: (VI).
Ecology: Brackish water, Epiphytic or Epipellic, pH (8.6), EC(29.1ms/cm²), and Salinity (1.6%).
- Navicula* sp12, Plate 66.
Distributions: (II).
Ecology: Brackish water, Epiphytic or Epipellic, pH (8.0), EC(10.1ms/cm²), and Salinity (0.2%).
- Cyclotella* sp5, Plate 67.
Distributions: (III).
Ecology: Brackish water, Epiphytic or Epipellic, pH (8.6), EC(29.1ms/cm²), and Salinity (1.6%).
- Navicula* sp13 Plate 68
Distributions: (VI), (V).
(IV) Tseng-Wen Estuary, (V) Chi-Ku Mangroves.
Ecology: Brackish water, Epipellic or Epiphytic, pH (8-8.7), EC (16.4-49.6ms/cm²), and Salinity (3.3-0.8%)
- Amphora* sp16, Plate 69.
Distributions: (VI), (V).
Ecology: Brackish water, Epipellic or Epiphytic, pH (8-8.7), EC (16.4-49.6ms/cm²), and Salinity (3.3-0.8%)
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五、參考文獻