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ALGOLOGIE

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Nous avons la tristesse de vous faire part du décès du Professeur Pierre BOURRELLY, survenue le 31 octobre 1995, dans sa 85^e année.

Une notice paraîtra dans un prochain fascicule.

ESTUDIO CUALITATIVO DEL FITOPLANCTON DEL EMBALSE RÍO HONDO (ARGENTINA): I

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RESUMEN — Se describen e ilustran 80 especies fitoplanctónicas pertenecientes a las Chlorophyta, Diatomophyceae (Chromophyta), Euglenophyta, Pyrrophyta y Schizophyta, de la zona limnética y las desembocaduras de los ríos Salí y Gastona del embalse Río Hondo (Argentina), en relación a la contaminación provocada por la actividad azucarera.

Se citan por primera vez para el Noroeste Argentino 19 especies: *Achnanthes inflata*, *Aulacoseira granulata* var. *angustissima*, *Closterium macilentum*, *Cymbella amphicephala*, *Gomphonema augur*, *G. clavatum*, *G. gracile*, *Gonatozygon kinahani*, *Merismopediu tenuissima*, *Nitzschia acicularis*, *N. commutata*, *N. reversa*, *Phacus curvicauda*, *P. longicauda* var. *insecta*, *Pinnularia interrupta*, *Rhopalodia gibberula*, *Scenedesmus quadricauda* var. *longispina*, *Surirella brebissoni*, *Trachelomonas armata*.

ABSTRACT — Eighty phytoplanktonic species of Chlorophyta, Diatomophyceae (Chromophyta), Euglenophyta, Pyrrophyta and Schizophyta of the limnetic zone and of the outlets of the Salí and Gastona rivers of the Río Hondo dam (Argentina) are described in relation to the contamination caused by the sugar activity.

Nineteen species from the NW of Argentina are quoted for the first time: *Achnanthes inflata*, *Aulacoseira granulata* var. *angustissima*, *Closterium macilentum*, *Cymbella amphicephala*, *Gomphonema augur*, *G. clavatum*, *G. gracile*, *Gonatozygon kinahani*, *Merismopediu tenuissima*, *Nitzschia acicularis*, *N. commutata*, *N. reversa*, *Phacus curvicauda*, *P. longicauda* var. *insecta*, *Pinnularia interrupta*, *Rhopalodia gibberula*, *Scenedesmus quadricauda* var. *longispina*, *Surirella brebissoni*, *Trachelomonas armata*.

PALABRAS CLAVES — fitoplancton, análisis cualitativo, contaminación, embalse Río Hondo (Noroeste Argentino).

INTRODUCCION

El presente estudio consistió en comparar la flora algal fitoplanctónica de la zona limnética ("olla") del embalse Río Hondo (Tucumán-Santiago del Estero) con las desembocaduras de los ríos Salí y Gastona ("cola"), en relación a la influencia de la actividad azucarera (julio-noviembre).

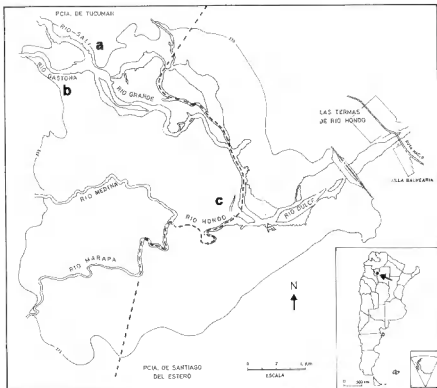


Fig. 1 a-c: Embalse Río Hondo (Noroste Argentino), desembocaduras de los ríos a: Sali, b: Gastona; c: zona limnética.

El embalse Río Hondo, de 42.000 Ha de extensión, está ubicado en el Noroeste Argentino entre los 27°30' de lat. S y los 65° de long. W (Locascio de Mitrovich *et al.*, en prensa). De sus cuatro tributarios, ríos Sali, Gastona, Medina y Marapa, los dos primeros son los principales receptores de los efluentes industriales y cloacales de la parte media de la cuenca Sali-Dulce (Romero *et al.*, 1994; Tracanna *et al.*, 1994).

Este trabajo forma parte de una serie de contribuciones inter-disciplinarias tendientes a diagnosticar limnológicamente a este cuerpo de agua para elaborar pautas de manejo y conservación.

MATERIALES Y METODOS

Los muestreos fueron efectuados durante junio (pre-zafra) y se-tiembre (zafra) de 1992. Las estaciones seleccionadas fueron: la "olla" (zona limnética) y la "cola" (desembocaduras de los ríos Sali y Gastona) (Fig. 1).

Se utilizó una red de plancton de 48 µm de malla, realizándose arrastre de aguas superficiales. Las muestras fueron fijadas "in situ" con formaldehído al 4 % para su estudio específico e infraespecífico. Para la clasificación taxonómica hasta nivel genérico se siguió a Bourrelly 1972, 1981, 1985.

La distribución del material estudiado se encuentra detallado en la tabla I.

RESULTADOS

Se identificaron un total de 80 especies (Tabla I; Figs. 2-77): 28 en la "olla", 54 y 46 en los ríos Salí y Gastona, respectivamente. Estas pertenecieron a las Chlorophyta, Diatomophyceae (Chromophyta), Euglenophyta, Pyrrophyta y Schizophyta.

En la "olla" se observaron 14 taxones en pre-zafra y 24 para la zafra. Responsables de esta diferencia fueron principalmente las algas verdes que aumentaron de un 36 % a un 54 %. Sin embargo, el número de diatomeas y algas azules no sufrió mayores cambios, 6 a 6 y 3 a 4 especies respectivamente, registrándose sólo para el periodo de zafra a: *Amphipleura lindheimerii*, *Gyrosigma acuminatum* y *Merismopedia tenuissima*. Las Pyrrophyta únicamente estuvieron representadas por *Peridinium gatunense* en los periodos considerados.

En los ríos Salí y Gastona se observó una disminución de la riqueza específica para el periodo de zafra de 48 a 44 para el primero y 34 a 29 para el segundo, siendo las diatomeas las que representaron el mayor porcentaje, superior o igual al 48 % de sus respectivos totales. Es importante destacar que los euglenoides aumentaron en el río Gastona, durante setiembre, de 1 a 6 especies.

Se citan por primera vez para el Noroeste Argentino según bibliografía consultada (Locascio *et al.* en prensa; Maidana, 1989 a-b; Martínez De Marco, en prensa; Mirande, 1994; Seeligmann, 1990; Seeligmann *et al.* 1994; Tell, 1985; Tracanna, 1982 y 1985; Tracanna *et al.*, 1994) a: *Achnanthes inflata*, *Aulacoseira granulata* var. *angustissima*, *Closterium macilentum*, *Cymbella amphicephala*, *Gomphonema augur*, *G. clavatum*, *G. gracile*, *Gonatozygon kinahani*, *Merismopedia tenuissima*, *Nitzschia acicularis*, *N. commutata*, *N. reversa*, *Phacus curvicauda*, *P. longicauda* var. *insecta*, *Pinnularia interrupta*, *Rhopalodia gibberula*, *Scenedesmus quadricauda* var. *longispina*, *Surirella brebissoni* y *Trachelomonas armata*.

TAXONOMIA¹

Schizophyta

* *Merismopedia tenuissima* Lemm., 1898 (Fig. 2).

Colonias de 16-100 células. Células de 1,5-2 µm de diámetro.

Microcystis flos-aquae (Wittr.) Kirchn., 1898 (Fig. 3 a-c)

Colonias esféricas a irregulares. Células de 3-6 µm de diámetro.

¹ * especie citada por primera vez para el Noroeste Argentino.

ESPECIES	LA OLLA		SALI		GASTONA	
	PZ/92	Z/92	PZ/92	Z/92	PZ/92	Z/92
Schizophyta						
<i>Anabaena flos-aquae</i>	x	x	x	x	x	
<i>Anabaena</i> sp.						x
<i>Lyngbya allorgei</i>			x			
<i>Lyngbya limnetica</i>			x	x	x	x
<i>Lyngbya</i> sp.				x		x
<i>Merismopedia tenuissima</i>		x				
<i>Microcystis flos-aquae</i>	x	x	x	x		
<i>Oscillatoria chalybea</i>			x	x	x	x
<i>Pseudanabaena mucicola</i>	x	x				
Pyrophyta						
<i>Peridinium gottmense</i>	x	x				
Diatomophyceae						
<i>Actinanthus inflata</i>			x		x	
<i>Amphipleura lindheimerii</i>		x	x	x	x	x
<i>Aulacoseira granulata</i>	x	x	x	x		x
<i>Aulacoseira granulata</i> var. <i>angustissima</i>	x	x	x	x	x	
<i>Bacillaria paradoxa</i>			x			
<i>Coconets placentalis</i> var. <i>euglypta</i>				x	x	
<i>Cyclotella meneghiniana</i>	x	x	x	x	x	x
<i>Cymatopleura solea</i>				x		
<i>Cymbella amphicephala</i>			x			
<i>Cymbella tumida</i>			x	x	x	x
<i>Entomoneis alata</i>			x	x		
<i>Eunotia pectinalis</i>					x	x
<i>Fragilaria arcus</i>			x			
<i>Fragilaria ulna</i>	x		x	x	x	x
<i>Gomphonema augur</i>					x	
<i>Gomphonema clavatum</i>			x	x	x	x
<i>Gomphonema gracile</i>				x	x	
<i>Gomphonema truncatum</i>				x		
<i>Gyrodinium acuminatum</i>		x	x	x	x	x
<i>Melosira varians</i>			x	x	x	x
<i>Navicula cuspidata</i>			x	x	x	x
<i>Navicula peregrina</i>			x	x		
<i>Navicula perrotetii</i>			x			
<i>Nitzschia acicularis</i>			x	x	x	
<i>Nitzschia commutata</i>			x			
<i>Nitzschia obtusa</i>	x		x	x	x	
<i>Nitzschia palea</i>	x	x	x	x	x	x
<i>Nitzschia reversa</i>			x	x	x	
<i>Nitzschia sigmoidea</i>			x	x	x	x
<i>Nitzschia</i> sp.			x	x		
<i>Pinnularia interrupta</i>			x	x		x
<i>Pinnularia maior</i>			x	x	x	x
<i>Pleurosigma laevis</i>			x	x		
<i>Rhoicosphenia abbreviata</i>			x	x	x	
<i>Rhopalodia gibba</i>			x	x		
<i>Rhopalodia gibberula</i>			x			
<i>Sarirella brebissoni</i>			x	x	x	
<i>Sarirella splendida</i>			x			

TABLA I: continuación

ESPECIES	LA OLLA		SALI		GASTONA	
	PZ/92	Z/92	PZ/92	Z/92	PZ/92	Z/92
Chlorophyta						
<i>Chlamydomonas globosa</i>	x	x				
<i>Closterium aciculare</i>		x				
<i>Closterium acutum</i> var. <i>variable</i>	x	x	x	x		
<i>Closterium eboracense</i>			x	x		
<i>Closterium lanceolatum</i>			x	x		x
<i>Closterium moellendorffii</i>						x
<i>Closterium venosum</i>		x				
<i>Cosmarium</i> sp. 1			x		x	x
<i>Cosmarium</i> sp. 2		x				
<i>Crucigenia fenestrata</i>		x				
<i>Eudorina elegans</i>	x				x	x
<i>Gonotrygon kinahani</i>				x	x	
<i>Micrasterias truncata</i>					x	
<i>Monoraphidium pusillum</i>		x	x	x		
<i>Oedogonium</i> sp. 1			x		x	
<i>Oedogonium</i> sp. 2					x	
<i>Pandorina morum</i>	x		x	x	x	x
<i>Pediastrum duplex</i> var. <i>punctatum</i>		x				
<i>Pediastrum simplex</i> var. <i>pseudoglabrum</i>	x	x				
<i>Scenedesmus acuminatus</i>		x				
<i>Scenedesmus intermedius</i>		x				
<i>Scenedesmus quadricauda</i> var. <i>longispina</i>		x				
<i>Spirogyra</i> sp. 1			x	x		
<i>Spirogyra</i> sp. 2				x	x	
<i>Stigeoclonium</i> sp.			x	x	x	
<i>Tetrastrum staurigeniaeforme</i>		x				
Euglenophyta						
<i>Euglena acus</i>			x		x	x
<i>Euglena oxyuris</i>						x
<i>Euglena proxima</i>			x	x		x
<i>Phacus curvicauda</i>						x
<i>Phacus longicauda</i> var. <i>insecta</i>						x
<i>Trachelomonas armata</i>						x
TOTAL DE ESPECIES	14	24	48	44	34	29

TABLA I: Lista cualitativa del fitoplancton del embalse Río Hondo y las desembocaduras de los ríos Sali y Gastona (PZ: pre-zafra, Z: zafra).

Anabaena flos-aquae (Lyngb.) Bréb. ex Born. et Flah., 1888 (Fig. 4).

Tricomas de 800-900 μm . Células de 5-7 μm de diámetro. Heterocistos de 8-9 μm de diámetro.

Observaciones: Los heterocistos fueron muy pocos frecuentes y no se observaron acinetos.

Anabaena sp. (Fig. 5).

Tricomas de 600 μm de largo. Células de 3-4 (4,5) μm de largo y 3,5-4 μm de ancho. Heterocistos de 7-8 μm de largo y 6 μm de ancho.

Observaciones: Material estéril, poco frecuente.

Lyngbya allorgei Frémy, 1930 (Fig. 6).

Filamentos de 5-5,5 μm de ancho. Células de 4-5 (5,5) μm de largo y 4 μm de ancho.

Lyngbya lunnetica Lemm., 1898 (Fig. 7 a-b).

Filamentos de 1-2 μm de ancho. Células de 4-5 (7) μm de largo y 1-2 μm de ancho.

Lyngbya sp. (Fig. 8).

Filamentos de 16-17 μm de ancho. Células de 3-4 (5,5) μm de largo y 16-16,5 μm de ancho.

Observaciones: El material no pudo ser determinado específicamente por ser muy escaso e incompleto.

Oscillatoria chalybea (Mertens) Gomont, 1892 (Fig. 9).

Tricomas ligeramente constrictos. Células de 3-4 (5,5) μm de largo y 6-7 (8) μm de ancho.

Pseudanabaena mucicola (Naumann et Hüber-Pestalozzi) Bourrelly, 1970 (Fig. 10).

Filamentos de pocas células, generalmente 8, de 4-16 μm de largo. Células de 1,5-2 (3) μm de largo y 1-1,5 μm de diámetro.

Observaciones: Sólo fue observada en *Microcystis flos-aquae* y, a veces, libre.

Pyrrophyta

Peridinium gatunense Nygaard, 1925 (Fig. 11 a-c).

Células de 45-55 μm de largo y 55-65 μm de ancho. Tabulación: epivalva: 7p + 4a + 3m, hipovalva: 5p' + 2a'

Chromophyta

Aulacoseira granulata (Ehr.) Simonsen, 1979 (Fig. 12).

Células de 14-22 μm de altura y 4-9 μm de diámetro. Estrias 8-9 en 10 μm . Espinas de 14-15 μm de largo.

**Aulacoseira granulata* var. *angustissima* (O. Müller) Simonsen, 1979 (Fig. 13).

Células de (9) 12-14 μm de altura y 2,5-3 μm de diámetro. Estrias 10-12 en 10 μm . Espinas de 8-11 μm de largo.

Cyclotella meneghiniana Kütz., 1844 (Fig. 14).

Células de 10-30 μm de diámetro. Estrias 8-9 en 10 μm .

Melosira varians Agardh, 1827 (Fig. 15).

Células de 11-12 μm de diámetro y 9-10 μm de altura.

Pleurosira laevis (Ehr.) Compère, 1982 (Fig. 16).

Células de 68 μm de largo y 55 μm de ancho. Estrias 14-15 en 10 μm . Poros, 12 en 10 μm .

Fragilaria arcus (Ehr.) Cleve, 1898 (Fig. 17).

Valvas de 38 μm de largo y 6-7 μm de ancho. Estrias 13 en 10 μm .

Fragilaria ulna (Nitzsche) Lange-Bertalot, 1980 (Fig. 18).

Valvas de 138-250 μm de largo y 6-8 μm de ancho. Estrias 10-12 en 10 μm .

Eunotia pectinalis (Dillwyn?, O.F. Müller?, Kütz.) Rabh., 1864 (Fig. 19).

Valvas de 85-160 μm de largo y 10-10,5 μm de ancho. Estrias 10-12 en 10 μm .

Cocconeis placentula var. *euglypta* (Ehr.) Cleve, 1895 (Fig. 20).

Valvas de 27 μm de largo y 15 μm de ancho. Estrias 18-19 en 10 μm .

**Achnanthes inflata* (Kütz.) Grunow in Cleve and Grunow, 1880 (Fig. 21 a-b).

Valvas de 36 μm de largo y 11-12 μm de ancho. Estrias 11 en 10 μm .

Amphipleura lindheimeri Grun., 1862 (Fig. 22).

Valvas de 170-190 μm de largo y 24-25 μm de ancho.

**Cymbella amphicephala* Naegeli in Kütz., 1849 (Fig. 23).

Valvas de 42 μm de largo y 9 μm de ancho. Estrias 11-12 en 10 μm .

Cymbella tumida (Bréb.) Van Heurck, 1880 (Fig. 24).

Valvas de 52-54 μm de largo y 17 μm de ancho. Estrias 9 en 10 μm en el centro y 12 en 10 μm en los extremos.

Entomoneis alata (Ehr.) Ehr., 1845 (Fig. 25).

Células en vista conectival de 80 μm de largo y 22 μm de ancho en el centro. Las valvas y las alas están ornamentadas por estrias transversales 17-18 en 10 μm .

**Gomphonema augur* Ehr., 1840 (Fig. 26).

Valvas de 50 μm de largo y 16 μm de ancho. Estrias 10-11 en 10 μm .

**Gomphonema clavatum* Ehr., 1832 (Fig. 27).

Valvas de 48 μm de largo y 13 μm de ancho. Estrias 9-10 en 10 μm .

**Gomphonema gracile* Ehr., 1838 (Fig. 28).

Valvas de 48-92 μm de largo y 12-14 μm de ancho. Estrias 10-13 en 10 μm .

Gomphonema truncatum Ehr., 1832 (Fig. 29).

Valvas de 47 μm de largo y 12 μm de ancho. Estrias 8-11 en 10 μm .

Gyrosigma acuminatum (Kütz.) Rabh., 1853 (Fig. 30 a-b).

Valvas de 91 μm de largo y 14 μm de ancho. Estrias longitudinales y transversales 19-20 en 10 μm .

Navicula cuspidata (Kütz.) Kütz., 1844 (Fig. 31).

Valvas de 63-72 μm de largo y 17-20 μm de ancho. Estrias 17-19 en 10 μm .

Navicula peregrina (Ehr.) Kütz., 1844 (Fig. 32).

Valvas de 74-92 μm de largo y 18-19 μm de ancho. Estrias 6-7 en 10 μm .

Navicula perrotettii Grun. (Fig. 33).

Valvas de 150 μm de largo y 34-35 μm de ancho. Estrias transversales 14 en 10 μm . Estrias longitudinales 10-11 en 10 μm .

**Pinnularia interrupta* W. Smith, 1853 (Fig. 34).

Valvas de 52 μm de largo y 10-11 μm de ancho. Costillas 12 en 10 μm .

Pinnularia maior (Kütz.) Cleve, 1853 (Fig. 35).

Valvas de 126-232 μm de largo y 18-35 μm de ancho. Costillas 7 en 10 μm .

Rhoicosphenia abbreviata (C. Agardh) Lange-Bertalot, 1980 (Fig. 36 a-b).

Valvas de 19 μm de largo y 5 μm de ancho. Estrias 13 en 10 μm en el centro y 12 en 10 μm en los extremos.

Rhopalodia gibba (Ehr.) O. Müller, 1895 (Fig. 37 a-b).

Valvas de 66 µm de largo y 10-11 µm de ancho. Fíbulas 5-6 en 10 µm. Estrias 16 en 10 µm. Vista conectival de 22 µm de ancho.

**Rhopalodia gibberula* (Ehr.) O. Müller, 1899 (Fig. 38).

Vista conectival de 102 µm de largo y 42 µm de ancho. Costillas 3-4 en 10 µm. Estrias 16 en 10 µm.

Bacillaria paradoxa Gmelin, 1791 (Fig. 39 a-c).

Valvas de 90-99 µm de largo y 6 µm de ancho. Fíbulas 7-9 en 10 µm. Estrias 20-23 en 10 µm.

**Nitzschia acicularis* (Kütz.) W. Smith, 1853 (Fig. 40).

Valvas de 78 µm de largo y 4 µm de ancho. Fíbulas 15 en 10 µm. Estrias alrededor de 60-72 en 10 µm según Krammer *et al.*, 1988.

**Nitzschia commutata* Grun. in Cleve & Grun., 1880 (Fig. 41).

Valvas de 98 µm de largo y 11 µm de ancho. Fíbulas 7 en 10 µm. Estrias 19-22 en 10 µm.

Nitzschia obtusa W. Smith, 1853 (Fig. 42).

Valvas de 112-115 µm de largo y 10 µm de ancho. Fíbulas 5-7 en 10 µm. Estrias 22-25 en 10 µm según Krammer *et al.*, 1988.

Nitzschia palea (Kütz.) W. Smith, 1856 (Fig. 43).

Valvas de 20-66 µm de largo y 4-5 (7) µm de ancho. Fíbulas 9-12 en 10 µm. Estrias 28-40 en 10 µm según Krammer *et al.*, 1988.

**Nitzschia reversa* W. Smith, 1853 (Fig. 44).

Valvas de 79 µm de largo y 5 µm de ancho. Fíbulas 13-15 en 10 µm. Estrias 55-60 en 10 µm según Germain, 1981.

Nitzschia sigmoidea (Nitzsch) W. Smith, 1853 (Fig. 45).

Células de 170-174 µm de largo. Fíbulas 7 en 10 µm. Vista conectival de 10 µm de ancho.

Nitzschia sp. (Fig. 46).

Valvas de 155 µm de largo y 10 µm de ancho. Fíbulas 6 en 10 µm. Estrias 14 en 10 µm.

Cymatopleura solea (Bréb.) W. Smith, 1851 (Fig. 47 a-b).

Valvas de 96 µm de largo y 20 µm de ancho. Estrias 8 en 10 µm. Las ondulaciones, sobre todo visibles en vista conectival, en número de 4 ó 6.

**Surirella brebissonii* Krammer & Lange-Bertalot, 1987 (Fig. 48).

Valvas de 80 μm de largo y 35 μm de ancho. Costillas 30 en 100 μm . Estrias 13 en 10 μm .

Surirella splendida (Ehr.) Kützing, 1844 (Fig. 49 a-b).

Valvas de 89-130 μm de largo y 36-62 μm de ancho. Costillas 20 en 100 μm .

Chlorophyta

Chlamydomonas globosa Snow, 1903 (Fig. 50).

Células de 10-12 μm de diámetro.

Eudorina elegans Ehr., 1831 (Fig. 51).

Colonias de 72-120 μm de diámetro. Células de 10-20 μm de diámetro.

Pandorina morum (Muell.) Bory, 1824 (Fig. 52).

Colonias de 42-60 μm de largo y 38-50 μm de ancho. Células 8-16 por colonia, de 15-18 μm de largo y (13) 15-16 μm de ancho.

Monoraphidium pusillum (Printz) Kómarková-Legnerová, 1969 (Fig. 53).

Células de 50 μm de largo y 2,5 μm de ancho.

Observaciones: Nuestros ejemplares poseen mayor longitud que las indicadas por Kómarková-Legnerová (1969), de 12-16,5-25 μm .

Crucigenia fenestrata Schmidle, 1900 (Fig. 54).

Colonias formadas por 4 células. Células de 3,5-4 μm de largo y 2 μm de ancho.

Scenedesmus acuminatus (Lagerh.) Chod., 1902 (Fig. 55).

Cenobios de (2) 4-8 células. Células de 13 μm de largo y 4 μm de ancho.

Scenedesmus intermedius Chod., 1926 (Fig. 56).

Cenobios de 4-6 células. Células de 4,5-8 μm de largo y de 2-4 μm de ancho. Espinas de 2-4 μm de largo.

**Scenedesmus quadricauda* var. *longispina* (Türp.) Bréb., 1835 (Fig. 57).

Cenobios de 2-4-8 células. Células de 8 μm de largo y 3-4 μm de ancho. En ambos polos de las células externas se encuentra un aguijón de 2/3 a 1/4 del largo de la célula.

Tetrastrum staurogeniaeforme (Schroeder) Lemmermann, 1900 (Fig. 58).

Cenobios formados por 4 células. Células de 5 μm de ancho.

Pediastrum duplex var. *punctatum* (Krieger) Parra, 1979 (Fig. 59).

Cenobios de 16-32 células. Células internas de 13-14 μm de largo y 14 μm de ancho. Células externas de 15 μm de largo y (13) 14-15 (16) μm de ancho.

Pediastrum simplex var. *pseudoglabrum* Parra, 1979 (Fig. 60 a-b).

Cenobios de 16-32 células. Células internas de 11-12 μm de largo y 15-16 μm de ancho. Células externas de 21-22 μm de largo y 13-15 μm de ancho.

Stigeoclonium sp. (Fig. 61).

Células del eje principal cilíndricas, de 9-10 (15) μm de largo y 5-7 (8) μm de ancho. Células de las ramificaciones de 10-12 (18) μm de largo y 4-5 μm de ancho. Las ramificaciones a veces terminan en un pelo hialino de unos 70 μm de largo y 2,5 μm de ancho.

Observaciones: material incompleto.

Oedogonium sp. 1.

Células cilíndricas de 26-39 μm de largo y 7-9 μm de ancho. Ápice redondeado.

Observaciones: Material estéril.

Oedogonium sp. 2.

Células cilíndricas de 80-115 μm de largo y 15-16 μm de ancho. Ápice terminado en un pelo hialino de 10 μm de largo.

Observaciones: Material estéril.

Spirogyra sp. 1.

Células cilíndricas de 58-78 μm de largo y 14 μm de ancho. Tres cloroplastos acintados por célula.

Observaciones: Material estéril.

Spirogyra sp. 2.

Células cilíndricas de 29-38 μm de largo y 9 μm de ancho. Un cloroplasto acintado por célula.

Observaciones: Material estéril.

Closterium aciculare West, 1860 (Fig. 62).

Células de 475 μm de largo y 5-6 μm de ancho. Ápice de 2 μm de ancho. Seis pirenoides por hemicélula dispuestos en una serie lineal. Cristales 1-3.

Closterium acutum var. *variabile* (Lemm.) Krieger, 1937 (Fig. 63).

Células de 72 μm de largo y 4 μm de ancho. Tres pirenoides por hemicélula dispuestos en una serie lineal. Cristales 1-2.

Closterium eboracense (Ehr.) Turner, 1886 (Fig. 64).

Células de 220 µm de largo y 42 µm de ancho. Cinco pirenoides por hemicélula linealmente dispuestos. Cristales aproximadamente 10.

Closterium lanceolatum Kütz., 1845 (Fig. 65).

Células de 250 µm de largo y 28 µm de ancho. Seis pirenoides por hemicélula linealmente dispuestos. Cristales aproximadamente 12.

**Closterium macilentum* Bréb., 1856 (Fig. 66 a-b).

Células de 238-900 µm y 12-15 µm de ancho. Doce pirenoides por hemicélula linealmente dispuestos. Cristales 2.

Closterium venus Kütz., 1845 (Fig. 67).

Células de 69-70 µm de largo y 7-8 µm de ancho. Tres pirenoides por hemicélula linealmente dispuestos. Cristales 2.

**Gonatozygon kinahani* (Archer) Rabh., 1868 (Fig. 68).

Células de 150-220 (263) µm de largo y 13 µm de ancho. Pirenoides 3-10.

Cosmarium sp. 1 (Fig. 69).

Células de 32 µm de largo y 24-26 µm de ancho. Ápices de 10 µm de ancho. Istmo de 8 µm de ancho.

Cosmarium sp. 2 (Fig. 70).

Células de 57 µm de largo y 46-49 µm de ancho. Ápices de 16-18 µm de ancho.

Micrasterias truncata (Corda) Bréb., 1848 (Fig. 71).

Células de 62 µm de largo y 69-70 µm de ancho. Istmo de 16 µm de ancho. Ápice de 51 µm de ancho.

Euglenophyta

Euglena acus Ehr., 1830 (Fig. 72).

Células de 142 µm de largo y 10,5 µm de diámetro. Siete paramilon de 10-17 µm de largo y 2-2,5 µm de ancho.

Euglena oxyuris Schmarda, 1846 (Fig. 73).

Células de 178 µm de largo y 20 µm de diámetro. Dos paramilon de 24-26 µm de largo y 13,5-14,5 µm de diámetro.

Euglena proxima Dang., 1901 (Fig. 74).

Células de 65-78 µm de largo y 25-30 µm de diámetro. Diez paramilon de 5-8 µm de largo y 2 µm de diámetro.

**Phacus curvicauda* Swir., 1915 (Fig. 75).

Células de 30 μm de largo y 22 μm de ancho. Apéndice caudal de 3 μm de largo. Dos paramilon en forma de anillos.

**Phacus longicauda* var. *insecta* Hüb.-Pest., 1955 (Fig. 76 a-c).

Células de 180 μm de largo y 56 μm de ancho. Apéndice caudal de 98 μm de largo. Un paramilon de 18 μm de diámetro.

**Trachelomonas armata* (Ehr.) Stein., 1878 (Fig. 77).

Lóriga de 42-44 μm de largo y 32-34 μm de diámetro. Cápsula con espinas de 1,5-2 μm de largo en el cuerpo y de 8-9 μm de largo en el polo posterior.

CONCLUSIONES

De las 28 especies registradas en la "olla" 15 pertenecieron a las Chlorophyta, 8 a las Diatomophyceae, 4 a las Schizophyta y 1 a las Pyrrophyta. En los ríos Salí y Gastona, de las 54 y 46 especies registradas en total, correspondieron respectivamente: 11/11 a las Chlorophyta, 36/24 a las Chromophyta (Diatomophyceae), 2/6 a las Euglenophyta y 6/5 a las Schizophyta.

El aumento de la riqueza específica en la "olla" durante la zafra azucarera se atribuyó principalmente a la aparición de las algas verdes: *Chlosterium aciculare*, *C. venus*, *Cosmarium* sp., *Crucigenia fenestrata*, *Monoraphidium pusillum*, *Pediastrum duplex* var. *punctatum*, *Scenedesmus acuminatus*, *S. quadricauda* var. *longispina* y *Tetrastrum staurogeniaeforme*. La disminución del número de especies en los ríos coincidió con el aumento de la carga contaminante, apareciendo además otras especies de Euglenophyta en el río Gastona: *Euglena oxyuris*, *Phacus curvicauda*, *P. longicauda* var. *insecta* y *Trachelomonas armata*.

Se citan por primera vez para el Noroeste Argentino diecinueve especies.

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LEYENDA DE LAS LAMINAS

Fig. 2: *Merismopedia tenuissima* Lemm.; Fig. 3 a-c: *Microcystis flos-aquae* (Wittr.) Kirchn., a-b: aspectos generales, b: detalle; Fig. 4: *Anabaena flos-aquae* (Lyngb.) Bréb. ex Born. et Flah.; Fig. 5: *Anabaena* sp.; Fig. 6: *Lyngbya allorgei* Frémy; Fig. 7 a-b: *Lyngbya limnetica* Lemm., a: filamentos, b: detalle; Fig. 8: *Lyngbya* sp.; Fig. 9: *Oscillatoria chalybea* (Mertens) Gomont; Fig. 10: *Pseudanabaena mucicola* (Naumann et Hüber-Pestalozzi) Bourrelly; Fig. 11 a-c: *Peridinium gautense* Nygaard, a: aspectos generales, b: hipoteca, c: epitoca; Fig. 12: *Aulacoseira granulata* (Ehr.) Simonsen; Fig. 13: *Aulacoseira granulata* var. *angustissima* (O. Müller) Simonsen; Fig. 14: *Cyclotella meneghiniana* Kütz.; Fig. 15: *Melosira varians* Agardh.

Las escalas equivalen a 10 µm, salvo en las figuras 3a: 200 µm y 7a: 100 µm.

Fig. 16: *Pleurocira laevis* (Ehr.) Compère; Fig. 17: *Fragilaria arcus* (Ehr.) Cleve; Fig. 18: *Fragilaria ulna* (Nitzsche) Lange-Bertalot; Fig. 19: *Eunotia pectinalis* (Dillwyn?, O.F. Müller?, Kütz.) Rabh.; Fig. 20: *Cocconeis placentula* var. *euglypta* (Ehr.) Cleve; Fig. 21 a-b: *Achnanthes inflata* (Kütz.) Grunow in Cleve & Grunow, a: epitoca, b: hipoteca; Fig. 22: *Amphipleura lindheimerii* Grun.; Fig. 23: *Cymbella amphicephala* Naegeli in Kütz.; Fig. 24: *Cymbella uonida* (Bréb.) Van Heurck; Fig. 25: *Entomoneis alata* (Ehr.) Ehr.; Fig. 26: *Gomphonema augur* Ehr.; Fig. 27: *Gomphonema clavatum* Ehr.; Fig. 28: *Gomphonema gracile* Ehr.; Fig. 29: *Gomphonema truncatum* Ehr.; Fig. 30 a-b: *Gyrosigma acuminatum* (Kütz.) Rabh., a: aspecto general, b: detalle; Fig. 31: *Navicula cuspidata* (Kütz.) Kütz.; Fig. 32: *Navicula peregrina* (Ehr.) Kütz.

Las escalas equivalen a 10 µm.

Fig. 33: *Navicula perrotettii* Grun.; Fig. 34: *Pinnularia interrupta* W. Smith; Fig. 35: *Pinnularia maior* (Kütz.) Cleve; Fig. 36 a-b: *Rhoicosphenia abbreviata* (C. Agardh) Lange-Bertalot, a: vista valvar, b: vista conectival; Fig. 37 a-b: *Rhopalodia gibba* (Ehr.) O. Müller, a: vista valvar, b: vista conectival; Fig. 38: *Rhopalodia gibberula* (Ehr.) O. Müller; Fig. 39 a-c: *Bacillaria paradoxa* Gmelin, a: aspecto general, b: vista valvar, c: detalle; Fig. 40: *Nitzschia acicularis* (Kütz.) W. Smith; Fig. 41: *Nitzschia commutata* Grun.; Fig. 42: *Nitzschia obtusa* W. Smith; Fig. 43: *Nitzschia palea* (Kütz.) W. Smith; Fig. 44: *Nitzschia reversa* W. Smith.

Las escalas equivalen a 10 µm.

Fig. 45: *Nitzschia sigmoidea* (Nitzsch) W. Smith; Fig. 46: *Nitzschia* sp.; Fig. 47 a-b: *Cymatopleura solea* (Bréb.) W. Smith, a: vista conectival, b: vista valvar; Fig. 48: *Surirella brebissonii* Krammer & Lange-Bertalot; Fig. 49 a-b: *Surirella splendida* (Ehr.) Kützing, a: vista valvar, b: vista conectival; Fig. 50: *Chlamydomonas globosa* Snow; Fig. 51: *Eudorina elegans* Ehr.; Fig. 52: *Pandorina morum* (Muell.) Bory; Fig. 53: *Monoraphidium pusillum* (Printz) Kómarková-Legnerová; Fig. 54: *Crucigenia fenestrata* Schmidle; Fig. 55: *Scenedesmus acuminatus* (Lagerh.) Chod.; Fig. 56: *Scenedesmus intermedius* Chod.; Fig. 57: *Scenedesmus quadricauda* var. *longispina* (Türp.) Bréb.; Fig. 58: *Tetrastrum staurogeniaeforme* (Schroeder) Lemmermann.

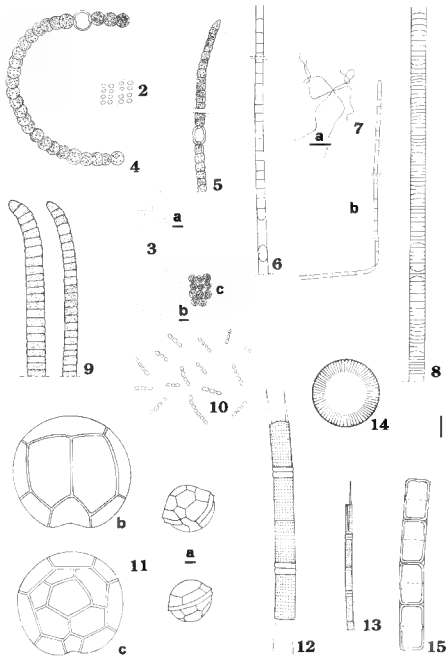
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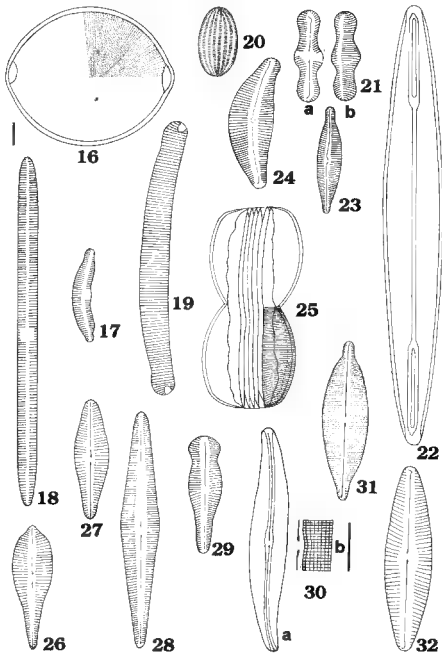
Fig. 59: *Pediastrum duplex* var. *punctatum* (Krieger) Parra; Fig. 60 a-b: *Pediastrum simplex* var. *pseudoglabrum* Parra, a: aspecto general, b: de-talle; Fig. 61: *Stigeoclonium* sp.; Fig. 62: *Closterium aciculare* West; Fig. 63: *Closterium acutum* var. *variabile* (Lemm.) Krieger; Fig. 64: *Closterium eboracense* (Ehr.) Turner; Fig. 65: *Closterium lanceolatum* Kütz.; Fig. 66 a-b: *Closterium macilentum* Bréb., a: aspecto general, b: detalle; Fig. 67: *Closterium venus* Kütz.; Fig. 68: *Gonatozygon kinahani* (Archer) Rabh.; Fig. 69: *Cosmarium* sp. 1; Fig. 70: *Cosmarium* sp. 2.

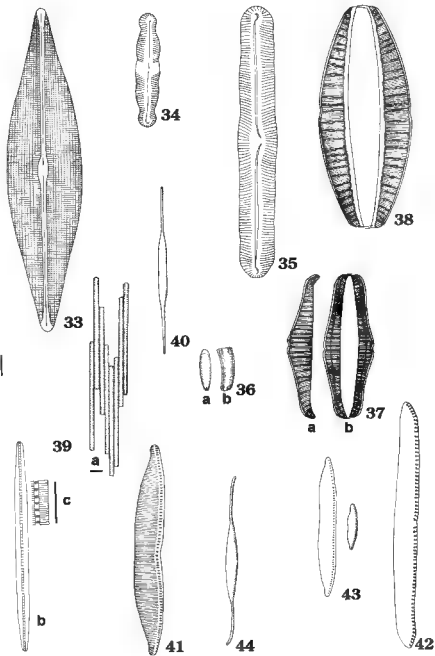
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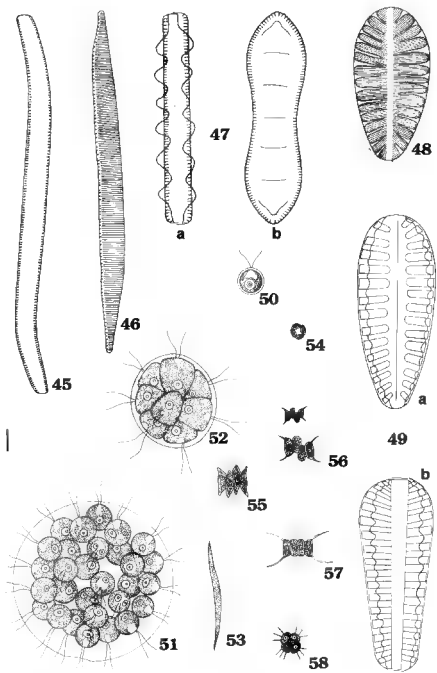
Fig. 71: *Microsterias truncata* (Corda) Bréb.; Fig. 72: *Euglena acus* Ehr.; Fig. 73: *Euglena oxyuris* Schmarada; Fig. 74: *Euglena proxima* Dang.; Fig. 75: *Phacus curvicauda* Swir.; Fig. 76 a-c: *Phacus longicauda* var. *insecta* Hüb. Pest., a-c: aspectos generales; Fig. 77: *Trachelomonas armata* (Ehr.) Stein.

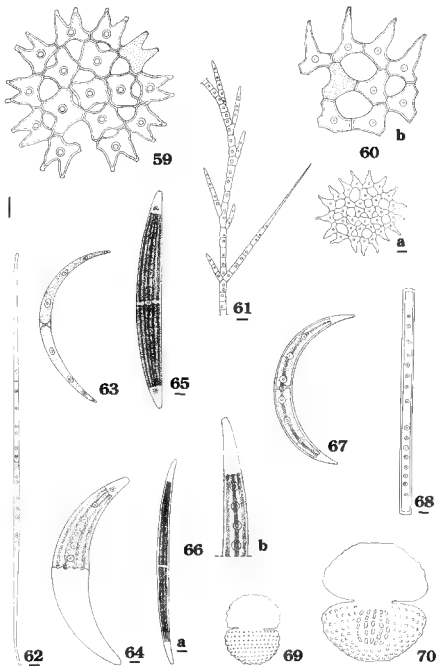
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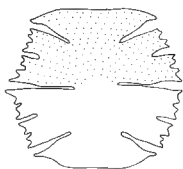










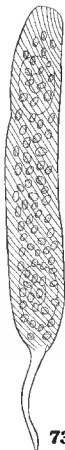


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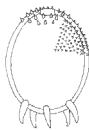
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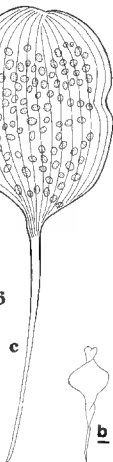


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a

76



c



b



74

MORPHOLOGICAL OBSERVATIONS ON *DINOPHYSIS* SPECIES (DINOPHYCEAE) FROM MEDITERRANEAN COASTAL WATERS

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ABSTRACT — Morphological aspects of various *Dinophysis* species (e.g. *D. sacculus*, *D. fortii* and *D. acuminata*) collected from Mediterranean coastal areas (southern Italy) are described. Data on the fluorescence of *Dinophysis* are given in addition to cell details in scanning electron and light microscopy.

Specimens of *D. sacculus* from Tyrrhenian brackish waters, where this species has been associated with slight DSP — toxicity of mussels, display high variability in cell shape and size, whereas the thecal ornamentation has a regular pattern. Cells of *D. sacculus*, as well as *D. acuminata* from the Straits of Messina, autofluoresce bright red and yellow — orange, indicating the possible presence of both chlorophyll and phycobilin pigments. Globular components similar to food vacuoles, were observed inside a few specimens of the *D. acuminata* complex and in *D. rotundata* cells, further supporting the respective mixotrophic capability and the heterotrophic behaviour of these dinoflagellates.

RÉSUMÉ — Les aspects morphologiques de diverses espèces de *Dinophysis* (par ex. *D. sacculus*, *D. fortii* et *D. acuminata*) prélevées dans les zones côtières de la Mer Méditerranée (Italie méridionale) sont décrites.

Les données concernant la fluorescence de *Dinophysis* sont fournies, avec en plus des détails de la cellule en microscopie électronique à balayage et photonique.

Les échantillons de *D. sacculus* des eaux saumâtres de la Mer Tyrrhénienne, où cette espèce a été associée à la toxicité DSP des coquillages, montrent une grande variabilité de forme et de dimension cellulaire, tandis que l'ornementation de la thèque montre un dessin régulier. Les cellules de *D. sacculus*, ainsi que celles de *D. acuminata* du Déroit de Messine, ont une fluorescence rouge et jaune — orange, indiquant la présence possible aussi bien de chlorophylle que de phycobilines. Des globules semblables à des vacuoles digestives ont été observés à l'intérieur de quelques exemplaires du complexe *D. acuminata* et de *D. rotundata*, confirmant ainsi la respective capacité mixotrophique et le comportement hétérotrophe de ces dinoflagellés.

KEY-WORDS — *Dinophysis*, morphology, Mediterranean Sea.

INTRODUCTION

Numerous species of *Dinophysis* Ehrenberg have been associated with DSP (Diarrhetic Shellfish Poisoning) in diverse geographical areas (e.g. Dahl & Yndestad,

1985; Lassus *et al.*, 1985; Sampayo *et al.*, 1990; Yasumoto, 1990; Delmas *et al.*, 1992; Boni *et al.*, 1993). The production of toxic metabolites, okadaic acid (OA) and its derivatives such as dinophysistoxins (DTXn), and occasionally pectenotoxins (PTXn), has however been proved only in a limited number of species, i.e. *D. acuminata*, *D. acuta*, *D. fortii*, *D. mitra*, *D. norvegica*, *D. sacculus*, *D. tripos* and, despite controversial opinions, for *D. rotundata* (Cembella, 1989; Lee *et al.*, 1989; Masselin *et al.*, 1992). This is probably due to low cell densities in coastal waters and unsuccessful attempts to cultivate this dinoflagellate genus so far.

First experimental studies seemed to evidence the capability of *Dinophysis acuminata* and *D. fortii* to prey upon cryptomonads (Ishimaru *et al.*, 1988) and the presence of food vacuoles and mixotrophy were shown for some photosynthetic species (*D. acuminata*, *D. norvegica*) (Jacobson & Andersen, 1994). Hallegraeff and Lucas (1988) also distinguished morphotypes *Dinophysis* and *Phalacroma* on the basis of physiological and ecological criteria, although the presence or absence of chloroplasts (or phagocytosed algal particles) cannot be considered as a distinctive character for both genera. Within the genus *Dinophysis (sensu stricto)*, in fact, species lacking chlorophyll or containing cyanobacteria-like endosymbionts were reported, in addition to species with chloroplasts (Lessard & Swift, 1986).

Another aspect of *Dinophysis* (e.g. the *D. acuminata* complex) is the high variability in cell shape and size, which may vary according to the site and the season (Solum, 1962). Changes in cell shape induced by the presence of food vacuoles and sexual dimorphism (Hansen, 1993) also complicate the species taxonomy.

Morphological observations on *Dinophysis* specimens selected from Mediterranean coastal waters are presented in this paper. Major attention is given to the thecal features of *D. sacculus* from a Tyrrhenian lagoon where spring blooms of this species have been associated with slight DSP-toxicity of experimentally contaminated mussels (Giacobbe *et al.*, 1995).

METHODS

Dinophysis cells were collected between 1988 and 1993 from the upper waters (0-5 m layer) of some Mediterranean areas: a Tyrrhenian lagoon of Sicily (Oliveri Bay, Gulf of Patti — 38°08' N, 15°03' E, April 1988 and April 1993); the harbour of Augusta, Ionian Sea (37°12' N, 15°03' E, March-August 1989); the coastline of Calabria (38°-40° N, 15°30'-17°30' E, March 1991 and September 1993); the Straits of Messina (38°10' — 38°13' N, 15°35'-15°39' E, July 1992).

Samplings were made using standard and Apstein nets (mesh: 40 and 20 µm, respectively) and/or Go-Flow Niskin bottles (General Oceanics). Most of the cells were preserved with neutralized formaldehyde (final concentration: 2 %) and examined by light microscope (Axiovert-35 Zeiss) equipped with a Contax 167MT camera. Brightfield or phase contrast light microphotographs were taken with Agfa PAN-F film, after cell staining with 1 % solution of Trypan blue.

Part of the fixed cell concentrates were washed with bidistilled water to remove salt crystals, passed over stubs, air-dried, sputter coated with gold and examined by Hitachi S-800 scanning electron microscope (University Policlinic,

Messina) or Hitachi S-4000 field emission SEM ("La Sapienza" University, Rome). SEM observations were made operating at accelerating voltages of 30 and 2-5 kV, respectively.

Some *Dinophysis* samples were preserved with glutaraldehyde (1%), stored in the dark at 4°C and examined by epifluorescence microscopy using an Axioplan and Zeiss filter set 487910 (BP 450-490 exciter filter, FT 510 chromatic beam splitter, BP 515-565 barrier filter).

RESULTS AND DISCUSSION

Micromorphometry of *D. sacculus* from Tyrrhenian brackish waters

Figure 1 shows the general morphology of *D. sacculus* Stein cells from Tyrrhenian waters (Green Pool, Oliveri Lagoon), whose salinity ranges from April to September, when this species is present, between 21 and 26 ppt (ITME, 1991).

The majority of specimens selected from the area have a total length within the size range of 48-60 µm, reported by Schiller (1933) for *D. sacculus*, whereas 35% of the cells encountered slightly exceeds the above range. On average, the total cell length is 59 ± 3 µm ($\bar{x} \pm SD$) ($n = 50$; coefficient of variation = 6%), being greater than that described for *D. cf. sacculus* from French coastal areas (Lassus & Bardouil, 1991). This observation agrees with previous studies on other *Dinophysis* species, showing how salinity influences the cell size. Solumn (1962) found that *D. acuminata* cells were longer in areas of low salinity, which was also noted by Matzenauer (1933) for some *Dinophysis* species belonging to the *caudata* group. Recent findings from the Galician Rias Baixas (NW Spain) also evidence changes in cell shape and size of *D. acuminata* in response to variations in environmental conditions, with smaller cells at higher values of salinity (34.5-35.5 ppt) and temperature (Bravo *et al.*, 1995a).

The average cell width of the specimens from the brackish area is 29 ± 3 µm ($n = 21$; c.v. = 11%) and the length/width ratio: 1.8 ± 0.1 ($n = 10$). The cell wall has the following characteristics: straight, slightly concave or convex dorsal margin (Figs 1A, 22), rounded antapex, with a few to numerous knobs of irregular size (Fig. 1C), flattened or slightly convex (similar to *D. acuminata*) ventral posterior margin (Figs 1A, 1C, 22), left sulcal list (lsl): 31 ± 3 µm in size ($n = 20$; c.v. = 9%), smooth, with straight or turned downwards posterior rib (R3) (Fig. 1B) and right sulcal list (rsl) curved in outline and extending beyond the middle rib (R2) of the left list (Fig. 2) (rsl = 0.5 lsl in length).

The cell concentrations of *D. sacculus* found in this area reach high values (max. 40000 cells l⁻¹ in 1988 and 8000 cells l⁻¹ in 1993) when compared to other coastal zones of Sicily, where *Dinophysis* spp. were reported in very low amounts (Giacobbe & Maimone, 1991; Giacobbe *et al.*, 1991). ELISA tests on mussels introduced in the lagoon as bioassay organisms, coupled with microscopical analysis of midgut contents, showed a spring OA-production by this species, even if at low levels (Giacobbe *et al.*, 1995). However, there is no information on the possible relationships between environmental conditions and changes in toxigenicity of this strain. The same species, together with other *Dinophysis* spp. (e.g. *D. fortii*, *D. cf.*

acuminata) has also been associated with DSP-toxicity of mussels in diverse areas of the Northern Adriatic Sea (e.g. Boni *et al.*, 1992; Della Loggia *et al.*, 1993).

A few cells of *D. sacculus* (15 % of the whole population) have a markedly concave dorsal margin (Fig. 23), as also observed by Sidari *et al.* (1995) in coastal waters of the Gulf of Trieste (Northern Adriatic Sea). However, this characteristic — included by Schiller (1933) among the morphological features of *D. sacculus* — was afterwards reported as belonging to *D. pavillardi* Schroeder (see Lassus & Bardouil, 1991). Although there is no real evidence of a specific difference between *D. sacculus* and *D. pavillardi*, the prevailing of one morphotype over the other may have ecological significance, since this is probably related to specific environmental conditions (Bravo *et al.*, 1995b).

No couplet of cells connected by a megacytic dorsal bridge, resulting from vegetative cell division, was observed among the specimens of *D. sacculus* from the Tyrrhenian area. Neither were there stages of sexual reproduction, i.e. couplets of cells of diverse size, joined along the ventral edge, as observed for specimens of *Dinophysis* cf. *acuminata* from Port Underwood, New Zealand (Mackenzie, 1992).

Figures 3 and 4 show the plate ornamentation of *D. sacculus*. The thecal plates are sculptured with a circular areolation; within the cingulum, as well as just behind the posterior cingular list (pcl), pores are arranged in a row, whereas they are unevenly and more widely spaced in the rest of the hypotheca. Here, areoles with pores are sometimes replaced by shallow pits (Fig. 3).

On the whole, cells of *D. sacculus* from this population display variable cell shape and size; in contrast, the surface architecture of the theca has a basic pattern remarkably similar in all the specimens examined.

***Dinophysis* spp from the Ionian Sea and the Straits of Messina: main interspecies differences**

The pattern of thecal ornamentation of *D. sacculus* is shared by other species of *Dinophysis*, e.g. *D. acuminata* Claparède et Lachmann, *D. acuta* Ehrenberg, *D. caudata* Saville-Kent, *D. norvegica* Claparède et Lachmann, *D. fortii* Pavillard (see Hallegraeff & Lucas, 1988). Cells of the latter species have, however, a more prominent circular areolation of the theca when seen by scanning microscopy (Figs 5, 6), as observed on samples from the coastline of Calabria and the bay of Augusta (Ionian Sea); a decoration of the left sulcal list of *D. fortii* is also visible by LM. These characteristics, as well as the general cell shape (Fig. 12) (with convex dorsal margin), and size (60–70 µm — Balech, 1976), point towards the specific identification, although a wide variation in minor features has led to some confusion as to the limits of *Dinophysis* species. A number of distinct internal components have been described by Lucas & Vesik (1990) for specimens of *D. fortii* and the closely related species *D. acuminata* from Tasmania, e.g. the nucleus location, at the antapex in the former species and at the apex in the latter and a higher number of chromatospheres (i.e. chloroplasts of senescent cells aggregated in spherical clumps) in *D. fortii*. In the same way, chloroplasts appear scattered throughout the cytoplasm in couplets of *D. caudata* (Fig. 9), which are commonly found in the bay of Augusta, whereas single cells of the variety *caudata*, as well as var. *acuminiformis*, display chloroplasts aggregated in three to four chromatospheres (Figs 14, 15). In contrast

to Lucas & Vesk's findings, no chloroplast arrangement in spherical groups is visible in cells of *D. fortii* and *D. acuminata* (Fig. 16) from the Ionian Sea and the Straits of Messina respectively; in the latter species, the nucleus is often located half-way between apex and antapex, close to the dorsal suture (Fig. 17), whereas in some specimens it covers part of the central cell area. Numerous globular components of uniform size, can be observed inside a few small cells of *D. acuminata* from the Straits. Such globules are scattered throughout the cytoplasm and resemble the food vacuoles described by Jacobson & Andersen (1994) for *Dinophysis* spp. from Boothbay Harbor (Maine) and Vancouver; they are more clearly visible in some larger-sized specimens of the *D. acuminata* complex (Figs 18, 19) from the same area. The latter cells are intermediate, in the general morphology, between *D. acuminata* and *D. sacculus*, being similar to *D. cf. acuminata* specimens from Quiberon, France (see Lassus & Bardouil, 1991/ Fig. 1f). Food vacuoles were also reported by Jacobson & Andersen for heterotrophic species like *D. rotundata* Claparède et Lachmann, which feeds on ciliates using a peduncle, through a process known as myzocytosis (see Schnepf & Deichgraber, 1983; Hansen, 1991). The majority of *D. rotundata* cells found in coastal waters of the Ionian Sea, apparently lack vacuoles, but some specimens clearly display numerous large food vacuole-like globules (Figs 20, 21). The pattern of surface sculpturing of *D. rotundata* is given by shallow depressions and by some pores distributed all over the thcca, whereas closely spaced pores border the cingulum (Figs 7, 8).

Table I summarizes the autofluorescence properties of most of the *Dinophysis* species encountered in this study. Under epifluorescence blue excitation, *D. acuminata*, *D. pavillardi* and *D. sacculus* show red and yellowish primary fluorescence, indicating the possible presence in each cell of chlorophyll and phycobilin pigments, but no cyanobacteria were found as endosymbionts. *D. caudata* and *D. fortii* fluoresce red, whereas *D. rotundata*, *D. doriphora* (Stein) Abé (Fig. 11) and *D. mitra* (Schutt) Abé (Fig. 10) from the Ionian Sea exhibit a widespread greenish-yellow or green fluorescence, which further confirms the heterotrophic behaviour of these dinoflagellates previously ascribed to the genus *Phalacrocoma*.

Cells of *D. rotundata*, *D. doriphora* and *D. mitra* are also present in the Straits of Messina where a high species diversity can be observed in summer. Four other *Dinophysis* spp., i.e. *D. caudata*, *D. pusilla* Joergensen, *D. sacculus* and *D. schuettii* Murray and Whitting, and other dinophysoid dinoflagellates (e.g. *Ornithocercus magnificus*) were in fact found in July 1992 in this area, which is characterized by high hydrodynamism.

All the species present in the Straits and in the Ionian Sea, including *D. schroederi* Pavillard (Fig. 13) from the bay of Augusta, never exceed cell densities of 2000 cells l⁻¹, with the highest concentrations during the summer season. This is consistent with other observations from the Adriatic Sea (e.g. Cabrini *et al.*, 1995). In contrast, marked blooms of *Dinophysis* (e.g. *D. sacculus*) — and sometimes of other potentially-toxic dinoflagellates (Giacobbe & Maimone, 1994; Giacobbe *et al.*, in press) — occur in lagoon waters of Sicily, often developing during spring. Additional data are however needed to establish the toxigenicity of these dinoflagellate strains and its possible associations with environmental factors.

Table I. Autofluorescence of *Dinophysis* species selected from diverse Mediterranean areas.

Species	Site	Fluorescence
<i>Dinophysis acuminata</i> Claparède et Lachmann	Sicily (The Straits of Messina)	° Bright red and yellow
<i>D. caudata</i> Saville-Kent	Harbour of Augusta (Ionian Sea)	° Red
<i>D. doriphora</i> (Stein) Abé	Harbour of Augusta (Ionian Sea)	* Greenish-yellow
<i>D. fortis</i> Pavillard	Calabria (Ionian Sea)	° Red
<i>D. mitra</i> Schütt	Harbour of Augusta (Ionian Sea)	* Greenish
<i>D. pavillardi</i> Schroeder	Oliveri Lagoon (Tyrrhenian Sea)	° Red and yellow-orange
<i>D. rotundata</i> Claparède et Lachmann	Calabria (Ionian Sea)	° Greenish-yellow
<i>D. sacculus</i> Stein	Oliveri Lagoon (Tyrrhenian Sea)	° Red and yellow-orange

(°) chloroplasts; (*) no visible chloroplasts

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CAPTIONS TO FIGURES

Fig. 1 — SEM. Specimens of *Dinophysis sacculus* from Tyrrhenian brackish waters (Green Pool, Sicily). Scale bars = 10 μ m.

(A) Left lateral view. Cell with flattened dorsal and posterior ventral margins (arrows). H2 = left dorsal hypothecal plate. (B) Ventral view. The left sulcal list is supported by straight R3 rib. H3 = right dorsal hypothecal plate. (C) Another specimen (left lateral view) with numerous antapical knobs; the posterior ventral edge is slightly convex (arrows).

Figs 2-8 — Thecal features of *Dinophysis* species. Bars = 2 μ m.

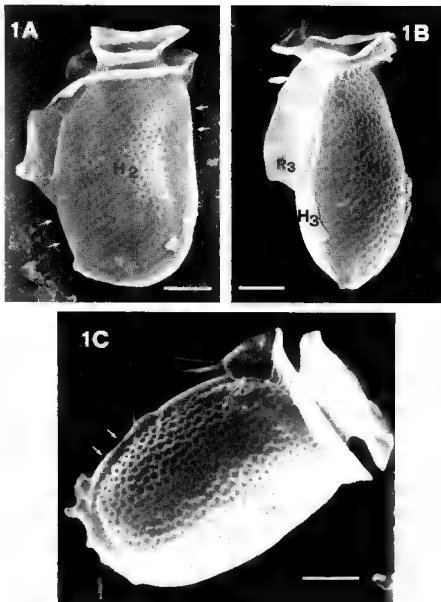
SEM. (2) Right lateral view. Theca of *D. sacculus* showing the right list of the sulcus (rs) and the circular areolation. (3) Enlarged detail of the above specimen with some areoles devoid of pores (arrowheads). (4) Ornamentation within the cingulum and behind the posterior circular list (pcl) in another cell of *D. sacculus*.

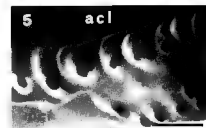
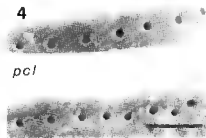
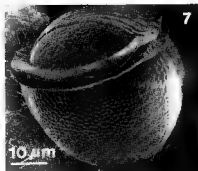
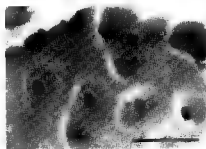
FE-SEM. (5) Thecal ornamentation of *Dinophysis fortii* (Calabria, Ionian Sea) within the cingulum, with a visible double row of poroids, and (6) in the hypotheca. The circular marking is more prominent than in *D. sacculus*. acl = anterior circular list. (7) *D. rotundata* from coastal waters of Calabria (Ionian Sea). Cell with visible E2 epithecal plate. (8) Detail of *D. rotundata* showing the faint thecal marking.

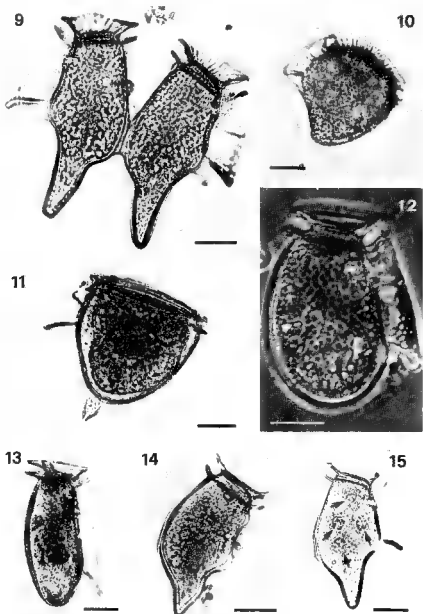
Figs 9-15 — LM. *Dinophysis* spp. from the bay of Augusta (Ionian Sea). Scale bars = 20 μ m.

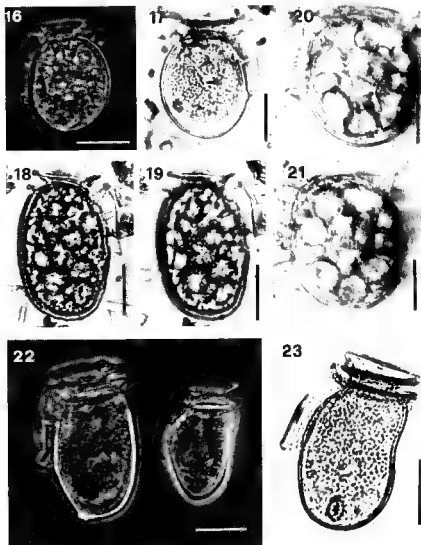
(9) Couplet of *D. caudata* with daughter cells still attached by the megacytic bridge (10) *D. mitra*. (11) *D. doriphora*. (12) *D. fortii*. (13) *D. schroederi*. (14-15) Single cells of *D. caudata* var. *acuminiformis* and var. *caudata* with chloroplasts aggregate in chromatospheres (arrows).

Figs 16-23 — LM. *Dinophysis* spp. Bars = 20 μ m. (16) Small *D. acuminata* cell from the Straits of Messina. (17) Another specimen of *D. acuminata* depicting the nucleus location (arrowheads). (18-19) Cells of *D. cf. acuminata* from the Straits and (20-21) *D. rotundata* (Ionian Sea) containing numerous food vacuole-like globules (two focal planes). (22) Morphotypes of *D. sacculus* with diverse cell shape and size (Green Pool, Sicily). (23) *D. pavillardii* from Green Pool, Sicily.









ASPECTS OF GROWTH AND NITROGENASE ACTIVITY OF THE PHOTOSYNTHETIC CYANOBACTERIUM *NOSTOC MUSCORUM* IN CONTINUOUS CULTURE.

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ABSTRACT — The level of photosynthetic oxygen evolution, chlorophyll, protein, nitrogenase and nitrate reductase activities were studied in the cyanobacterium *Nostoc muscorum* growing in continuous culture under various nitrogen sources (N_2 -free medium, NO_3^- or NH_4^+ -media). The growth and production rate of *N. muscorum* were optimal in the presence of NO_3^- rather than in the presence of NH_4^+ or molecular N_2 . The rate of photosynthetic O_2 evolution showed correlation with the increased chlorophyll and protein level in NO_3^- -grown cultures. The level of the key enzyme of nitrogen metabolism in cyanobacteria (evaluated by nitrogenase and nitrate reductase activities) were maxima in NO_3^- -cultures, while NH_4^+ -grown cultures had the lowest level.

RÉSUMÉ — L'évolution de la production d'oxygène photosynthétique, les teneurs en chlorophylle et en protéine, ainsi que l'activité de la nitrogenase et de la nitrate réductase, ont été étudiées chez la cyanobactérie *Nostoc muscorum* maintenue en culture continue, en présence de sources d'azote variées (azote gazeux N_2 , nitrate NO_3^- ou ammonium NH_4^+). La croissance et le taux de production de *N. muscorum* ont été supérieurs en présence de nitrate NO_3^- , qu'en présence d'une source d'azote ammoniacal NH_4^+ ou moléculaire N_2 . L'évolution de la production d'oxygène photosynthétique présente une corrélation avec l'augmentation des teneurs en chlorophylle et en protéine, dans les cultures où l'azote est fourni sous forme de nitrate. La quantité d'enzyme-clé du métabolisme azoté chez les cyanobactéries (évaluée par la mesure des activités de la nitrogenase et de la nitrate réductase) a été maximale dans les cultures où l'azote est présent sous forme de nitrate, tandis qu'elle a été minimale en présence d'azote ammoniacal. (Traduit par la rédaction).

KEY WORDS : *Nostoc muscorum*, growth, production rate, nitrogenase activity.

INTRODUCTION

Cyanobacteria play a major role among the micro-organisms which reduce dinitrogen to ammonia, and a range of cyanobacterial species known to be N_2 -fixing exist in rice field ecosystems. Virtually all the dominant cyanobacteria in rice fields

are N_2 -fixing, and therein lies the explanation of how rice, which provides the staple diet for about one-half of the world's population, has been grown continuously in paddy soils for many centuries without addition of fertilizer (Roger & Watanabe, 1984; Watanabe *et al.*, 1987; Abd-Alla *et al.*, 1994). Various factors affect the growth of cyanobacteria in paddy fields including physical, biological and soil factors. Cyanobacteria can be cultured either in laboratory enclosed bioreactors or in open pond systems utilizing sunlight (Borowitzka & Borowitzka, 1989; Tapie & Bernard, 1989).

Continuous culture technique enable to use very low nutrient concentrations and to obtain a dynamic equilibrium between the nutrient input and algal growth (Müller, 1972). A desired cell density can be maintained either by controlling the levels of the limiting nutrients in the reservoir or by controlling the rate of their inflow. In this well defined environment, the desired growth can be easily selected and maintained for a long period at any rate between zero and maximum.

In the present study, we have investigated some aspects of growth and enzymatic activities of the photosynthetic cyanobacterium *Nostoc muscorum* with respect to nitrogen sources using a continuous culture system.

MATERIALS AND METHODS

Culture conditions

The clonal axenic culture of *Nostoc muscorum* Agardh was grown photoautotrophically in modified Chu No. 10 medium (Gerloff *et al.*, 1950) under continuous light ($50 \mu E m^{-2} s^{-1}$) at $28 \pm 1^\circ C$ using chemostat culture at a constant dilution rate of $0.25 day^{-1}$ as described by Müller (1972). The N_2 -medium represents combined nitrogen free medium, while media containing 5 mM $NaNO_3$ or 1 mM NH_4Cl have been referred to as NO_3^- or NH_4^+ -media, respectively. The pH of the medium was maintained at 8.2 ± 0.1 by buffering with HEPES-NaOH buffer. There was no change in the pH of the medium during the experiments period. The air supply to the N-limited chemostats was passed through 1 N H_2SO_4 to remove ammonia before bathing through water. Autoclaved medium in 10 l reservoirs was continuously pumped into the cultures using Micro-pump (MP/K₂).

Growth measurements

The absorbance at 665 nm was measured to monitor changes in the culture biomass (Singh *et al.*, 1978). When the absorbance did not change more than 5 % over 5 days, the cultures were considered to be in steady-state. At that time, the entire culture volumes were sampled for composition and metabolic measurements. Cell number was counted in 1 ml medium obtained after cell swirling. Chlorophyll *a* was determined colorimetrically after acetone extracted as recommended by Metzner *et al.* (1965).

Estimation of O₂-evolution

At steady-state, photosynthetic O₂-evolution was measured polarographically at 30°C in 3 ml buffer by illuminating the cyanobacterial suspension with saturating light intensity at 87.5 $\mu\text{Em}^{-2}\text{s}^{-1}$ using a Clark type oxygen electrode (Rank) as described previously (Peschek & Schmetterer, 1978; Sharma *et al.*, 1979).

Nitrogenase activity

The acetylene reduction technique of Stewart *et al.* (1971) was used to assay the enzyme activity.

Nitrate reductase activity

This was assayed colorimetrically in the cell-free aqueous extract by diazotization of nitrite formed using the method of Harper (1972).

Analytical methods

Nitrite was estimated by diazocoupling reaction (Snell & Snell, 1949); cellular protein was estimated after treating the cells with 10 % trichloroacetic acid (Lowry *et al.*, 1951).

RESULTS AND DISCUSSION

The growth of *Nostoc muscorum* was studied in modified Chu No. 10 media either in the presence of a fixed nitrogen source such as NO₃⁻ or NH₄⁺ or in the absence of an exogenous fixed nitrogen source. The continuous culture technique was used at a constant dilution rate of 0.25 day⁻¹ in all experiments. At the steady-state when growth rate (μ) equals dilution rate (D) the growth parameters revealed significant differences with respect to the nitrogen source in the inflow medium (Table I). The NO₃⁻-grown culture, accumulated the maximum amount of chlorophyll *a* and protein in addition to cell number. The chlorophyll and protein levels under this condition increased more than twofold over in culture free nitrogen. Moreover, the NO₃⁻-grown cultures had a significantly higher level of chlorophyll *a* and protein when compared to NH₄⁺-grown cultures. The poor growth in NH₄⁺-medium has been attributed to the severe drop in pH of the external medium, following rapid NH₄⁺ uptake and accumulation within the cell (Fogg *et al.*, 1973).

The production rate refers to the biomass which overflows the culture vessel per time unit. Concerning the cell number, chlorophyll *a* and total protein contents, the rate of production was higher in culture containing NO₃⁻ than in NH₄⁺ or N₂-free media, while the rate of dry weight increased in the N₄ medium more than in NO₃⁻ or N₂-free media. It is suggested that cell number and chlorophyll were the best measurements of growth and production rate of cyanobacterium.

Table I. effect of nitrogen source in inflow medium on the growth and production rate of *N. muscorum* at a constant dilution rate (0.25 day^{-1}).

Parameters	Nitrogen sources		
	N_2	NaNO_3 (5 mM)	NH_4Cl (1 mM)
Cell number (10^6 l^{-1})	10.3 ± 0.1	11.6 ± 0.7	5.8 ± 0.3
Dry weight (mg l^{-1})	53.0 ± 6.1	64.0 ± 5.1	71.0 ± 7.2
Chlorophyll <i>a</i> ($\mu\text{g l}^{-1}$)	6.7 ± 0.1	12.7 ± 0.07	5.3 ± 0.09
Protein (mg l^{-1})	6.1 ± 0.3	13.6 ± 0.7	9.3 ± 0.8
(Production rate)			
mg dry weight $\text{l}^{-1} \text{ day}^{-1}$	10.6 ± 0.7	12.8 ± 0.7	14.2 ± 1.1
Cell number $10^6 \text{ l}^{-1} \text{ day}^{-1}$	2.06 ± 0.1	2.32 ± 0.3	1.16 ± 0.1
μg chlorophyll <i>a</i> $\text{l}^{-1} \text{ day}^{-1}$	1.34 ± 0.1	1.94 ± 0.2	1.06 ± 0.1
mg protein $\text{l}^{-1} \text{ day}^{-1}$	1.22 ± 0.3	2.32 ± 0.7	1.86 ± 0.2

Each value represent the mean of three replicates \pm standard error.

The rate of photosynthetic O_2 evolution, of *Nostoc muscorum* grown in chemostat culture, also appeared correlated with the increased chlorophyll and protein level in NO_3^- -grown cultures. In NO_3^- -grown culture, it was more than twice as high compared to N_2 - or NH_4^+ -grown cultures, when expressed either on cell basis or chlorophyll basis (Table II). Inhibition of photosynthesis is the prime reason for the observed low growth in NH_4^+ -medium, by imposing a limitation on ATP availability (Bagghi *et al.*, 1985, Fernandez-Valiente *et al.*, 1991).

The failure of N_2 not being a good source of nitrogen as NO_3^- is because under the aerobic growth conditions, the N_2 assimilatory enzyme nitrogenase, remains confined only to heterocysts (Stewart, 1973; 1980; Singh *et al.*, 1978; Bagghi *et al.*, 1985). The level of the key enzyme of nitrogen (N_2) metabolism in cyanobacteria (as tested by nitrogenase activity) was maximum in NO_3^- -grown culture, while NH_4^+ -grown culture had the lowest nitrogenase level (Table II). In this respect, Guerrero & Larra (1987) stated that the addition of ammonia to the cyanobacterial culture repressed the nitrogenase activity even at low concentrations. Since ammonia or its metabolites repress the formation of heterocysts, it has been difficult to establish whether inhibition of N_2 fixation is due to an inhibition of heterocyst differentiation or to a repression of nitrogenase synthesis. Furthermore, ammonia may inhibit nitrogenase activity *in vivo* by interrupting ATP or reductant supply (Rowell & Kerby, 1991).

Similarly, the level of nitrate reductase activity in NO_3^- -grown culture was significantly higher than in N_2 -culture when expressed on cell number basis. The low level of nitrate reductase in NH_4^+ -grown culture is however due to repression of nitrate reductase by NH_4^+ (Bagghi *et al.*, 1985). On the other hand, expressing nitrate reductase activity on the basis of total cellular protein reversed the pattern for enzyme activity in N_2 or NO_3^- -grown cultures. Generally in N_2 -grown cultures, N_2 -fixation is confined only to heterocysts, the limited availability of fixed N_2 results

Table II. Rate of photosynthetic O₂ evolution, nitrogenase and nitrate reductase activities in the cyanobacterium *N. muscorum* grown in chemostat culture under different nitrogen sources at constant rate (0.25 day⁻¹).

Nitrogen source	Photosynthetic O ₂ evolution		Nitrogenase activity		Nitrate reductase activity	
	Cell basis μ mol O ₂ /h/10 ⁸ cells	Chlorophyll basis μ mol O ₂ /h/ mg Chl. <i>a</i>	Cell basis n mol C ₂ H ₂ /h/10 ⁸ cells	protein basis n mol C ₂ H ₂ /mg protein	Cell basis μg NO ₂ /h/10 ⁸ cells	Protein basis μ NO ₂ -N/h/mg protein
N ₂	7.11 ± 0.3	165.1 ± 7.3	8.5 ± 0.1	2.8 ± 0.3	3.1 ± 0.1	3.9 ± 0.3
NaNO ₃ (5 mM)	15.80 ± 0.9	361.2 ± 9.7	12.6 ± 0.3	3.7 ± 0.1	5.6 ± 0.3	1.9 ± 0.1
NH ₄ Cl (1 mM)	6.9 ± 0.7	187.9 ± 6.3	5.4 ± 0.2	0.81 ± 0.1	1.1 ± 0.0	0.9 ± 0.3

Each value represent of the mean of three determinations ± standard error.

in non accumulation of protein and pigments. On the other hand, NO_3^- can be reduced in all cells of filament by nitrate reductase via a process which is directly coupled to photolysis of water and occurs even in the absence of CO_2 (Flores *et al.*, 1983). In view of nitrogen-source-dependent variations in pigment and protein level in *Nostoc muscorum* cells, it is suggested that the cell number is a better parameter to express growth and enzymatic activities rather, than the pigment level.

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***STROMBOMONAS TAIWANENSIS* NOV. SP. (EUGLENOPHYTA, EUGLENOPHYCEAE)**

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ABSTRACT — The authors describe by mean of photonic and scanning electron microscopes a new species of the genus *Strombomonas*, *S. taiwanensis* sampled in a small pond in Taiwan (China). This taxa differs from the others by its lorica morphology and by its ring-like paramylon.

RÉSUMÉ — Les auteurs décrivent, à l'aide des microscopes photonique et électronique à balayage, une nouvelle espèce de *Strombomonas*, *S. taiwanensis* récoltée dans un petit étang à Taïwan (Chine). Celle-ci se distingue des autres taxons par la morphologie de sa logette et par la forme annelée de ses réserves de paramylon.

KEY WORDS — Euglenophyta, Euglenophyceae, new taxa, Taïwan, ultrastructure, taxonomy.

INTRODUCTION

During a trip in Taïwan (China), in May 1988, different samples of planctonic freshwater algae have been collected by one of the authors¹. Between the diverse taxa which have been observed, one of them of euglenoid type, morphologically similar both with genus *Euglena* Ehrenberg and *Strombomonas* Deflandre, has seemed to us very interesting by its morphology and the granular aspect of its sheath. As it was abundant it was possible to try to study it by mean of scanning electron microscope to state precisely its taxonomical position.

MATERIAL AND METHODS

The biological material was sampled in May 1988 in Taïwan (China), in the vicinity of Pinglin (NE of the island; see the map) in a small narrow pond used for



irrigation. The algae were collected with a plankton net (mesh side: 25 μ m). Physico-chemical data concerning the pond were impossible to be measured.

Fixation has been done with a solution of formaline in water (concentration: 4 %). The reference number of the sample is: TYF 481.

For scanning electron microscope, cells have been selected with the help of a micropipette under binocular and after rinsing with distilled water they have been directly put on the stub according to the method recommended by Couté and Thérézien (1994).

The photographs have been taken on the scanning electron microscope JEOL JSM 840 A of the service commun des laboratoires des Sciences de la Vie of the National Museum of Natural History of Paris.

RESULTS

The cells are fusiform more or less swollen in their middle part and their two apical parts are morphologically different (fig. 1 to 12). The posterior one (L: 18-22 μ m) ends by a very tapered tip (fig. 20-21-23) nearly completely colourless. The anterior part (l: 2-4 μ m) is generally colourless too, opened at its apex by a pore often obliquely cutted (fig. 1-2-5-19-22). The cell median enlargement varies in dimensions (L: 13-20,2 μ m) and in location. In fact some cells are larger whether at the base of the anterior or posterior apical end than in the middle part (fig. 1-4-7-9).

With photonic microscope, the cell appears included in a translucent colourless lorica the wall of which seems lightly rough (fig. 1 to 12 and 19-20). With scanning electron microscope (fig. 13 to 18 and 21 to 26) the lorica wall appears covered by numerous particles the morphology and dimensions of which are very much various. Sometimes bacteria are stucked on the lorica surface (fig. 25). When the lorica is broken (fig. 17-18) it is possible to observe the pellicular strips which cover the cell body. The lorica wall is very thin.

Allowing for the sampling circumstances it was impossible to observe the flagella and to know exactly if the cell is contractile or not.

Chloroplasts are numerous, discoïd, parietal, small, probably green and scattered in the cell body. The storages appear like two ring-shaped (L: 12-14 μ m) paramylon grains (fig. 2-4-6-12) disposed along the antero-posterior cell axis.

Dimensions: $L_{\text{lorica}} = 60-95 \mu\text{m}$; $l_{\text{lorica}} = 11-19 \mu\text{m}$; $l_{\text{pore}} = 2-4 \mu\text{m}$
 $L_{\text{cell}} = (55)-65-84 \mu\text{m}$; $l_{\text{cell}} = 9-17 \mu\text{m}$

Latin diagnosis:

Cellula fusiformis in media parte inflata et in una hyalina leviter granulata lorica inclusa. Posterior pars in acerosa caudata. Anterior pars (collum) paulo longius quam latius et cum leviter obliquo collo. Chromatophora numerosa, verisimiliter viridia, parietalia, parva et dispersa. Duo grana magna et annularia paramyli. Dimensiones loricae: $L = 60-95 \mu\text{m}$; $l = 11-19 \mu\text{m}$; diameter colli: $2-4 \mu\text{m}$; caudae longitudo: $18-22 \mu\text{m}$.

Dimensiones cellulae: $L = (55)-65-84 \mu\text{m}$; $l = 9-17 \mu\text{m}$.

Habitatio: in parva lacuna irrigationis prope Pinglin in Taiwan (Sina) insula, Maio mense 1988.

Iconotypus: fig. nost. 1 et 13

Cellulae in herbario Tokyo Plankton Institute, Kanagawa, Japan depositae.

In the sample where the new species has been found, the accompanying algae were scarce. However some of them have been identified and their names are given as following:

- Euglenaceae: *Euglena oxyuris* Schmarda
Lepocinclis fusiformis (Carter) Lemm. em. Conr.
L. ovum var. *bütschlii* Conr.
Phacus hamatus Pochm.
P. triquetus (E.) Duj.
Strombomonas triquetra (Playf.) Defl.
- Chlorophyceae: *Pediastrum duplex* Meyen
P. simplex Meyen
Scenedesmus Meyen sp.

DISCUSSION AND CONCLUSION

The organism sampled in Taiwan and examined here is truly an Euglenophyceae because of the pellicular strips on its cell body surface and of the paramylon storages.

The presence of a thin colourless lorica authorizes to conclude that it is not the genus *Euglena* Ehrbg. Moreover the apical pore demonstrates that it is not an encysted *Euglena*. As the lorica is not ornamented with punctuations, spines or scrobiculations, this alga is not a *Trachelomonas* Ehrbg. Finally the fusiform cell morphology with the anterior part attenuated in a collar and the posterior one tapered like a tail and especially the aggregation of mineral and organic particles on the lorica wall surface indicate that our taxon belongs to the genus *Strombomonas* as defined by Deflandre (1930).

This alga differs from all the other species of the genus by its very characteristic morphology. Nevertheless it presents some resemblances with *Strom-*

bomonas maxima (Skvortzov) Deflandre (1930) by its general outline (but this last species has a smooth lorica surface and granular paramylon) and with *S. fluviatilis* (Lemm.) Deflandre (1930) and peculiarly with the variety *levis* (Lemm.) Skvortzov (1925) (described first from China and which possesses an obliquely cutted apical pore) or with the other variety *major* found in Brazil by Conforti (1993). It differs from these two last varieties by its fusiform morphology, its colourless lorica wall (and not brown light) and especially by its ring-shaped paramylon storages. This last character is very similar by the number and the morphology of paramylon granules with the one of *Euglena oxyuris* Schmarda (1846). It is a very new storage organisation for the genus *Strombomonas* in which no species is known containing such type of paramylon ring-shaped granules except perhaps for *S. girardiana* var. *maxima* Martinez (1978) described from the Philippines and represented with two rings (p. 318, fig. 19) but of undefined nature.

All the above mentioned characters are enough to consider the alga from Taiwan as a new species of the genus *Strombomonas*. We propose to name it *Strombomonas taiwanensis* nov. sp.

However to be completely sure with this identification, it would be necessary to observe this organism living to determine the presence or absence of flagellum and to count their number.

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LEGENDS OF FIGURES

Figures 1 to 26: *Strombomonas taiwanensis* nov. sp.

Fig. 1 to 12: photonic microscope; different cells showing the morphological variability. The two ring-shaped paramylon are conspicuous on fig. 2, 4, 6 and 10.

Fig. 13 to 18: Scanning electron microscope;

Fig. 13 to 16: four different cells; fig. 17-18: details of the broken lorica wall of two different cells. The pellicular strips are well perceptible.

Fig. 19-20: photonic microscope

Fig. 19: anterior and median parts of a cell. The lorica wall surface appears covered by numerous particles.

Fig. 20: posterior and median parts of a cell.

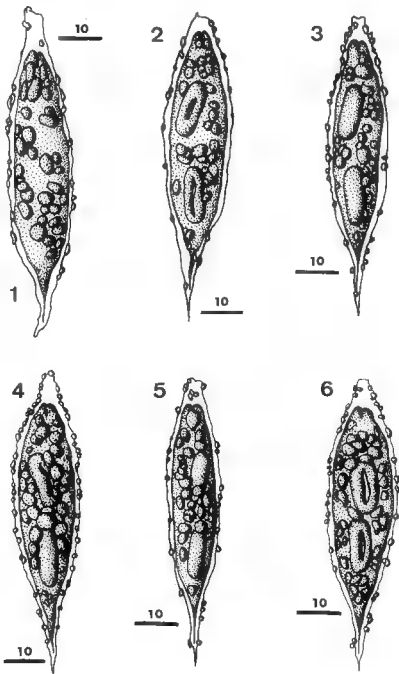
Fig. 21 to 26: scanning electron microscope;

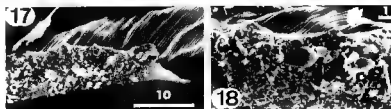
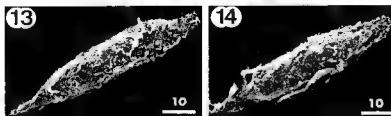
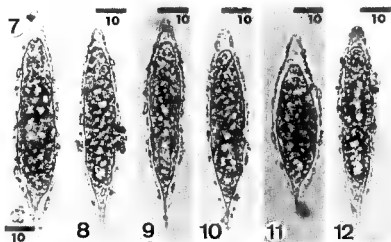
Fig. 21 and 23: two posterior apex or tails

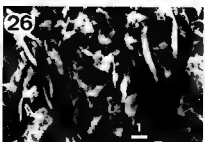
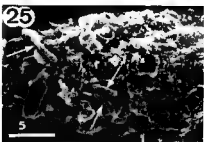
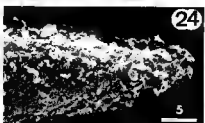
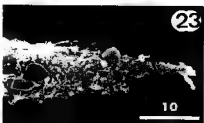
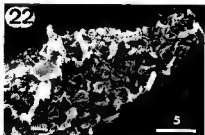
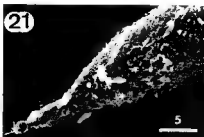
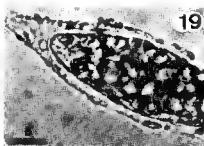
Fig. 22 and 24: two anterior apex with collar

Fig. 25 and 26: details of the median region of two different cells. Bacteria are present (fig. 25, arrows).

For all the figures scale bar values are given in micrometres.







TAXONOMIC NOTES AND TYPIFICATION OF THE DIATOMS DESCRIBED BY C. MONTAGNE

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ABSTRACT — The diatoms (Bacillariophyta) described by Camille Montagne, which include one genus and eleven species, are listed and typified with specimens housed in the Laboratoire de Cryptogamie, Muséum National d'Histoire Naturelle, Paris (PC). Photographs of the herbarium sheets on which the type material occurs and of original drawings made by Montagne of his new taxa are presented. Comments regarding possible synonyms and previous reports of Montagne's species are provided.

RÉSUMÉ — Le Laboratoire de Cryptogamie, Muséum National d'Histoire Naturelle, Paris (PC), conserve les collections de Camille Montagne: spécimens, correspondance et dessins originaux. Les diatomées (Bacillariophyta) décrites par C. Montagne, un genre nouveau et onze espèces nouvelles, sont typifiées et illustrées par des photographies des échantillons types et par celles des dessins originaux qu'il avait effectués de ses nouveaux taxons. Un commentaire nomenclatural accompagne la synonymie des espèces et leurs éventuelles mentions antérieures dans la littérature.

Key Words — Diatom, Bacillariophyta, type, taxonomy, Camille Montagne, herbarium, PC, iconography.

INTRODUCTION

Camille Montagne (1784-1866), privately pursued a career in Botany in Paris beginning in 1830 after retiring from a career as a surgeon in the napoleonian military. Rapidly, he devoted his work to the study of cryptogams, particularly those from "exotic countries": e. g. South America, Africa, etc... He donated his herbarium and manuscripts (including catalogues, notes, publications, proofs and correspondance) to the Muséum National d'Histoire Naturelle (PC). His herbarium included original drawings, and in order to conserve those drawings they have been separated from the specimens and provided with a numbering system that relates them to the specimens. There are more than 6000 drawings kept in acid-free sheets with the

manuscripts. Data from the herbarium labels and the drawings have been computerized in the Museum's computer cataloging system. Herbarium specimen numbers from the Montagne collection are designated beginning with "MS" while Montagne's drawings are designated beginning with "MA".

Montagne published on a wide array of cryptogams among these are his work on diatoms including the description of one new genus and eleven new species of diatoms. Some of his diatoms species are widely known, while others have apparently not been considered since their original description. We include here: 1) an alphabetical list of the diatoms described by Montagne and designation of lectotypes in the Laboratoire de Cryptogamie du Muséum National d'Histoire Naturelle of Paris (PC), 2) photographs of the herbarium sheets on which the type material occurs, 3) publication for the first time of Montagne's own illustrations of his species, and 4) a discussion of nomenclatural issues associated with some of the taxa. The present report is made to bring attention to and facilitate research on Montagne's diatom species.

A note concerning the date of publication of Montagne's works for the "*Annales des Sciences Naturelles, Botanique*" should be made. There was some delay between the date reported on the volume and the effective date of publication. The bibliography in the "*Compte rendu hebdomadaire des Séances de l'Académie des Sciences*" provides some evidence for a difference in the publication dates and this difference is suggested by other sources of information, including Montagne's notes on his manuscripts. For example, all the "9th Centurie" was prepared for the volume 14 of the "*Annales des Sciences Naturelles, Botanique*", year 1860, but the last proofs were sent to Montagne in July 1861. Therefore, volume 14 of the "*Annales des Sciences Naturelles, Botanique*", including this "Centurie" was edited in 1861, not in 1860 as indicated on the volume. Moreover, we cannot consider the reprints as preprints (see Stafleu & Cowan 1981, pp. 556-564), because the delay was due to the editor; reprints were made at the same time as the journal or just afterwards (D. Lamy, unpublished data).

CHECK-LIST AND TYPIFICATION OF DIATOM TAXA DESCRIBED BY C. MONTAGNE¹

Achnanthes brachypus Montagne, 1838, *Ann. Sci. Nat., Bot.*, 2^e sér., 8: 348, "1837" (1838).

= *Achnanthes pachypus* Montagne, 1839, *Voy. Amér. mérid., Bot. [Florula]*: 1. *nom. superfl.* (Greuter *et al.*, 1994, Art. 52.1).

Holotype: PC n° MA 13863 (Figure 1).

Type locality and collector: "*Ad fila Confervae allantoidis Montag. parasitans, prope Callao Regni Peruviani Cl. d'Orbigny legit*".

¹ Type locality and collection information included in this checklist is quoted from the original species diagnoses.

Montagne's original illustration: PC n° MS 438-5875 (Figure 2) and 438-5876 (Figure 3), and a drawing directly on the herbarium sheet (Figure 1).

Comments: In the *Sylogie* (Montagne, 1856, p. 470) Montagne indicates *A. pachypus* was described in the *Florulae boliviensis* (Montagne, 1839, p. 1). In this 1839 work, however, Montagne refers to his work in the *Annales des Sciences naturelles* (1838), a publication that preceded the *Florulae boliviensis*. In 1838, this *Achnanthes* species was described as *A. brachypus*, and this name also is used in the original handwritten manuscripts housed at PC (n° MS 323). Thus the epithet « *brachypus* » (1838) has priority over the epithet « *pachypus* » (1839).

Mills (1933, p. 71), *sub pachypus*, considers this a valid species but Van Landingham (1967, p. 55) indicates it is a synonym of *A. brevipes* var. *parvula* (Kützing) Cleve. *Achnanthes pachypus* has been reported by Kützing (1844), Rabenhorst (1864) and Pritchard (1861).

Amphora vitrea Montagne, 1861, *Ann. Sci. Nat., Bot., 4^e sér.*, 14: 167, "1860" (1861).

Lectotype: PC n° MA 13882 (Figure 4).

Isotype: PC n° MA 13580.

Type locality and collector: "In aquis thermalibus Sti Nectarii (Puy-de-Dôme) *Oscillatoriae nectariensis* consortem hanc *Amphoram* legit mecumque communicavit cl. Basset, harum thermarum medicus inspector". Saint-Nectaire, France. (N.B. Type of *Oscillatoria nectariensis* Montagne: PC n° MA 13579, typified by F. Drouet, 1968, p. 296).

Montagne's original illustration: PC n° MS 438-5879 (Figure 5), 438-5880 (Figure 6) and 438-5814 (Figure 7).

Comment: A later homonym of Montagne's name is *A. vitrea* Cleve. Montagne's species is indicated by Van Landingham (1967, pp. 277-278) to be a synonym of *A. ostrearia* Brébisson in Kützing, but he adds a "?" at the end of this entry.

Biddulphia australis Montagne, 1842, *Hist. Phys. Cuba, Bot., Pl. Cell.*: 5.

= *B. pulchella* Gray 1821

= *B. quinquelocularis* Kützing 1844.

Holotype: PC n° MA 13894 (Figure 8).

Type locality and collector: "Ad Florideas varias in portu Havonensi lectas parasitans". Cuba. Ramon de la Sagra coll.

Montagne's original illustration: PC n° MS 438-5884 (Figure 9).

Comments: This species is considered as a later synonym of *B. pulchella* Gray (Mills, 1933, p. 281; Van Landingham, 1968, p. 522). "Montagne" (*sic*) is listed as the authority by Mills.

Fragilaria brevis Montagne, 1855, *Ann. Sci. Nat., Bot.*, 4^e sér., 3: 323.

Holotype: PC n^o MA 14014 (Figure 10).

Type locality and collector: ["*In caule et foliis Hypni lonchophylli* Montagne"]², "*in aquis dulcibus, prope Cayennam, fluitans*". Guyana. Leprieur coll., "n^o 1378" (The type of *Hypnum lonchophyllum* Montagne is held at PC, without inventory number. The label bears the notation: "13.X.89, 1 éch. Leprieur n^o 1378").

Montagne's original illustration: PC n^o MS 418-1187 (Figure 11).

Comments: Montagne's n^o 675 corresponds to *Hypnum lonchophyllum* Montagne, on which the diatom was found. Mills (1934a, p. 724) and Van Landingham (1971, p. 1764) indicate this species was described in 1842, but this seems erroneous. This species has apparently not been observed since it was described originally.

Isthmia polymorpha Montagne, 1840, *Ann. Sci. Nat., Bot.*, 2^e sér., 13: 200, n^o 9.
= *Odontella polymorpha* (Montagne) Kützing, 1844, p. 138.

Holotype: PC n^o MA 6027 (Figure 12) (also the type of *Polysiphonia subtilissima* Montagne).

Type locality and collector: "*Ad Polysiphonium subtilissimum Noh. parasitat, Meloseirae hormoidis et Achnantis seriatae in consortio*" ["*apud Cayennam*"]³. "Leprieur coll. n^o 353".

Montagne's original illustration: PC n^o MS 434-4931 (Figure 13).

Comments: Mills (1934a, p. 870) suggests this taxon is conspecific with *Cerataulus laevis* (Ehrenberg) Ralfs, but Van Landingham (1971, p. 2089) registered some uncertainty by providing a "?" next to his proposed synonymy of *I. polymorpha* with *Biddulphia laevis* Ehrenberg.

Navicula aequinoctialis Montagne, 1851, *Ann. Sci. Nat., Bot.*, 3^e sér., 14: 309, "1850"(1851).

Holotype: PC n^o MA 13630 (Figures 14-15) (also the type of *Phormidium guyanense* Montagne, typified by F. Drouet, 1968, p. 134).

Type locality and collector: "*In consortio Phormidii guyanensis inventi*". Guyana. Leprieur coll., "n^o 1093".

Montagne's original illustration: PC n^o MS 438-5823 (Figure 16).

² The part of the sentence into square brackets comes from the *Sylloge*, the rest comes from the diagnosis of *Hypnum lonchophyllum*.

³ The part of the sentence into square brackets comes from the *Sylloge*.

Comments: This species was suggested (with a “?”) to be a synonym of *Pinnularia dactylus* Ehrenberg by Mills (1934a, p. 972).

Navicula algeriensis Montagne in Bory de Saint-Vincent & Durieu de Maisonneuve, 1849, *Expl. Sci. Algérie, Bot.* 1: 190.

Holotype: PC n° MA 14158 (Figure 17). Montagne wrote on the herbarium sheet (Figure 18): “Le *Navicularia* (*sic*) *algeriensis* doit passer dans le genre *Pinnularia* si il est bon”.

Type locality and collector: “In fronde *Plocamii coccinei* in consortio *Biddulphiae pulchellae* Gray; Cherchell”. Bory de Saint-Vincent coll.

Montagne’s original illustration: PC n° MS 438-5927 (Figure 19) and MS 438-5885 (Figure 20).

Comments: This species was listed by Mills (1934a, p. 974), and Van Landingham (1975, p. 2367) in lower case letters, suggesting it is a later synonym, but no preferred name was indicated.

Rhipidophora craticula Montagne, 1851, *Ann. Sci. Nat., Bot.*, 3^e sér., 14: 308, “1850”(1851).

Holotype: PC n° MA 11352 (Figure 21). Isotypes: MA 11350 and MA 11353 (Figure 21) (all numbers + n° MA 11351, Figure 21, correspond to type material of *Cladophora oedogonia* Montagne).

Type locality and collector: “In *Cladophora Oedogonia* [Montagne] *parasitica*” [Cayenna]. Guyanna. [Leprieur]⁴ “coll. n° 826”.

Montagne’s original illustration: PC n° MS 430-5430 (Figure 22).

Comments: This species was first transferred to *Podosphenia* by Rabenhorst (1864, p. 298) and then later to *Licmophora* by De Toni (1892, p. 739) with a “?”.

Schizonema crispum Montagne, 1842, *Prodr. gen. phyc.*: 16.

Lectotype: PC n° MA 14190 (Figure 23).

Isotype: PC n° MA 14189 (Figure 23).

Type locality and collector: “Ins. Auckland”. Dumont “d’Urville” coll.

Montagne’s original illustration: PC n° MS 438-5939 (Figure 24).

Comments: Grunow (1880, p. 1594) transferred this species to *Berkeleeya*.

⁴ Parts of the sentence into square brackets comes from the *Sylloge*.

Schizonema investiens Montagne, 1851, *Ann. Sci. Nat., Bot.*, 3^e sér., 14: 308, "1850" (1851).

Holotype: PC n° MA 14226 (Figure 25).

Type locality and collector: "In *Bostrychia monosiphonia* [Montagne] *supra* *descripta parasitans lectum*". Guyana. Leprieur "coll. n° 1111". (N.B. Type material of *Bostrychia monosiphonia* Montagne is held at PC under the n° MA 626, 627, 628 and 629).

Montagne's original illustration: MS 438-5941 (Figure 26).

Comments: Mills (1934b, p. 1432) lists this species as a valid member of *Schizonema*.

Genus *Trochiscia* Montagne, 1838, *Ann. Sci. Nat., Bot.*, 2^e sér., 8: 349, "1837" (1838).

Holotype: PC n° MA 14185 (Figure 27).

Type locality and collector: "Ad fila *Callithamnii floccosi* Ag. Ad Callao legit cl. du Petit-Thouars". Peru.

Montagne's original illustration: MS 438-5934 (Figure 28).

Type species: *Trochiscia moniliformis* Montagne, 1838, *Ann. Sci. Nat., Bot.*, 2^e sér., 8: 349, "1837" (1838) = *Melosira hormoides* Montagne, 1839, p. 2 (sub *Meloseira*) = *Podosira nummuloides* Ehrenberg, 1840, p. 158 = *Podosira moniliformis* Ehrenberg, 1840, p. 161 = *Podosira hormoides* (Ehrenberg) Kützting, 1844, p. 52, *nom. illeg.*

Holotype: PC n° MA 14185 (Figure 27).

Type locality and collector: *Ad fila Callithamnii floccosi* Ag. Ad Callao legit cl. du Petit-Thouars. Peru.

Montagne's original illustration: MS 438-5934 (Figure 28) and MS 438-5935 (Figure 29).

Comments: Montagne described his genus from Peru, and included in it a single species *T. moniliformis*. In the original publication (1838), Montagne described this diatom on *Callithamnion floccosum*. Two years later (1839) he reported it on *Polysiphonia dendroides* and *C. floccosum*. In the *Sylloge* (Montagne, 1856) he lists it only from *Polysiphonia*. The original drawing is made of *Trochiscia* on *Callithamnion versicolor*, and the label indicates: "voir le *Callithamnion thuyoides* et le *C. floccosum*". PC specimens of these species from the same locality include the holotype material of *Trochiscia* on *C. floccosum* (n° MA 14185), *C. versicolor* C. Ag. (n° MA 1204 and MA 1205) and "*C. thuyoides* C. Ag.?" (n° MA 1201, MA 1202 and MA 1203).

Trochiscia Montagne is a later homonym of *Trochiscia* Kützing 1833, a green algal genus. The Kützing article was reprinted in 1834 by Farr *et al.* 1979 in the *Index Nominum Genericorum*. Thus, *Trochiscia* Montagne is to be considered *nom. illeg.*

Regarding the specific epithet for Montagne's species, *T. moniliformis* was transferred to *Melosira* by Montagne in 1839. The specific epithet *moniliformis* was occupied in *Melosira* by *M. moniliformis* Agardh, so a new name, *M. hormoides* Montagne was selected. In 1840, Ehrenberg described his new genus *Podosira* and included in it *P. nummuloides* and *P. moniliformis*. Kützing (1844) then transferred Montagne's *Melosira hormoides* to *Podosira*, making the combination *P. hormoides* (Montagne) Kützing. Both Mills (1934a, p. 1356) and Van Landingham (1978, p. 3412 and p. 3414) indicate Ehrenberg's species as synonyms of Montagne's species, although Van Landingham apparently regarded *T. moniliformis* Montagne and *M. hormoides* Montagne as different entities, since *T. moniliformis* is listed as "Montagne 1837, p. 349" (Van Landingham, 1978, p. 3414) and *M. hormoides* is listed to have its original description in "Montagne, 1839, p. 2" (Van Landingham, 1978, p. 3412). If Ehrenberg's taxa are synonymous with Montagne's species, then Ehrenberg's two new species names are superfluous (Greuter *et al.*, 1994, Article 52). The correct names for Montagne's taxon are:

- Trochiscia moniliformis* Montagne
- Melosira hormoides* Montagne
- Podosira moniliformis* (Montagne) Ehrenberg

Podosira moniliformis (Montagne) Kützing would then be considered *nom. illeg.*

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LEGENDS OF THE FIGURES

Figs. 1-3. *Achmanthes brachypus* Montagne, 1838, *Ann. Sci. Nat., Bot.*, 2^e sér., 8: 348, "1837" (1838). **1.** Holotype with Montagne's original illustration; PC n° MA 13863. **2.** Montagne's original illustration, PC n° MS 438-5875. **3.** Montagne's original illustration, PC n° MS 438-5876.

Figs. 4-7. *Amphora vitrea* Montagne, 1861, *Ann. Sci. Nat., Bot.*, 4^e sér., 14: 167, "1860" (1861). **4.** Lectotype, PC n° MA 13882. **5.** Montagne's original illustration, PC n° MA 438-5879. **6.** Montagne's original illustration, PC n° MA 438-5880. **7.** Montagne's original illustration, including illustration of *Oscillatoria nectariensis* Montagne, PC n° MA 438-5814.

Figs. 8-9. *Biddulphia australis* Montagne, 1842, *Hist. Phys. Cuba, Bot., Pl. Cell.*: 5. **8.** Holotype, PC n° MA 13894. **9.** Montagne's original illustration, PC n° MS 438-5884.

Figs. 10-11. *Fragilaria brevis* Montagne, 1855, *Ann. Sci. Nat., Bot.*, 4^e sér., 3: 323. **10.** Holotype, PC n° MA 14014. **11.** Montagne's original illustration, including illustration of *Hypnum lonchophyllum* Montagne, PC n° MS 418-1187.

Figs. 12-13. *Isthmia polymorpha* Montagne, 1840, *Ann. Sci. Nat., Bot.*, 2^e sér., 13: 200, n° 9. **12.** Holotype, PC n° MA 5027 (also the type of *Polysiphonia subtilissima* Montagne). **13.** Montagne's original illustration, PC n° MS 438-4931.

Figs. 14-16. *Navicula aequinoctialis* Montagne, 1851, *Ann. Sci. Nat., Bot.*, 3^e sér., 14: 309, "1850" (1851). **14.** Labels. **15.** Holotype, PC n° MA 13630 (also the type of *Phormidium guyanense* Montagne). **16.** Montagne's original illustration, PC n° MS 438-5823, including illustration of *Phormidium guyanense* Montagne.

Figs. 17-20. *Navicula algeriensis* Montagne in Bory de Saint-Vincent & Durieu de Maisonneuve, 1849, *Expl. Sci. Algérie, Bot.* 1: 190. **17.** Holotype, PC n° MA 14158. **18.** Montagne's comment on the herbarium sheet. **19.** Montagne's original illustration, PC n° MS 438-5927. **20.** Montagne's original illustration, PC n° MS 438-5885.

Figs. 21-22. *Rhipidophora craticula* Montagne, 1851, *Ann. Sci. Nat., Bot.*, 3^e sér., 14: 308, "1850" (1851). **21.** Lectotype, PC n° MA 11352, and isotypes, MA 11350 and MA 11353 (all numbers + n° MA 11351 correspond to type material of *Cladophora oedogonia* Montagne). **22.** Montagne's original illustration, PC n° MS 438-5430.

Figs. 23-24. *Schizonema crispum* Montagne, 1842, *Prodr. gen. phyc.*: 16. **23.** Lectotype, PC n° MA 14190, and isotype, n° MA 14189. **24.** Montagne's original illustration, PC n° MS 438-5939.

Figs. 25-26. *Schizonema investiens* Montagne, 1851, *Ann. Sci. Nat., Bot.*, 3^e sér., 14: 308, "1850" (1851). **25.** Holotype, PC n° MA 14226. **26.** Montagne's original illustration, PC n° MS 438-5941.

Figs. 27-29. *Trochiscia moniliformis* Montagne, 1838, *Ann. Sci. Nat., Bot.*, 2^e sér., 8: 349, "1837" (1838). **27.** Holotype of genus and species, PC n° MA 14185. **28.** Montagne's original illustration, PC n° MS 438-5934. **29.** Montagne's original illustration, PC n° MS 438-5935.

Scale of the herbarium sheets: Width of printed word "TYPE" = 11 mm.

Scale of Montagne's original illustrations: Width of herbarium stamp = 45 mm.



TYPE

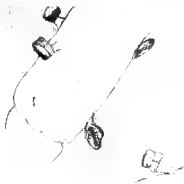
1

YA 13863

Achnanthes pachypus Huston

ad *Confusum glaucum* Huston

Linn. et D. Orsteg.



HS

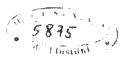
HS

100x



Achnanthes pachypus Huston

2





3

Achnanthes pachypus Montg.



4

MA 13582

Amphora vitrea M.



École Normale de St. Nicolas

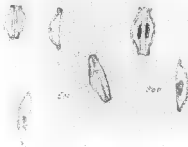
Rue de Lenoir 11 Paris

Encaenia thymabada de St. Sabinus (Lepid. M. Alp.)
Encaenia thymabada (Lepid. M. Alp.)

5879

5

Encaenia thymabada de St. Sabinus (Lepid. M. Alp.)
 M. le Docteur Baillet.



6

S. Nebulae in aq. salina

Scillaria tenuis v. *nebulosus* Moq. et
Cocconeoma cygniformis

Frustula affinis Hy.

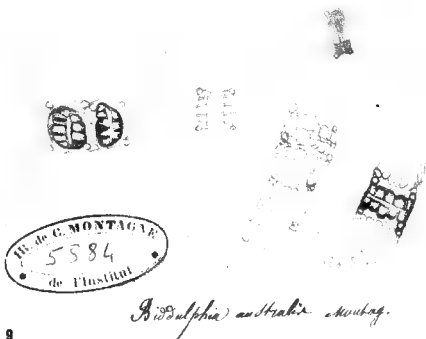
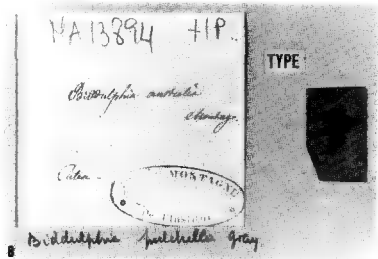
Amphora affinis Hy.
an et *S. Salinae* Linn.



2 2/3 centimètres Longit.
4 2/5 millimètres Transv.

M. G. T. Basses

7



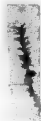
MA 140/4. 2P. TYPE

Fragilaria brevistriata Huston

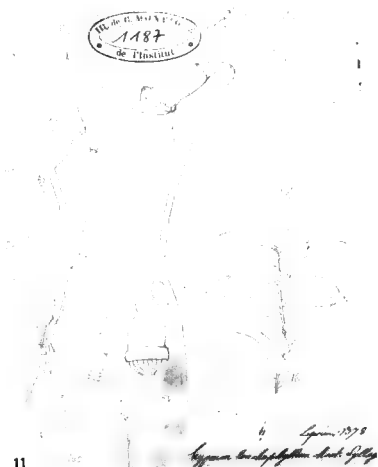
Fragilaria ad. bypruvon

Lauchophyllum W. 1978

Lauchophyllum Huston



10



MUSEUM DE L'INSTITUT
1187

Aprin. 1978
Fragilaria brevistriata Huston

11



H. 1214 # 2 p. 15
Althia polymorpha *alticola*
Melissa *lanceolata* *alticola*
Achillea *striata* Ag.
 et *Polytrichum subtilissimum*
 alticola
Cayenne - *Supra*
 in herbario in *alticola* et *alticola*
 in *alticola* et *alticola*

TYPE



Thalassira polyserpata Montg.

Thalassira hamulosa Montg.

"Guyane: fucus limosa
 rivulorum adhaerens circa
 Cayenne l'ethem, Leprieux
 no. 1093."

Phormidium
guianense Montagne
 cc
var. nuda

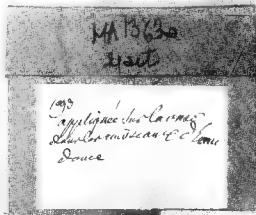
TYPE

Phormidium nuda (Kütz.) Gom.
 (TYPE of *P. guianense* Montagne)

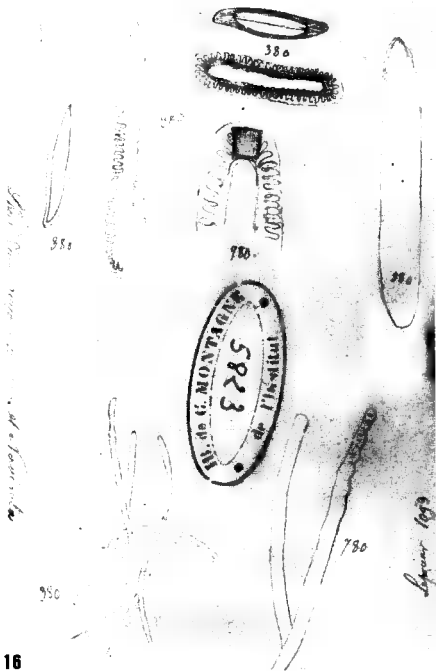
14

Described by Frank Ditsch

1960



15



TYPE

MA 14158

P

Navicula algeriensis M.at *Navicula*

Charvillat

17

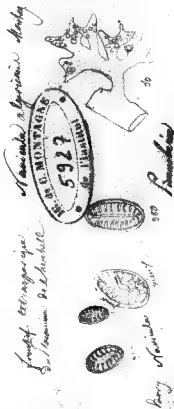
La Navicula algeriensis

deit-gasse dans l'égout

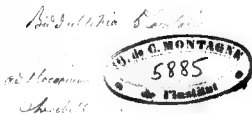
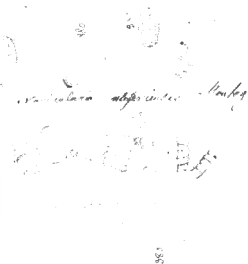
Navicula

Charvillat

18



19



20

426
 3 ans de puits
 au jardin de l'Alpide
 de Cayenne

114450 3 puits

MA 11352 n° 026

2P.

Chrysochloris (Chrysochloris) chrysochloris
 à puits Cayenne
 à puits de Cayenne

CYPR

114450 3 puits n° 026 P

Chrysochloris chrysochloris n° 11
 à puits de Cayenne

MA 11351



Chrysochloris chrysochloris n° 11
 à puits de Cayenne



Chrysophora? *Chrysophora iralicula* Montagn. prop. D. offic. Sept. 826

1741181 P

Schizanema crispum
 e. Houbag

ad *Selysiph. glomerulata*
 Auckland M. D'Uville



TYPE

1741190 3P.

Schizanema crispum
 e. Houbag

ad *Selysiph. glomerul.*

Auckland M. D'Uville





Schizosira crispata Grunow

M. de G. MONTAGNE
5939
de l'Institut

24

Schizoneura investitor n. sp.
 (= *Schizoneura*?) *Bastylachia* *novae*
Cyrene Leprieux n. 1111

TYPE

MA 2226



Schizoneura investitor n. sp.
 n. sp.

Leprieux n. 1111

Schizoneura investitor n. sp.
 (= *Bastylachia* *novae*
Cyrene) Leprieux n. 1111

*Schizoneura investitor* n. sp.



MA 14183

TYPE



Melospiza harmonides *Maudslayi*.

Callao *Peru*.

as *Callithrix* *flavescens*.



Pseudo-nitzschia multiflorus
Callitriche
 Pseudo-nitzschia multiflorus (L.) Grunow
 et C. floccosa
 5334



29

Galathea in *Antarctica* (Lamarck) Volanteg. 5935

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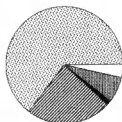
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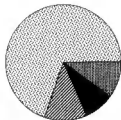
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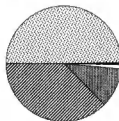
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