Gymnodinium Brown Tide in the Magellanic Fjords, Southern Chile

Marea café provocada por *Gymnodinium* en los fiordos magallánicos (Sur de Chile)

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Abstract.- In April 1999, a brown tide was recorded in the Magellanic fjords, Southern Chile. The causative taxa were two unidentified morphs of *Gymnodinium* that resemble *Gymnodinium mikimotoi* Miyake *et* Kominami *ex* Oda. Although there were many reports from fishermen about water discolorations along the region, just two localities were sampled by scientific personnel: the oceanic entrance of Canal Abra (53°22' S – 73° 25' W) and Punta Carrera (53° 35' S– 70° 55' W), which is situated in the Strait of Magellan. After discolorations, *Gymnodinium* concentrations ranged between 3,000 to 43,000 cells L-1. The *Gymnodinium* bloom lasted for about three weeks in the fjords. Invertebrates (sea urchins, sea stars, snails, limpets, octopus) and fish were reported as dead, but no quantification was done.

This phenomenon took place some weeks after a bloom of *Gymnodinium*, recorded around Chiloé Island (42° 30 S - 73' 55' W). Neither species form part of the normal flora in the Southern chilean fjords and their blooming supports the idea of a large scale phytoplankton transport along South East Pacific coast.

Keywords: Red Tides, HAB, marine mortalities

Resumen.- En abril de 1999 se registró una marea café en la región de fiordos y canales magallánicos. Los taxa causantes fueron dos morfos no identificados de *Gymnodinium,* los que guardan un parecido con *Gymnodinium mikimotoi* Miyake *et* Kominami *ex* Oda. Aunque hubo numerosos informes de pescadores acerca de discoloraciones a lo largo de la región, sólo dos localidades fueron investigadas por personal científico: la entrada oceánica de canal Abra (53°22' S – 73° 25' W) y punta Carrera (53° 35' S– 70° 55' W), que se encuentra en el estrecho de Magallanes. Las concentraciones de *Gymnodinium,* evaluadas después de las discoloraciones, variaron entre 3.000 a 43.000 cél. L^{-1}. La floración de *Gymnodinium* duró aproximadamente tres semanas en los fiordos. Se verificó la muerte de invertebrados (erizos de mar, estrellas de mar, mauchos, caracoles y pulpos) y peces, pero no se efectuaron cuantificaciones.

Este fenómeno tuvo lugar algunas semanas después de una floración de *Gymnodinium* alrededor de la isla de Chiloé (42° 30 S - 73° 55' W). Este taxa no forma parte de la flora común de los fiordos del sur de Chile y su floración en subsistemas muy separados entre sí y solo conectados a través del océano presta apoyo a la idea de un transporte de fitoplancton a gran escala a lo largo de la costa del Pacífico Sureste.

Palabras claves: marea roja, FAN, mortandades marinas

Introduction

Southern Chile is characterized by a broken coast line with hundreds of channels and fjords, extending over nearly 1,500 km from around 41.5 to 56° S. This archipelagic fjord region is the only one place in South East Pacific where extensive Harmful Algal Blooms (HAB) have been recorded. Several prolonged and intensive Paralytic Shellfish Poisoning (PSP) outbreaks caused by *Alexandrium catenella* (Whedon *et* Kofoid) Balech have happened since 1972 (Guzmán *et al.* 1975, Lembeye 1981). Dinoflagellate blooms associated with Diarrhetic Shellfish Poison (DSP), of shorter duration but extending along this region have also been recorded (Lembeye *et al.* 1993, Uribe *et al.* 2001). Moreover, noxious blooms affecting salmon farming activity have also taken place in the northern part of this zone (Clément & Lembeye 1993).

On 8 April 1999, a group of fishermen reported, to the Fisheries Authority in Punta Arenas, seawater discolorations that ocurred in many localities along Magellanic fjords (those located in XII region or Magellan Region). The phenomenon was associated with mortality of invertebrates and fish. One of the areas mentioned was Canal Abra (53°22' S – 73° 25' W) where hundreds of sea urchins, sea stars, octopuses and congers were washed ashore. On the next day, the

Coast Guard from Punta Arenas made a flight by helicopter to the site, to collect water samples, which were analysed by the Instituto de Fomento Pesquero (IFOP) (Guzmán *et al.* 1999). Later, on Monday 12 April, the Coast Guard provided a cutter cruise to the site with IFOP personnel on board, who collected samples in a more systematic way. Parts of those samples were kindly passed to the Instituto de la Patagonia, Universidad de Magallanes.

In the following week fishermen reported water discolorations in the northern area of the Magellan Region, including Grupo Lobos (51° 35' S - 74° 45' W) and Canal Oeste (50° 30' S - 75° 15' W). A flight over this and other sectors was carried out on 16 April by a Navy plane. Samples were also collected on 17 April in Punta Carrera, 50 km south of Punta Arenas, to determine the presence of the causative microorganism in the inner part of the fjord system. Here we summarize the findings made during this brown tide in the Magellanic waters.

Material and Methods

Qualitative phytoplankton samples from Canal Abra (Fig. 1) were collected by vertical tows of a 20 µm net and fixed in Lugol's iodine. Two additional hydrographic stations (named inner and outer) were sampled at Punta Carrera, Strait of Magellan (Fig. 1). Net phytoplankton samples from this area were fixed in glutaraldehide 2.5%. Quantitative samples of phytoplankton were taken only in Punta Carrera, by using a 10 m hose that permitted an integrated sample of the water column. In this case, the material was fixed with a 1% formalin solution. Qualitative analyses were made with a standard optical microscope, whereas quantitative analyses were done with an inverted microscope (Hasle 1978). In Punta Carrera temperature and salinity profiles were also recorded with a SBE-19 CTD.
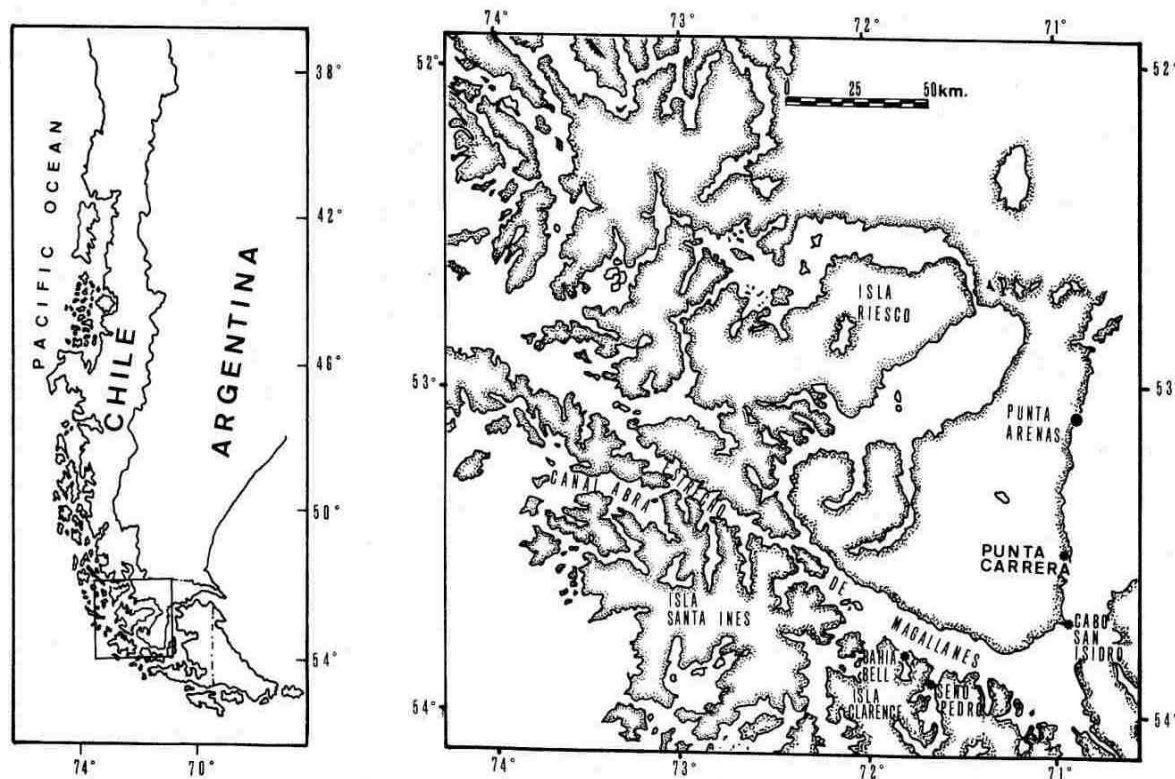

Figure 1
Location of the sampling sites
Ubicación de los sitios de muestreo

Part of the net samples were sent to the Electronic Microscopy Laboratory (University of Concepción) where they were treated by conventional methods, applied to delicate specimens (Cohen 1974). The material was observed in a scanning microscope ETEC, Autoscan U-1.

Results

The flight to Canal Abra permitted to observe the water discoloration reported by fishermen, that was especially evident in the oceanic entrance of this channel (R. Schipmann pers. com.). During the later flight that lasted over two hours over the northern area of Magellanic region no evidence of a brown tide was observed.

Net samples collected in Canal Abra showed the existence of a rich phytoplankton assemblage, including 18 species of diatoms and 15 species of dinoflagellates. Species of the genus *Ceratium*, *Dinophysis* and *Gymnodinium* were well represented (Table 1). The qualitative composition of the samples taken in Punta Carrera on 17 April was very similar (Table 2). In both localities, the presence of two *Gymnodinium* morphs were observed (indicated as *Gymnodinium* sp. 1 and *Gymnodinium* sp. 2 in the tables).

Before the appearance of this phenomenon, two sampling sites had been periodically visited in Punta Carrera giving an opportunity to follow phytoplankton structure changes during the brown tide. Quantitative composition at the end of March was characterized by scarce phytoplankton concentration (Table 2). However, it is interesting to note that cells of *Gymnodinium* were present at that time. This was verified by a second analysis, when the brown tide was known. On 17 April, the phytoplankton concentration increased notably due to the presence of dinoflagellates, specially of the genus *Gymnodinium*. Both morph rose to 32,600 cells L^{-1} in the inner station and 32,400 cells L^{-1} in the outer one, making up more than 90% of the entire sample (Table 2). This result stimulated to carry out one second visit to this site, a week later, but as it is shown in Table 2, the *Gymnodinium* concentration and all the other species were by then much lower.

Morphometric evaluations were made on fixed cells of both morphs. *Gymnodinium* sp. 2 was smaller, but partly overlapping in size with *Gymnodinium* sp.1 (Table 3). Both morphs had a premedian cingulum with a displacement less than a 1/5 of body length (Figs 2, 4). A sulcal extension was evident in both morphs (Figs 2, 4). A swelling caused by fixation was observed, since live cells (at least in *Gymnodinium* sp. 1) were flattened dorso-ventrally, whereas fixed cells were more spherical. In spite of this, it was possible to observe a clear difference in the outline of the cells of the two morphs as is showed in Table 3 and Figs 2-7. Other differences included a prominent apical groove present in *Gymnodinium* sp. 1 (Fig. 2) as compared with the very inconspicuos one in *Gymnodinium* sp. 2 (Fig. 4). The apical groove of *Gymnodinium* sp. 1 occupied ca. 2/3 of the ventral zone of the episome, from the contact point to the sulcal extension, intruding for a short distance in the dorsal zone (Figs 2, 3). Moreover, in the ventral zone, the apical groove was surrounded by a prominent ridge along the right side (Fig. 2). The nucleus of *Gymnodinium* sp. 1 was prominent, quite spherical and bigger than that of *Gymnodinium* sp. 2 (Figs 6-7). In both forms the nuclei were located in a subcentral position in the hyposome (Figs. 6, 7). Chloroplasts were ellipsoid in both morphs (not shown), but the number per cell was lower in *Gymnodinium* sp. 2 (Table 3).

From the reports of the fishermen and the observations made by the Coast Guard and by the authors, it was possible to establish a toxic effect of the blooms upon the marine fauna, since a profusion of dead organisms were washed ashore in the areas visited.

On 25 April, dwellers from Punta Carrera, a rural locality, reported mortality of many invertebrates in that area, and it was possible to verify the presence of sea urchins (*Loxechinus albus* Molina), limpets (*Fisurella* spp.) and a lesser proportion of Magellanic limpets (*Nacella magellanica* Gmelin) in the rocky shore, being partly consumed by seagulls. A similar situation was observed by a team of benthologists of the Instituto de la Patagonia in a nearby locality during the previous days. On the same day (25 April) the death of 700 scallops (*Chlamys patagonica*), mantained experimentally in Punta Carrera since December 1998 was verified. This differs from the 100% of scallop survival observed since the beginning of that experiment.

Table 1

Phytoplankton composition in Punta Carrera and Canal Abra
Composición del fitoplancton en Punta Carrera y Canal Abra

	PUNTA CARRERA						CANAL ABRA
	03/31/1999		04/17/1999		04/25/1999		04/13/1999
	INNER	OUTER	INNER	OUTER	INNER	OUTER	
DIATOMS							
Asterionellopsis glacialis (Castracane) Round		+		+			
Asterionella sp.							+
Biddulphia sp.		+			+		
Cerataulina pelagica (Cleve) Hendey		+		+		+	
Corethron criophilum Castracane		+	+	+	+	+	
Coscinodiscus sp. A		+	+	+	+	+	+
Cylindrotheca closterium (Ehrenberg) Lewin & Reimann	+			+		+	
Chaetoceros compressus Lauder			+	+	+	+	
Chaetoceros constrictus Gran	+	+	+	+	+	+	
Chaetoceros curvisetus Cleve			+	+		+	+
Chaetoceros convolutus Castracane	+	+	+	+	+	+	+
Chaetoceros decipiens Cleve	+						
Chaetoceros diadema (Ehrenberg) Gran	+						
Chaetoceros didymus Ehrenberg			+				
Chaetoceros tortissimus Gran	+			+	+		+
Dytilum brightwelli (West) Grunow	+	+				+	
Fragilaria virescens *Ralfs*	+			+	+		
Guinardia delicatula (Cleve) Hasle							+
Leptocylindrus danicus Cleve	+	+			+	+	+
Leptocylindrus minimus Gran	+			+		+	
Navicula sp.	+	+	+		+	+	
Nitzschia longissima (Brébisson) Ralfs							+
Nitzschia sp.							+
Pennates undet.			+				+
Pleurosigma normanii Ralf					+		
Pleurosigma sp.		+	+		+	+	+
Proboscia alata (Brightwell) Sundström			+	+		+	
Pseudo-nitzschia cf. p*seudodelicatissima*		+	+	+	+	+	+
Pseudo-nitzschia cf. *australis*		+		+	+	+	+
Rhizosolenia hebetata Bailey				+			
Rhizosolenia setigera Brightwell		+	+	+	+	+	+
Skeletonema costatum (Greville) Cleve			+				
Stephanopyxis palmeriana (Greville) Grunow				+	+		
Striatella unipunctata (Lyngbye) C. A. Agardh					+		+
Thalassiosira cf. g*erloffii*		+	+	+	+	+	+
Thalassiosira cf. *mendiolana*		+	+	+	+	+	+
Thalassiosira cf. *anguste-lineata*							+
Tropidoneis sp.		+	+		+		
DINOFLAGELLATES							
Alexandrium catenella (Whedon & Kofoid) Balech	+	+					
Ceratium fusus (Ehrenberg) Dujardin	+	+		+	+	+	+
Ceratium lineatum (Ehrenberg) Cleve	+	+	+	+	+	+	+
Ceratium minutum Jorgensen	+	+	+	+		+	+
Ceratium pentagonum Gourret	+	+	+	+		+	+
Ceratium tripos (O.F.Müller) Nitzsch		+		+		+	
Ceratium sp.						+	
Dinophysis acuminata Claparède & Lachmann	+	+	+	+	+		+
Dinophysis acuta Ehrenberg		+	+	+	+	+	+
Dinophysis truncata Cleve		+	+	+	+	+	+
Dinophysis sp.	+						
Dyplopsalis sp	+			+	+	+	+
Gonyaulax sp.			+	+		+	
Gymnodinium sp. 1	+		+	+	+	+	+

(Continuación Tabla 1)

| | PUNTA CARRERA | | | | | | CANAL ABRA |
| | 03/31/1999 | | 04/17/1999 | | 04/25/1999 | | 04/13/1999 |
	INNER	OUTER	INNER	OUTER	INNER	OUTER	
Gymnodinium sp. 2			+		+	+	+
Gyrodinium sp.							+
Phalacroma rotundatum (Claparède & Lachmann) Kofoid & Michener					+		
Protoperidinium cf. o*ceanicum*		+	+				
Protoperidinium cf. p*allidum*	+		+	+		+	+
Protoperidinium cf. p*entagonum*				+			
Protoperidinium claudicans (Paulsen) Balech				+		+	
Protoperidinium conicum (Gran) Balech	+	+	+	+		+	
Protoperidinium crassipes (Kofoid) Balech				+			
Protoperidinium divergens (Ehrenberg) Balech				+			
Protoperidinium pellucidum Bergh	+	+	+	+	+	+	
Protoperidinium sp.			+	+	+		+
Scrippsiella trochoidea (Stein) Loeblich III		+		+	+	+	
SILICOFLAGELLATES							
Dictyocha speculum Ehrenberg	+	+	+	+	+	+	+
EUGLENOPHYTES							
Euglenoides indet.					+		
NUMBER OF TAXA	24	33	34	41	36	37	33

Table 2
Phytoplankton concentration (cells L^{-1}) in Punta Carrera
Concentración del fitoplancton (céls. L^{-1}) en Punta Carrera

| | 03/31/1999 | | 04/17/1999 | | 04/25/1999 | |
| | | | STATIONS | | | |
	Inner	Outer	Inner	Outer	Inner	Outer
DIATOMS						
Cylindrotheca closterium (Ehrenberg) Lewin & Reimann	100	0	0	0	100	0
Chaetoceros convolutus Castracane	0	0	0	0	0	1300
Dytilum brightwelli (West) Grunow	0	200	200	0	0	0
Fragillaria virescens Ralfs	1100	0	0	1300	400	0
Leptocylindrus minimus Gran	0	800	0	0	0	0
Navicula sp.	0	200	100	0	0	200
Pennates undet.	0	0	100	0	0	0
Pleurosigma sp.	0	0	0	0	0	100
Pseudonitzschia cf. p*seudodelicatissima*	0	0	0	300	100	300
Pseudonitzschia cf. *australis*	0	0	0	100	0	0
Rhizosolenia setigera Brightwell	0	100	0	200	0	0
Skeletonema costatum (Greville) Cleve	0	0	0	300	0	0
Thalassiosira cf. *gerloffii*	0	0	200	0	0	0
Tropidonies sp.	100	0	0	0	0	0
DINOFLAGELLATES						
Ceratium lineatum (Ehrenberg) Cleve	0	0	600	200	0	0

(Continuación Tabla 2)

| | 03/31/1999 | | 04/17/1999 | | 04/25/1999 | |
| | | | STATIONS | | | |
	Inner	Outer	Inner	Outer	Inner	Outer
Ceratium minutum Jorgensen	0	0	0	500	100	0
Ceratium pentagonum Gourret	400	100	0	0	0	0
Dinophysis acuminata Claparède & Lachmann	100	0	100	0	100	0
Dinophysis acuta Ehrenberg	0	0	100	0	0	0
Diplopsalis sp.	100	0	600	0	100	0
Gymnodinium sp. 2	0	0	15600	17200	0	500
Gymnodinium sp. 1	1900	0	17100	16300	400	900
Gyrodinium sp.	0	0	0	0	0	100
Protoperidinium pellucidum Bergh	0	0	300	100	0	0
Protoperidinium sp.	0	0	0	0	100	0
Scrippsiella trochoidea (Stein) Loeblich III	0	0	0	0	300	0
OTHERS						
Dictyocha speculum Ehrenberg	200	0	200	0	100	0
Euglenoides undet.	0	0	0	0	0	100
DIATOMS	1300	1300	600	2200	600	1900
DINOFLAGELLATES	2500	100	34400	34300	1100	1500
TOTAL ABUNDANCE	4000	1400	35200	36500	1800	3500

Table 3
Comparison of some features of the two morphs found in Magellan waters with *G. mikimotoi*
Comparación de algunos rasgos de los dos morfos encontrados en Magallanes con G. mikimotoi*

| | | Species | | | | | |
| | | *Gymnodinium* sp. 1 | | *Gymnodinium* sp. 2 | | *Gymnodinium mikimotoi* | |
Feature		Mean	Range	Mean	Range	Mean	Range
Size	Body lenght	44.7 μm	38-48 μm	41.4 μm	32-48 μm	28.3 μm	21-34 μm
	Body width	45.1 μm	32-54 μm	37.4 μm	32-42 μm	23.5 μm	16-29 μm
Body	Shape						
	Episome	Broadly conical		Rounded		Rounded	
	Hyposome	Truncated cone		Rounded, notched		sligthly bilobed	
Apical groove		Marked		Inconspicous		Marked	
Chloroplasts (shape)		Ellipsoid		Ellipsoid		Rounded, asymmetric sometimes	
Chloroplasts per cell		56 +/- 9		34 +/- 8		18 +/- 6	
Chloroplast lenght		9.6 μm		9.6 μm		_____	

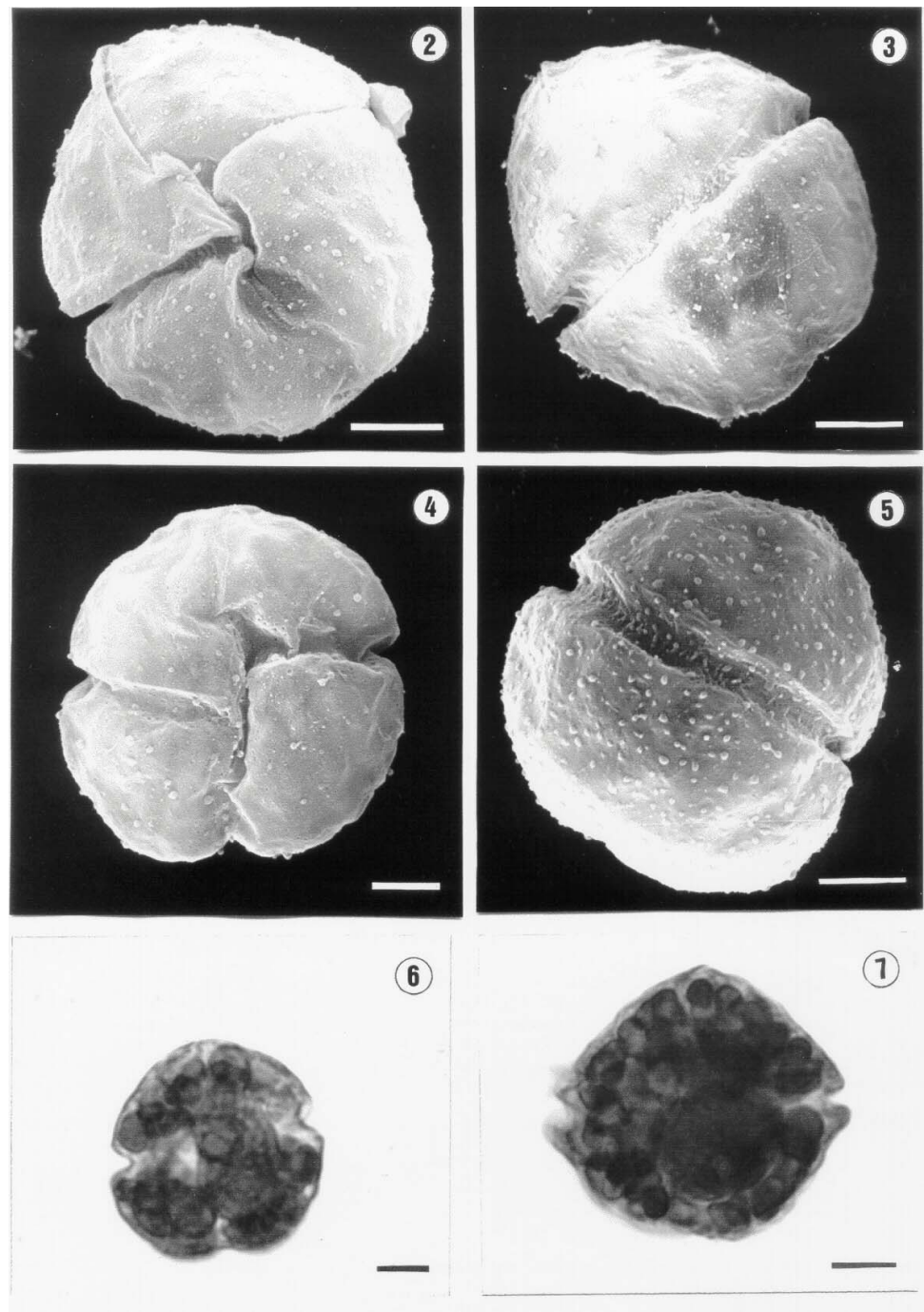(* As *G. nagasakiense* in Partensky *et al.*, 1988)

Figure 2-7

***Gymnodinium* sp. 1 (Figs. 2,3,7) and *Gymnodinium* sp. 2 (Figs. 4-6). Fig. 2. Ventral view of *Gymnodinium* sp. 1. Fig. 3. Dorsal view of *Gymnodinium* sp. 1. Fig. 4. ventral view of *Gymnodinium* sp. 2. Fig. 5. Dorsal view of *Gymnodinium* sp 2. Fig. 6.   *Gymnodinium* sp. 2 outline (optical microscopy). Fig. 7. *Gymnodinium* sp. 1 outline (optical microscopy). Each bar represent 10 µm.**

Gymnodinium sp. 1 (Figs. 2,3,7) y *Gymnodinium* sp. 2 (Figs. 4-6). Fig. 2. Vista ventral de *Gymnodinium* sp. 1. Fig. 3.   Vista dorsal de *Gymnodinium* sp. 1.   Fig. 4. Vista ventral de *Gymnodinium* sp. 2. Fig. 5. Vista dorsal de *Gymnodinium* sp 2. Fig. 6.   Contorno de *Gymnodinium* sp. 2 outline (microscopía óptica). Fig. 7. Contorno de *Gymnodinium* sp. 1 (microscopía óptica). Cada barra representa 10 µm.

Discussion

The above description represent the first record of a brown tide in Magellanic waters. Some weeks before, a similar phenomenon took place at Chiloé Island (42° 30 S - 73° 55' W), produced also by a *Gymnodinium* sp. (Clément 1999), probably the same species as described here.

The term brown tide is too much broad for characterizing a phytoplanktonic bloom, since brown water discolorations can be produced by microorganisms as different as *Aureococcus anophagefferens* Hargraves *et* Sieburth (Cosper *et al.*, 1989), *Aureoumbra lagunensis* De Yoe & Stockwell (Villareal *et al.* 1997) or *Gymnodinium mikimotoi* Miyake *et* Kominami *ex* Oda (Hansen et al. 2000), all of them with singular peculiarities. For these reasons comparison must be restricted to species or genus levels.

Brown tides produced by *Gymnodinium* are known in Europe, Australia, Japan and Korea (Taylor *et al.* 1995). *Gymnodinium cf. nagasakiense* has been described as a common blooming species from Norway (70°N) (Braarud & Heimdal 1970) to the coast of Spain (40°N) (Fraga & Sánchez 1985) and specially in the coast of Brittany (Partensky *et al.* 1991).

The features evaluated in these *Gymnodinium* did not permit the assignment to any particular species, since this genus is highly complex and comprises more than 200 species with high morphological variability (Taylor *et al.* 1995). Moreover, as indicated by Haywood *et al.* (1996) morphological changes occur in preserved material reducing the possibility of accurate identification. However, we consider both morphs as distinct and not the result of different stress, since they were obtained from the same samples. Both share features with *G. mikimotoi* and with others species like *Gymnodinium* sp. (Mackenzie *et al.* 1996). The presence of a groove was characteristic in *Gymnodinium* sp.1 resembling that of *G. mikimotoi*, but it is clearly more prominent than those reported by Partensky et al. (1988) and Hansen *et al.* (2000). The cell outline of *Gymnodinium* sp.1 differed from *G. mikimotoi* especially by the length/wide ratio as indicated in Hansen *et al.* (2000). *Gymnodinium* sp. 2 presented a more similar outline to *G. mikimotoi*, but differed notably in the apical groove. Both morphs were larger than *G. mikimotoi*, although they overlap in the upper range of the larger *G. mikimotoi* isolate, mentioned in Hansen *et al.* (2000). In *Gymnodinium* sp. 1 and *Gymnodinium* sp. 2 the position of the nucleus was also different from the above mentioned species of *Gymnodinium*, since it was more spherical and centrally located. Both morphs could represent new species in this highly complex genus, but the alternative of

different stages of the same species can not be discarded. Pigment composition analisis made by Carreto *et al.* (2001), on *Gymnodinium* sp. from Chiloé bloom did not throw light on this subject either.

Gymnodinium cf nagasakiense (= *G. mikimotoi*) is one of the best studied species in the genus, and it is described as eurytherm and euryhaline (Nielsen & Tonseth 1991). However, high concentrations of this species has been associated with high temperatures and high salinities (Roden *et al.* 1981, Partensky & Sournia 1986). Occasionally this species has been observed in waters with low temperatures (<10° C) (Tangen, 1977) and low salinities (Braarud & Heimdal 1970). The mean temperature and salinity at Punta Carrera, recorded during the sampling period, were 8.40 °C and 30.06 psu respectively, and both are normal values during the autumn. In Chiloé, higher concentrations of *Gymnodinium* were associated with temperatures above 13.5 °C and salinities above 33.2 psu (Clément *op. cit.*).

Another known characteristic of the ecology of these species is that when blooms arise, they are often associated with an off shore tidal front, spreading later to the coastal zone (Arzul 1993). This situation seems to be coincident with the observations in the Patagonic fjords. It was evident both in Chiloé and in the Magellan Region, that brown patches were well developed in the oceanic entrance of the fjord system and later the microorganisms were detected in the inner waters. These observations and the other common features such as the quasi-simultaneous blooming and the presence of the same genus as a major component, indicate that both episodes could represent a manifestation of one major event. However, the lack of sampling in the geographic space in between, and the different methods used to fix the material, preclude a definitive conclusion. At Chiloé, various sites were evaluated and a maximum of 4,000,000 cells L^{-1} was detected (Clément 1999). In the Magellan Region, the brown patches observed in Canal Abra indicated high concentrations of the microorganism but the survey made by IFOP showed a maximum of 43,000 cells L^{-1} (Guzmán *et al.* 1999). Two days before this sampling, a windy front reached the Magellan Region and seemed to be the most probably factor that dissipated the brown tide. The lower values detected at Punta Carrera indicate a limited dispersion into the inner waters. However, it must be considered that higher concentrations could be reached since the high motility of dinoflagellates permit them to concentrate at specific depths (Passow 1991).

At Chiloé the phenomenon lasted around one month, from the second week of March to the second week of April (Clément *op. cit.*). In Magellan waters the phenomenon stayed for a shorter time. In samples

obtained between 24 March and 27 March, *Gymnodinium* was not detected by a Red Tide Monitoring Program in localities nearby Punta Carrera: Bahía Bell, Seno Pedro, San Isidro (see Fig 1) (Guzmán *et al*. 1999). Moreover, the data obtained on 25 April, indicates a very low concentration. Thus, it can be assumed that the concentration of *Gymnodinium* declined quickly and its blooming last roughly three weeks.

Gymnodinium cf. nagasakiense, and *G. mikimotoi*, two very close taxa are commonly cited as causing invertebrate mortalities world-wide, including cultivated species of mussels, scallops and also salmonids (Parstensky *et al*. 1988, Mahoney *et al*. 1990). The death of wild fishes trapped in coastal zones by the blooming of this species has also been reported (Arzul, 1993). Concentracions of *G. cf. nagasakiense*, able to produce toxic effects in marine fauna are variable. Widdows *et al*. (1979), reported that 100,000 cells l^{-1} can cause damage in the gut cells of experimentally exposed mussels. In Chiloé, the brown tide caused the death of more than 750,000 farmed salmonids, equivalent to 1,155 tons, in various centers of that archipelago (Clément *op. cit*.). Others species, such as abalone and native fauna were also affected. In both cases, death was attributed to toxic effects instead of oxygen deprivation (Clément *op. cit*.). This *Gymnodinium* showed a strong haemolytic and allelopathic activity (Clément *et al*. 2001). In Magellan waters the association between *Gymnodinium* and invertebrate mortalities was evident. Its lethal effects was observed also in Canal Fallos (48° 37 S - 75° 00 W) where a big bed of mussels (*Aulacomya ater* Molina), sampled over many years, was decimated (Guzmán *et al*. 1999). The low concentration of *Gymnodinium* detected in Magellanic waters as compared to others reports (Mahoney *et al*. 1990) permit us to presume it was a bloom of highly toxic cells.

This sudden *Gymnodinium* blooming in many unconnected fjord subsystems, support the idea of a large scale phytoplankton transport along this part of the South Eastern Pacific, that until now remain as a quite unknown system. A similar situation seems to happen with *A. catenella* blooms (Uribe 1992). Therefore, it is evident that the improvement in the knowledge of coastal current patterns will   help to explain HAB phenomenons in Southern Chile fiords.

Acknowledgements

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