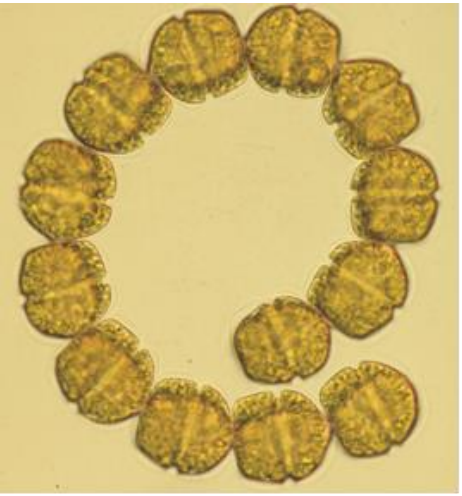
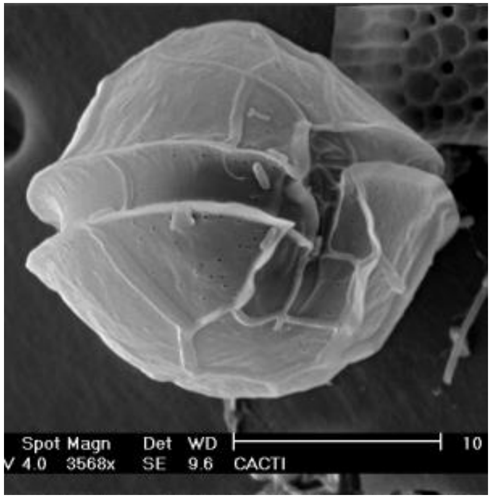
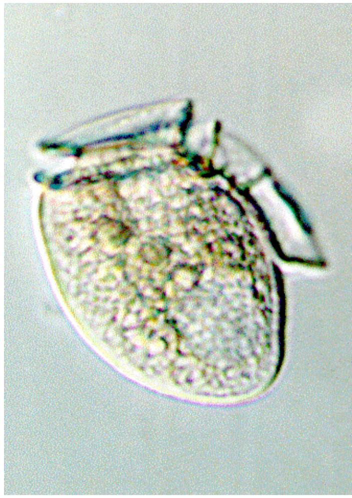
Monitorización de condiciones oceanográficas y fitoplancton en zonas de producción

SEMINARIO INTERNACIONAL DE SALUD PUBLICA Y MAREA ROJA
Puerto Varas, Chile. 23-24 de agosto de 2017







Yolanda Pazos

Jefa de Unidad de Oceanografía y Fitoplancton
Instituto Tecnológico para el Control del Medio Marino de Galicia. INTECMAR

intecmar
INSTITUTO TECNOLOXICO PARA O CONTROL DO MEDIO MARIÑO DE GALICIA

XUNTA DE GALICIA
CONSELLERÍA DO MAR


Galicia:
1195 km de costa
29,575 km²
2,737,370 habitantes
Galicia
P2
Portugal
Image © 2005 EarthSat
N
W
E
S
©2005 Google
Pointer 42°21'34.33" N 8°46'25.48" W
Streaming |||||||||| 100%
Eye alt 204.13 mi


Rias Baixas
P2
Image © 2005 EarthSat
©2005 Google
N
W
E
S
Pointer 42°21'34.33" N 8°46'25.48" W
Streaming |||||||||| 100%
Eye alt 135.84 mi


Muros
Arousa
Pontevedra
P2
Vigo
Vigo
Image © 2005 EarthSat
Image © 2005 DigitalGlobe
N
W
E
S
© 2005 Google
Pointer 42°21'34.33" N 8°46'25.48" W
Streaming |||||||||| 100%
Eye alt 70.69 mi

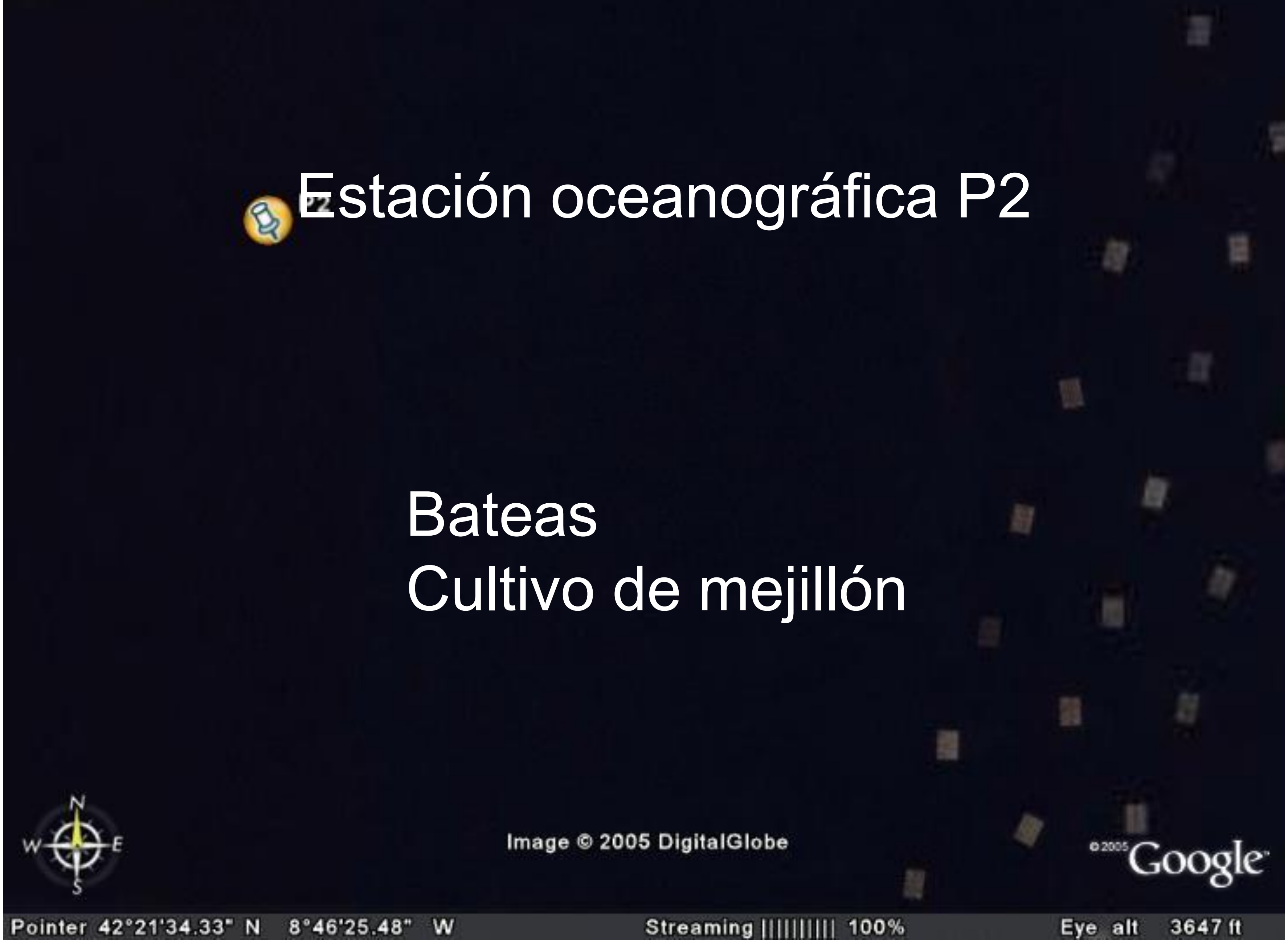
Ría de Arousa
Pontevedra
Ría de Pontevedra
P2
Image © 2005 EarthSat
Image © 2005 DigitalGlobe
Ría de Vigo
Vigo
©2005 Google
N
W
E
S
Pointer 42°21'34.33" N 8°46'25.48" W
Streaming |||||||||| 100%
Eye alt 24.27 mi


Ría de Pontevedra
P2
Polo
Pontevedra
Sanxenxo
Marín
Bueu
Moaña
Cangas
Image © 2005 EarthSat
Image © 2005 DigitalGlobe
© 2005 Google
Pointer 42°21'34.33" N 8°46'25.48" W
Streaming |||||||||| 100%
Eye alt 13.72 mi
N
W
E
S


Estación de Bueu
P2
Bueu
Image © 2005 DigitalGlobe
© 2005 Google
Pointer 42°21'34.33" N 8°46'25.48" W
Streaming |||||||||| 100%
Eye alt 31004 ft


P2
Polígono de bateas
N
W
E
S
Image © 2005 DigitalGlobe
©2005 Google
Pointer 42°21'34.33" N 8°46'25.48" W
Streaming |||||||||| 100%
Eye alt 21605 ft

RIA DE PONTEVEDRA

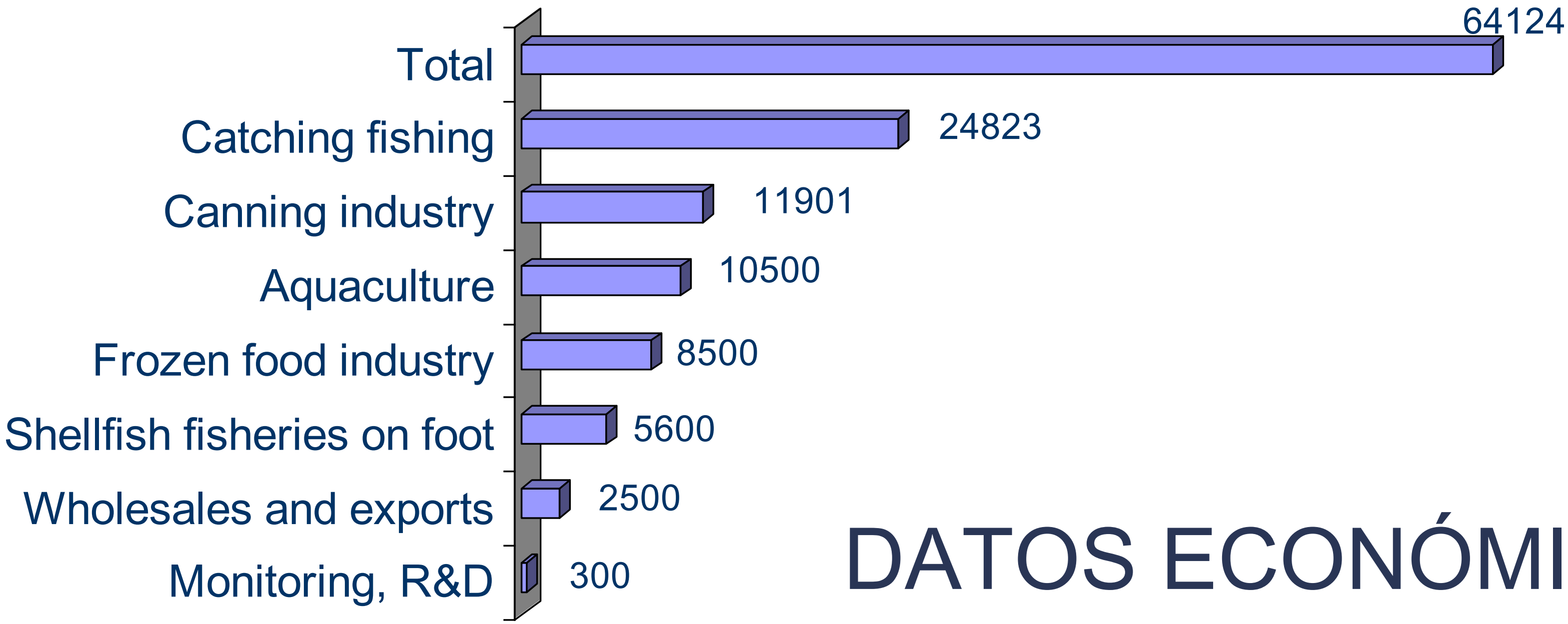


SECTOR DEL MAR EN GALICIA

SECTOR DEL MAR EN GALICIA

Importancia social de la pesca

EMPLEOS DIRECTOS



DATOS ECONÓMICOS

Catching sector and fish processing industry	1,583 x 10^6 €
Galician G.D.P.	33,600 x 10^6 €
Amount of fishing in the G.D.P.	4.6 %

SECTOR DEL MAR EN GALICIA

SECTOR MARISQUERO

Mariscadoras a pie

5,600 shellfisherwomen

(99% women)

,

Mariscadores a flote

6,000 shellfishermen (mainly men)

2,903 authorised boats

SECTOR DEL MAR EN GALICIA

marisqueo

La producción anual es sobre 9000 toneladas y unos 64 millones de €

Clams:
Annual production 4,450,142 Kgs
First sail income 45,203,639 euros

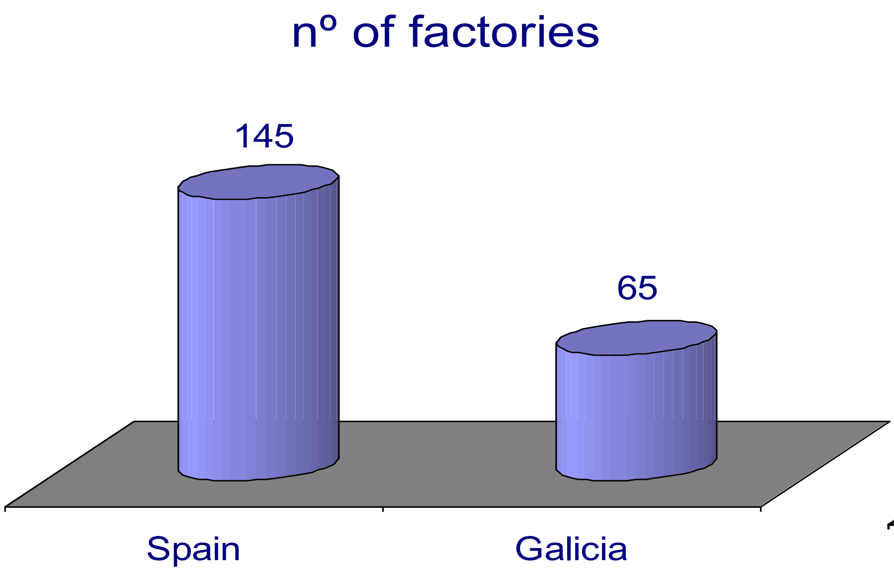
Cockles:
Annual production 4,142,744 Kgs
First sail income 15,564,754 euros

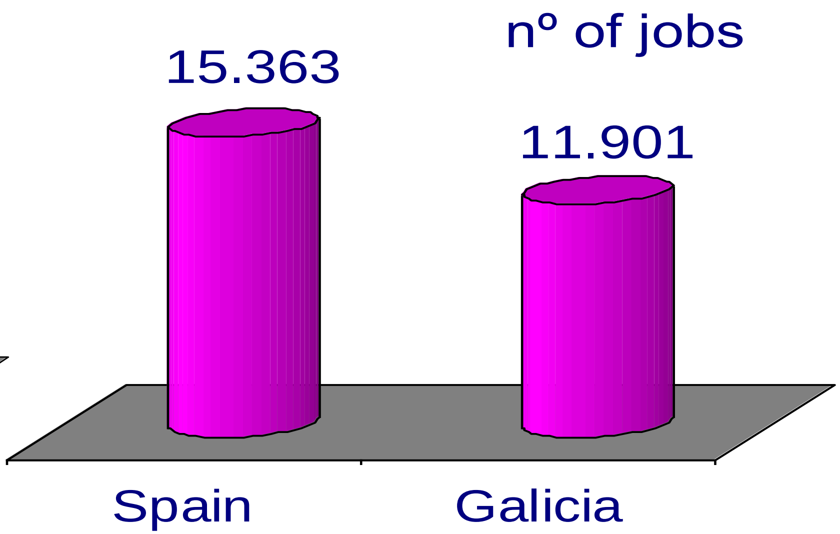
Razor clams:
Annual production 155,129 Kgs
First sail income 2,156,750 euros

Pectinids:
Annual production 289,158 Kgs
First sail income 1,247,944 euros

Oysters:
Annual production 25,709 Kgs
First sail income 94,924 euros

La conserva





Source: ANFACO

Volume of Spanish exports	177,233 t	413 x 10^6 €
Volume of Galician exports	90,386 t	284 x 10^6 €

Source: ANFACO

Producción de mejillón

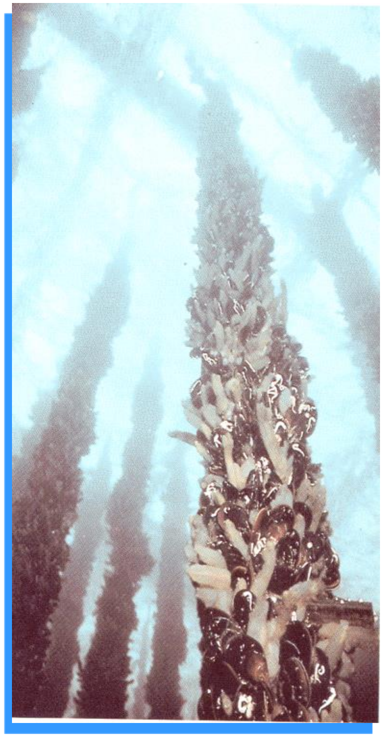
El mejillón es la especie base de la acuicultura en Galicia

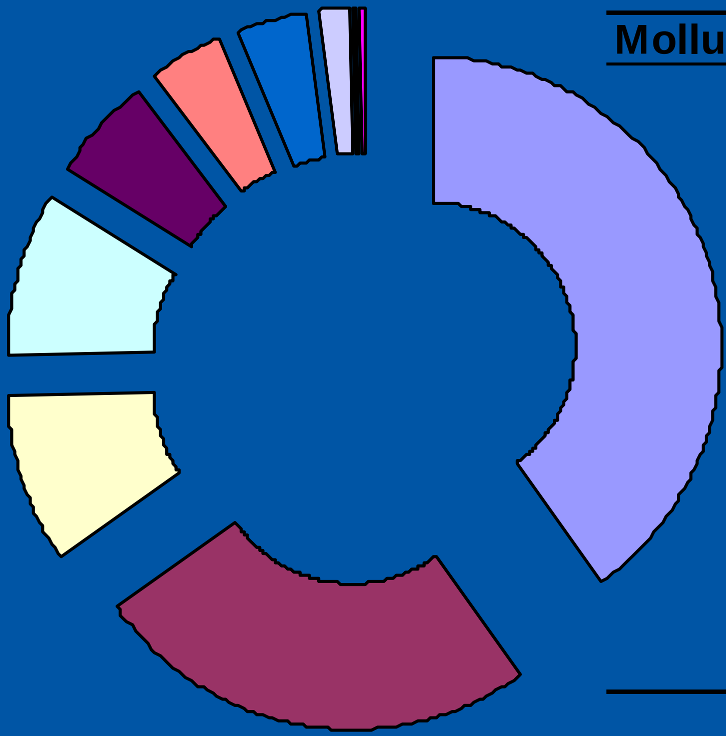
La producción anual es de 250,000-275,000 toneladas año siendo

95% of de la producción española,

37% de la producción europea

21 % de la producción mundial





Mollucs production in Europa in 2004 (tonnes live weight)

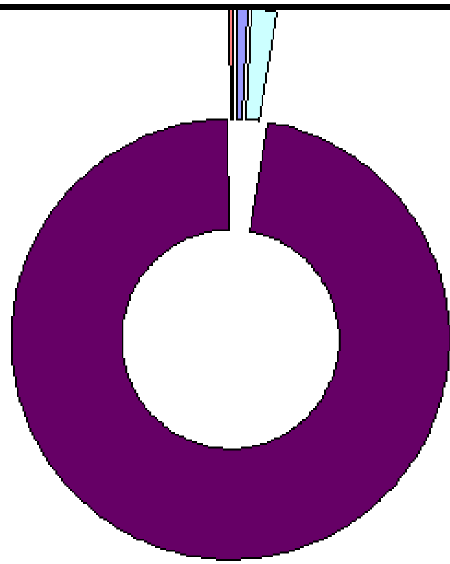
Spain	302181
France	191750
Netherlands	70400
Italy	70357
Ireland	43092
United Kingdom	32500
Greece	28803
Germany	12559
Portugal	2681
Sweden	1435
Slovenia	164
Denmark	55

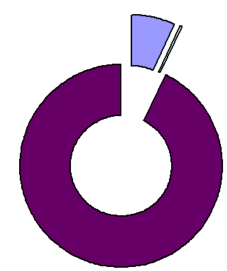
European Commission

http://ec.europa.eu/eurostat/

Galicia is the main producer of shellfish in Spain

	2013	2013	2013
	Mytilus galloprovincialis	***Ruditapes philippinarum***	**10^3 Tonnes**
Andalucía	1601940	102280	1,70
Baleares	129800		0,13
Cantabria		650	0,00
Cataluña	3436280	5270	3,44
Galicia	183169490	1384910	184,55
Valencia	607430		0,61
TOTAL Kg	188944940	1493110	190,44

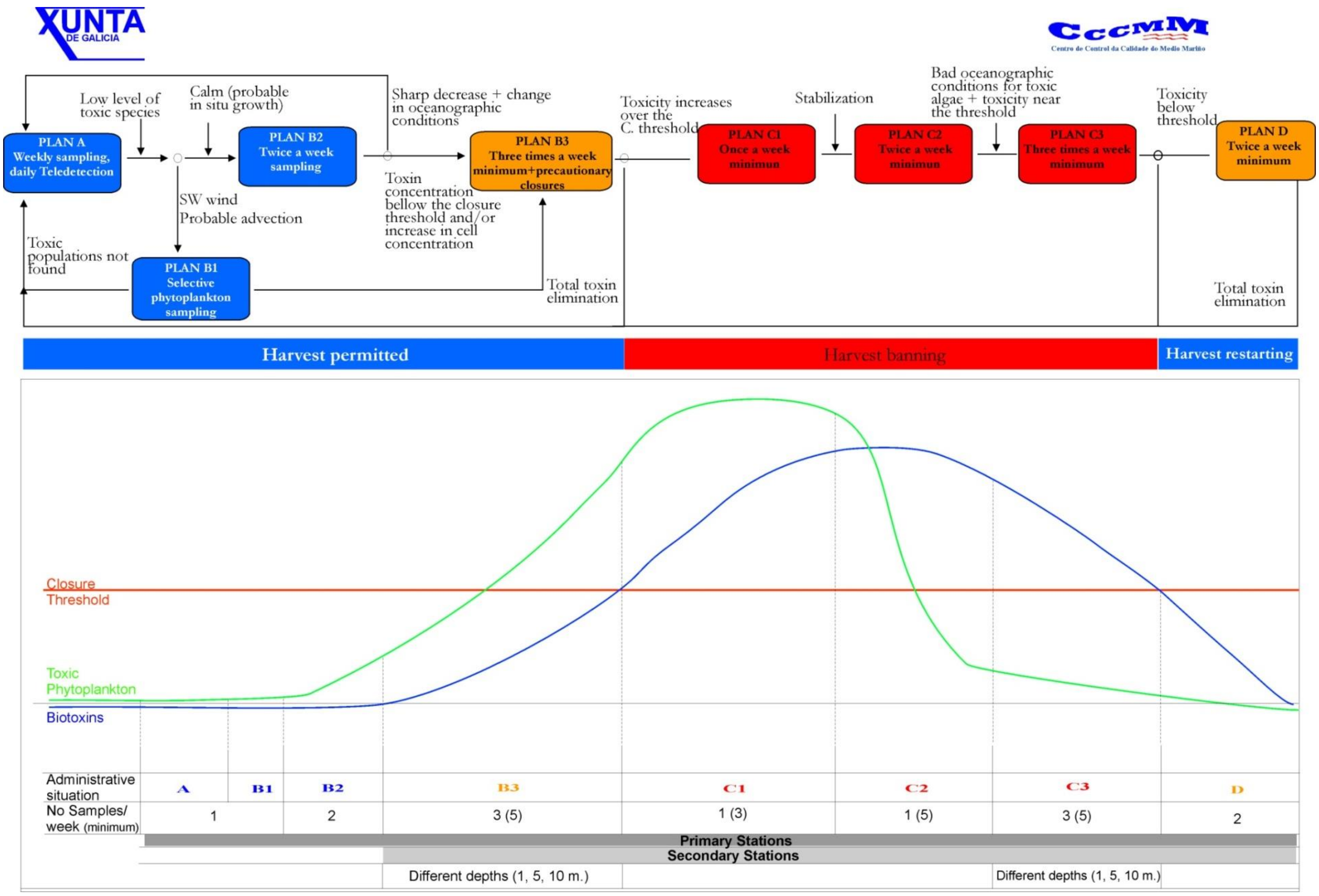




http://www.magrama.gob.es/app/jacumar/datos_produccion/datos_produccion.aspx

Rafts for mussel farming

www.intecmar.gal


XUNTA DE GALICIA
CCCMM
Centro de Control da Calidade do Medio Mariño
PLAN A Weekly sampling, daily Teledetection
Low level of toxic species
Calm (probable in situ growth)
PLAN B2 Twice a week sampling
Sharp decrease + change in oceanographic conditions
PLAN B3 Three times a week minimum+precautionary closures
Toxin concentration bellow the closure threshold and/or increase in cell concentration
SW wind
Probable advection
Toxic populations not found
PLAN B1 Selective phytoplankton sampling
Total toxin elimination
Toxicity increases over the C. threshold
PLAN C1 Once a week minimun
Stabilization
PLAN C2 Twice a week minimun
Bad oceanographic conditions for toxic algae + toxicity near the threshold
PLAN C3 Three times a week minimum
Toxicity below threshold
PLAN D Twice a week minimum
Total toxin elimination
Harvest permitted
Harvest banning
Harvest restarting
Closure Threshold
Toxic Phytoplankton
Biotoxins
Administrative situation
A
B1
B2
B3
C1
C2
C3
D
No Samples/ week (minimum)
1
2
3 (5)
1 (3)
1 (5)
3 (5)
2
Primary Stations
Secondary Stations
Different depths (1, 5, 10 m.)
Different depths (1, 5, 10 m.)

XUNTA DE GALICIA
CONSELLERÍA DO MAR

intecmar
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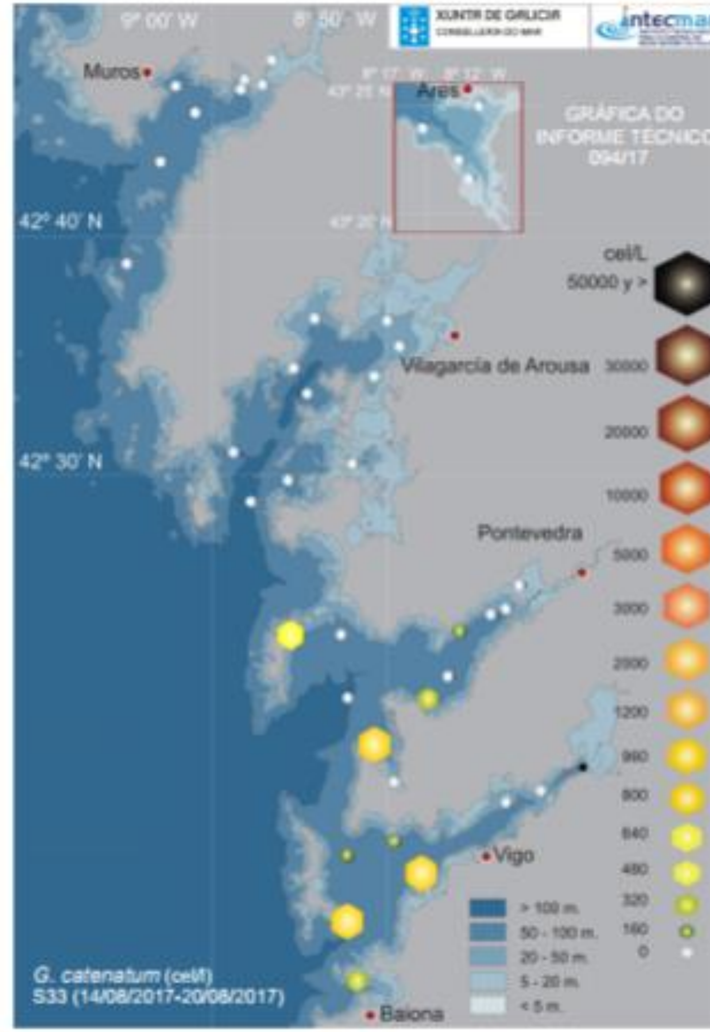
Peirao de Vilaxoán s/n
36611 Vilagarcía (Pontevedra)
Telf.: 986 51 23 20 / 22
Fax: 986 51 23 00
www.intecmar.gal

SITUACION DAS ZONAS
(Viveiros Flotantes)

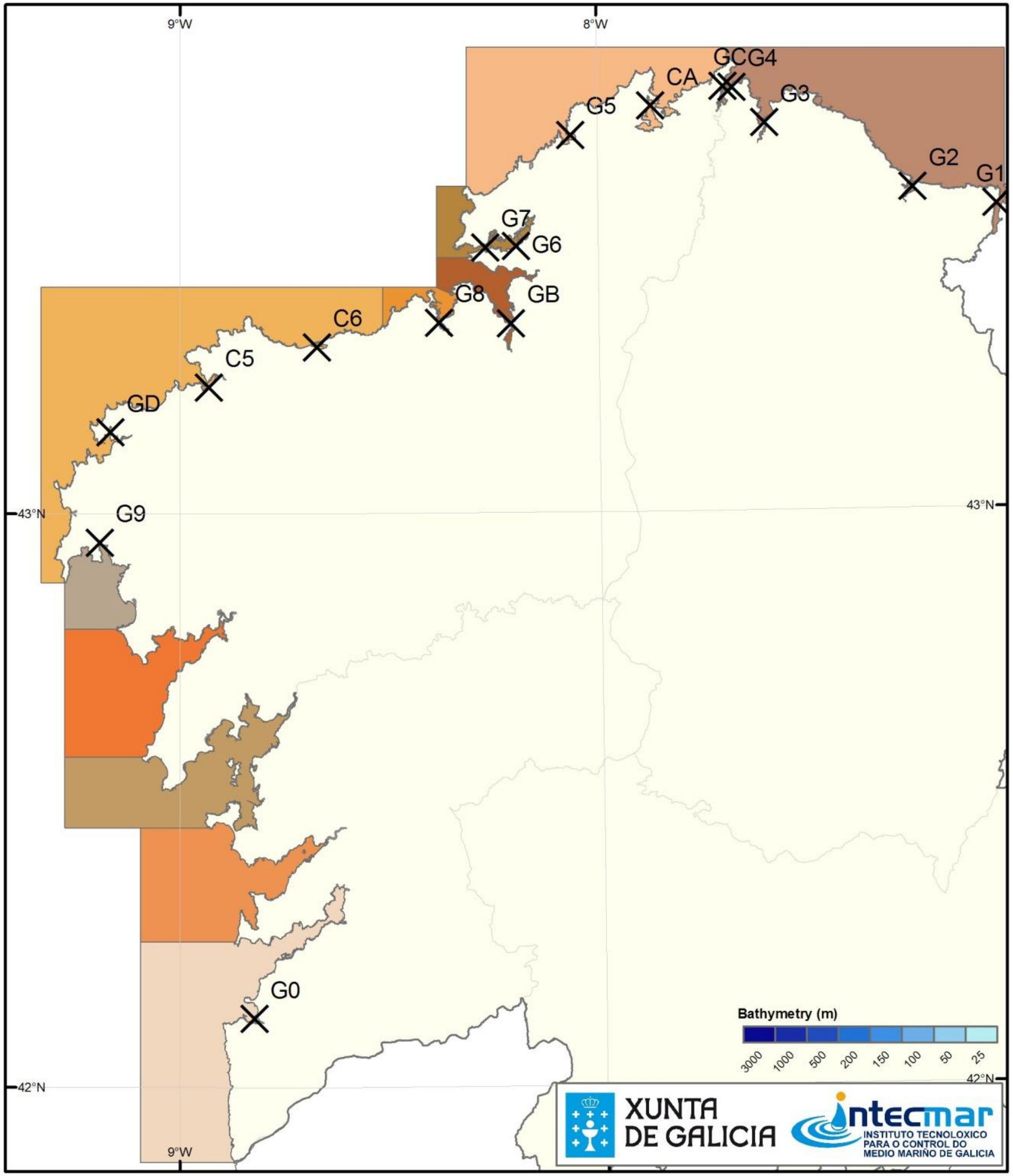
DATA: 24/08/2017 HORA: 11:26 Folla 2 de 2
INFORME Nº: SZ000337/17

Orde do 14 de novembro de 1995 (DOG Nº 221 do 17/11/1995)
Orde do 31 de outubro de 1989 (DOG Nº 235 do 11/12/1989)
Orde do 28 de outubro de 1996 (DOG Nº 226 do 19/11/1996)
Orde do 14 de marzo de 1997 (DOG Nº 64 do 04/04/1997)

RIA	ZONA	SUB-ZONA	POLIGONO		Plan de Actuación		Situación Administrativa
				PSP	Lipofílicas	ASP	
Muros-Noia	I	I	Muros B	B1	B2	B2	Aberta (06/06/2017)
Muros-Noia	II	II	Muros A	B1	B2	B2	Aberta (03/06/2017)
Muros-Noia	III	III	Noia A	B1	B2	B2	Aberta (27/05/2017)
Muros-Noia	IV	IV	Muros C	B1	B2	B2	Aberta (06/06/2017)
Pontevedra	I	I.1	Cangas A ✓	B3	B2	B1	Aberta (15/06/2017)
Pontevedra	I	I.2	Cangas B ✓	B3	B2	B1	Aberta (17/06/2017)
Pontevedra	***II***	***II.1***	Bueu B ×	B3	****B2***	B1	Aberta (22/08/2017)
Pontevedra	II	II.2	Bueu A2 ×	C3	B3	B1	Pechada (11/08/2017)
Pontevedra	II	II.3	Bueu A1	C1	C1	B1	Pechada (07/08/2017)
Pontevedra	III	III.1	Portonovo A ✓	B3	B2	B1	Aberta (06/06/2017)
Pontevedra	III	III.2	Portonovo B ✓	B3	B3	B1	Aberta (06/06/2017)
Pontevedra	III	III.3	Portonovo C	C1	B3	B1	Pechada (22/08/2017)



Pazos & Maneiro, 1999 Algal Bloom Detection Monitoring and Prediction


9°W
8°W
GCG4
CA
G3
G5
G2
G1
G7
G6
G8
GB
C6
C5
GD
43°N
G9
G0
Bathymetry (m)
3000
1000
500
200
150
100
50
25
42°N
XUNTA DE GALICIA
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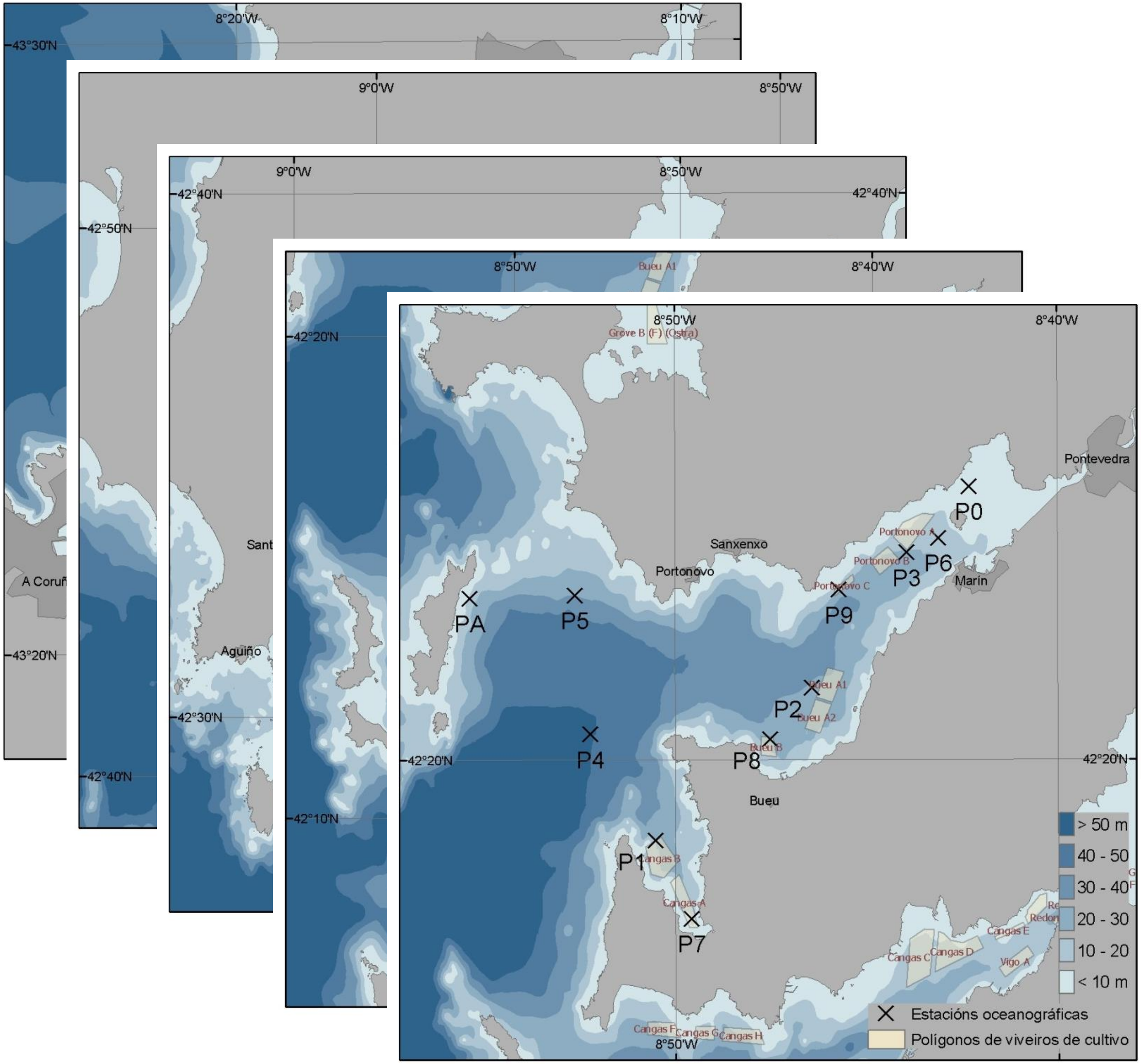

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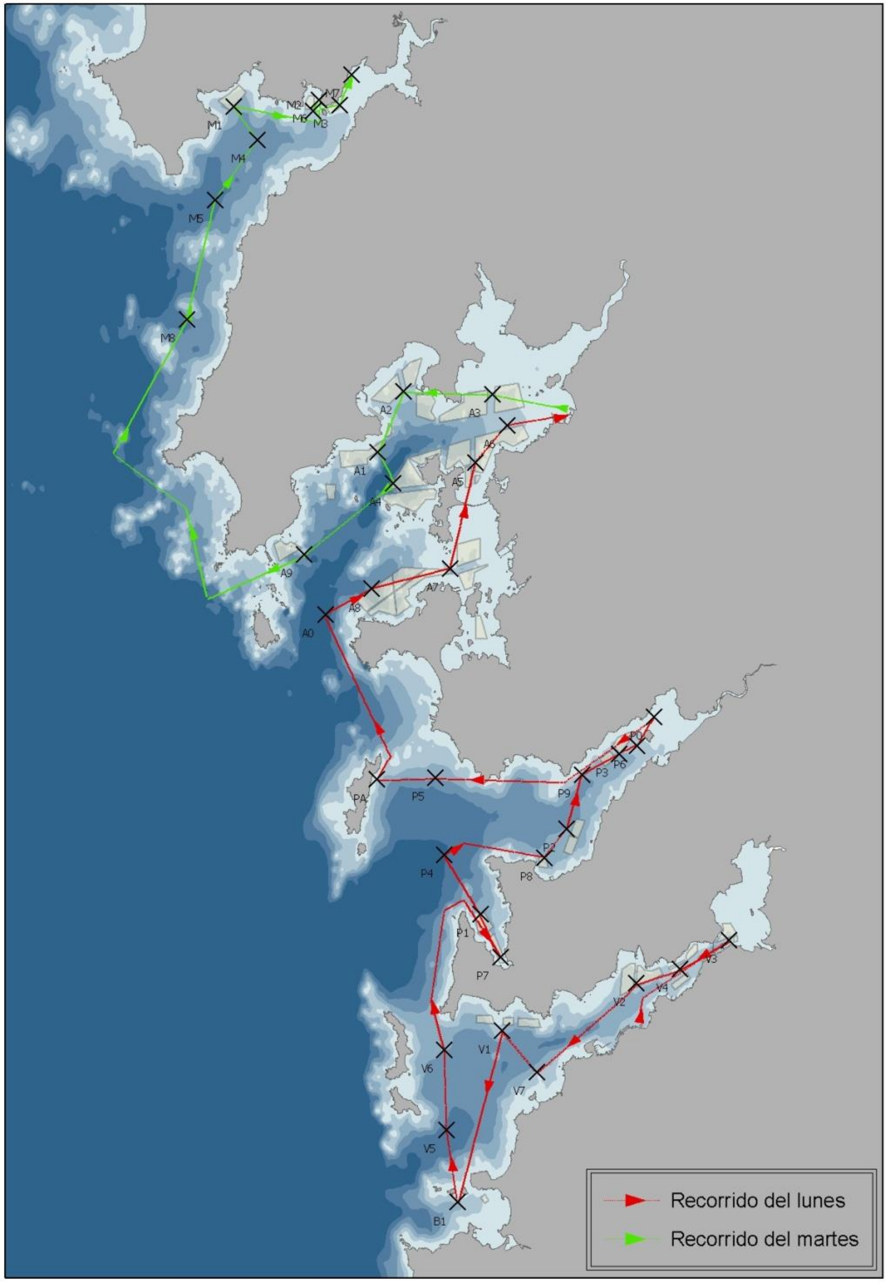

B/O José María Navaz
Instituto Español de Oceanografía

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

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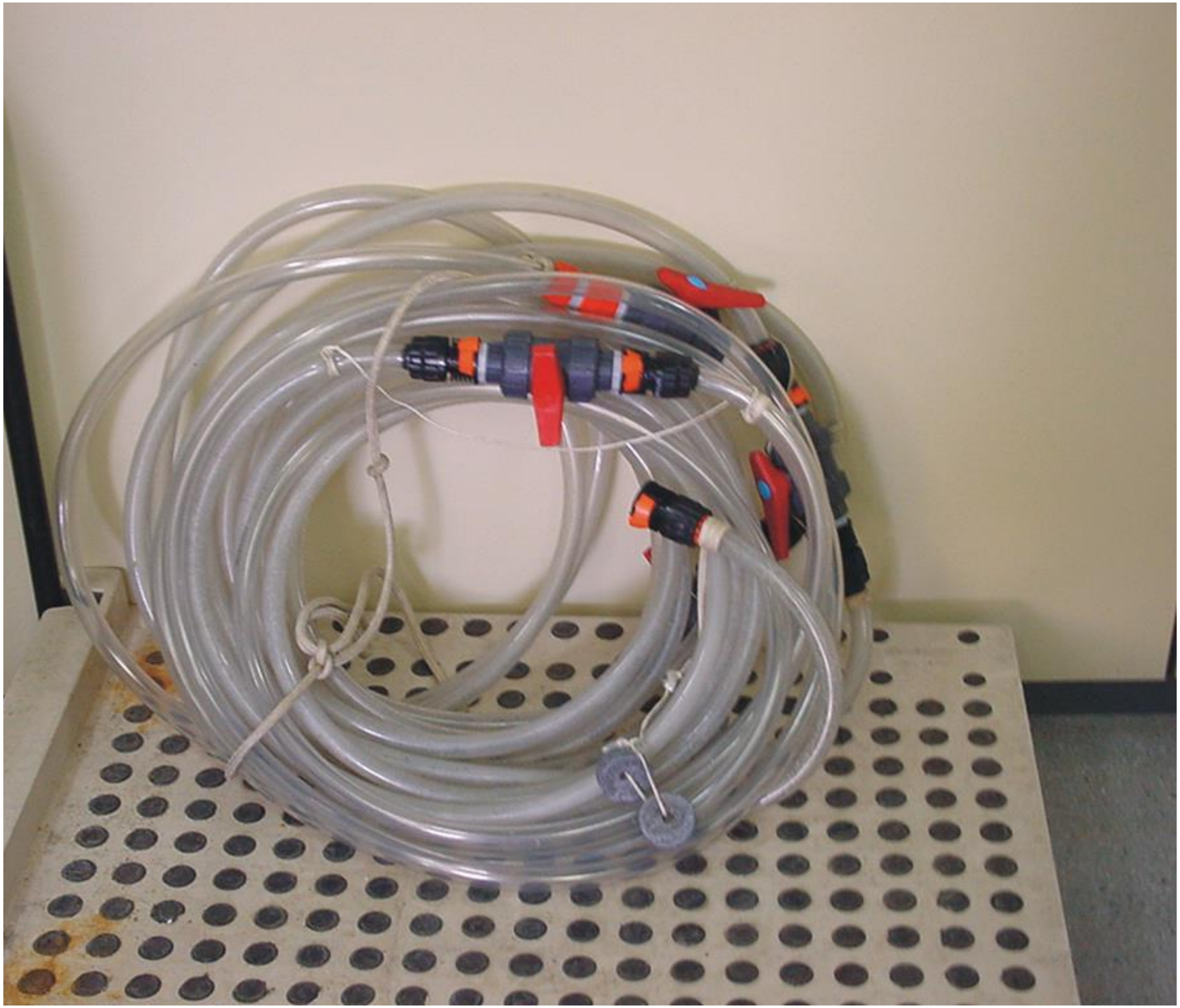
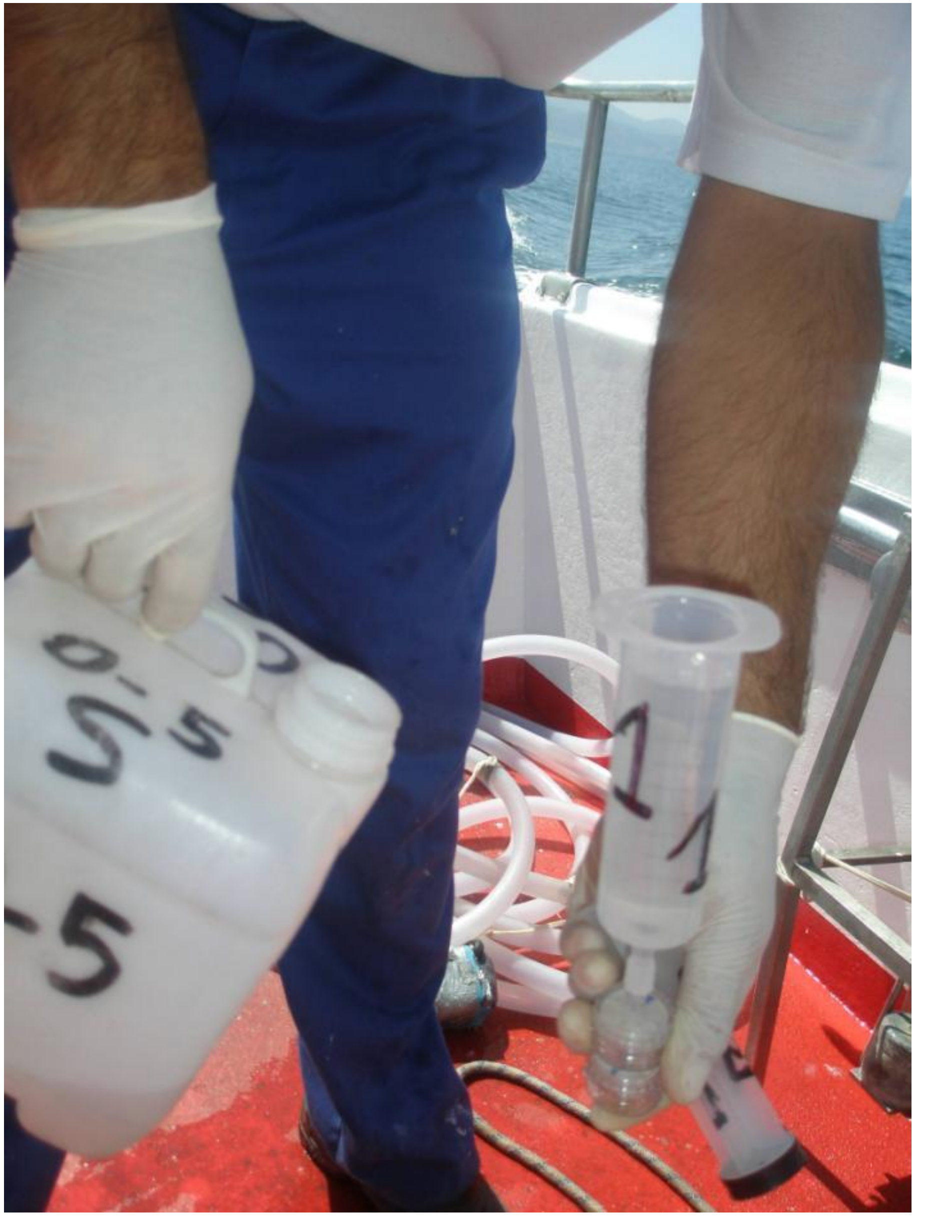
PESCA 1




5-10
0-5


0-5
5
1

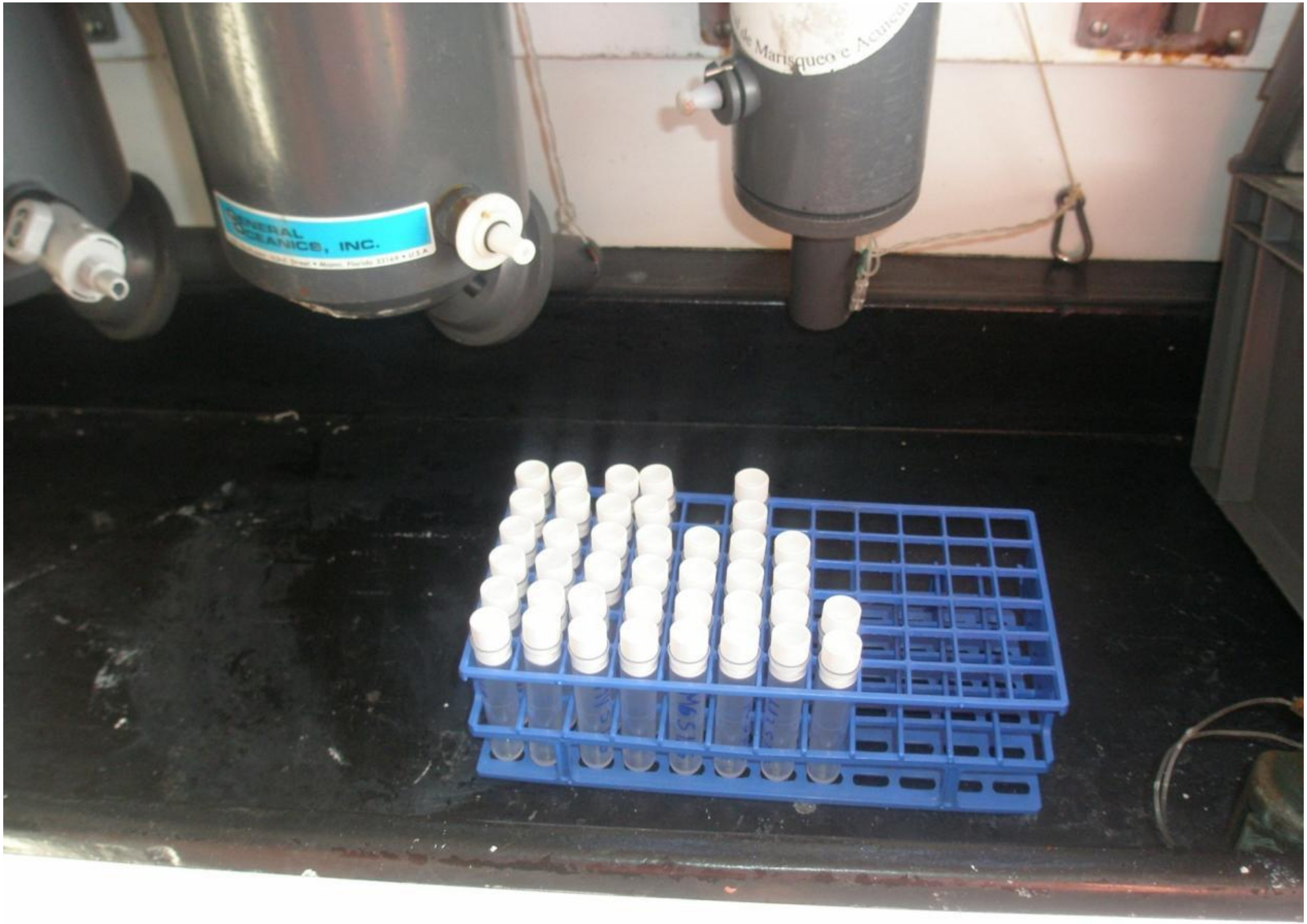

A1
M5
M2
2F


BD Plastipak


Pazos.INTECMAR


REMOLCANOSA
VIGO


A1
PYREX®
50 ml
A1
A1
A1




S
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S
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EMS

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INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

Red tide off Moon Bay in Shenzhen, S China

Sample Bottles

Edler and Elbräetcher in Karlson et al 2010

Preservation agents

Recipes for Lugol's iodine solution

Acidic	Alkaline	Neutral
20 g potassium iodide (KI)	20 g potassium iodide (KI)	20 g potassium iodide (KI)
10 g iodine (I_2)	10 g iodine (I2)	10 g iodine (I_2)
20 g conc. acetic acid	50 g sodium acetate	200 mL distilled water
200 mL distilled water	200 mL distilled water	

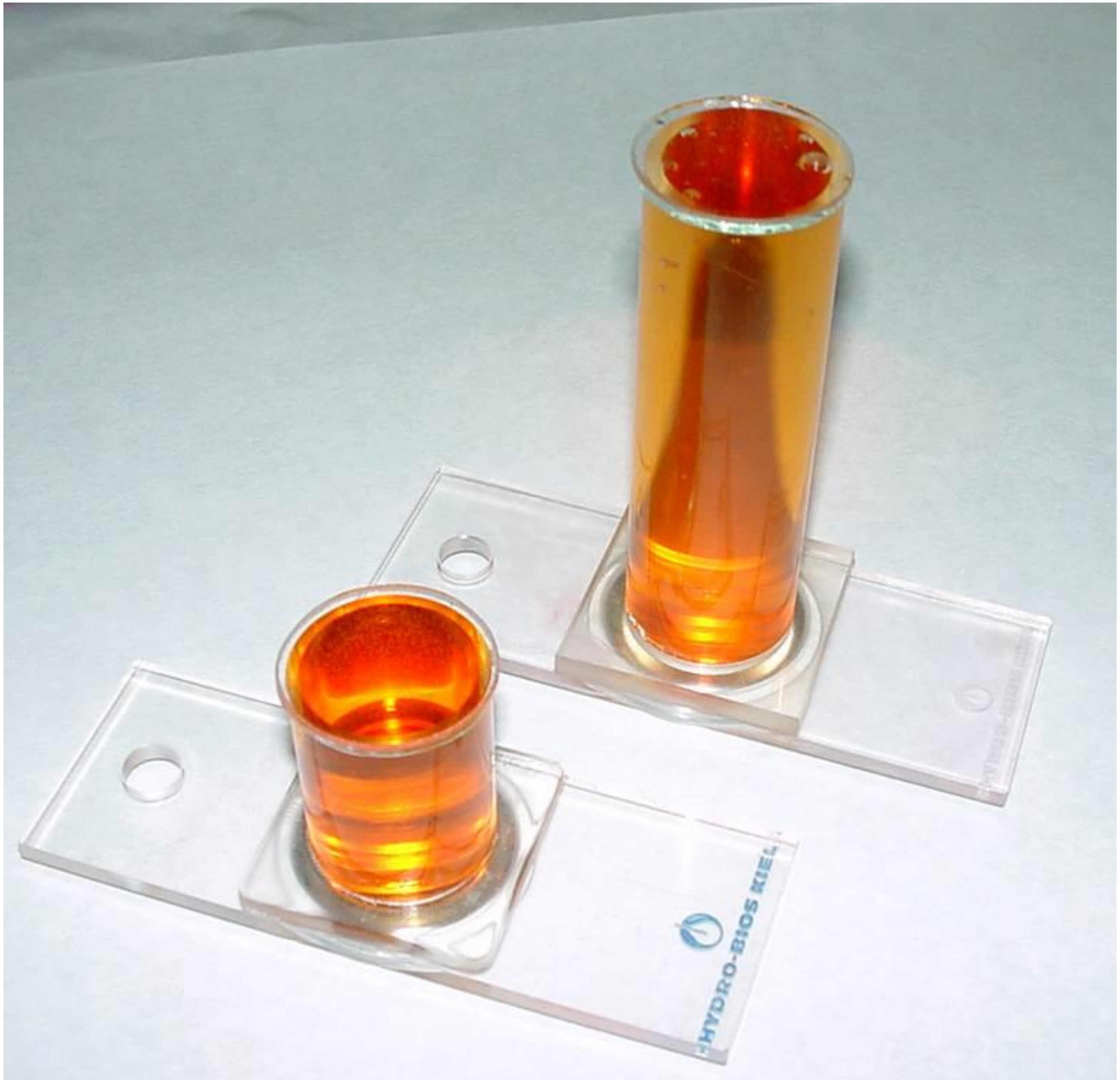
Utermöhl 1958, Willén 1962, Andersen and Throndsen, 2004

Preservation agents

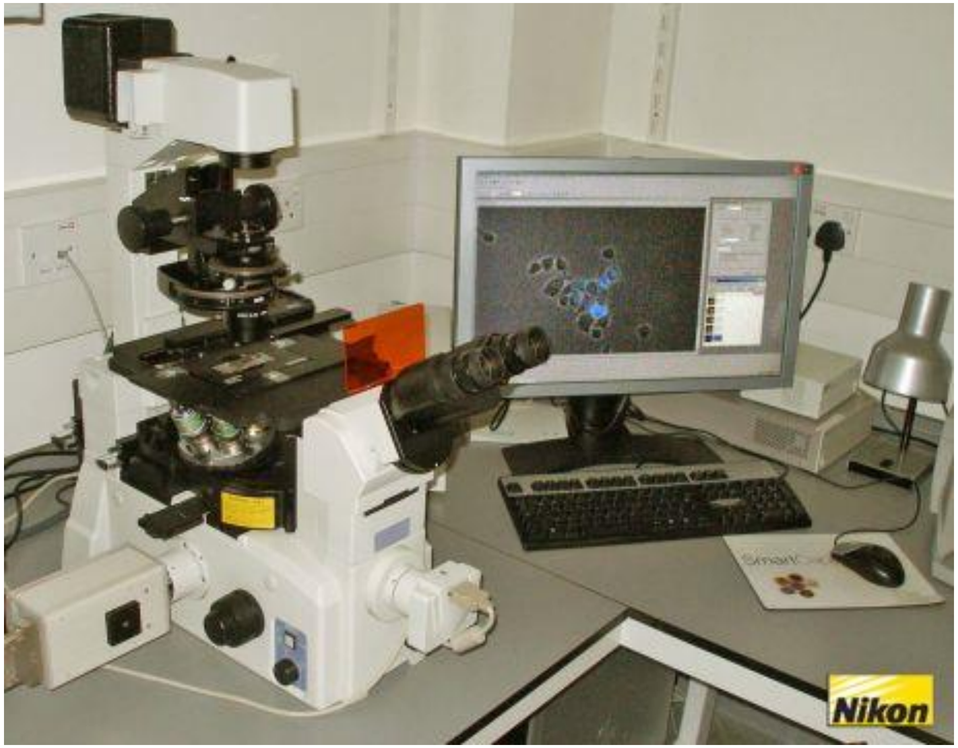
Recipe for neutral formaldehyde: Filter after one week to remove any precipitates.

Neutral formaldehyde
500 mL 40% formaldehyde
500 mL distilled water
100 g hexamethylentetramid
pH 7.3 – 7.9

Throndsen 1978, Edler 1979, Andersen and Throndsen 2004


HYDRO-BIOS KIEL

The inverted microscope



Phase- and/or differential interference-contrast for general phytoplankton

Bright-field for coccolitophorids

Epifluorescence for samples staineds

Autofluorescence in live samples (chlorophyll)

Fixed sample fluorescence (calcofluor for plates of dinoflagellates) DAPI (staining of nucleic acids)…

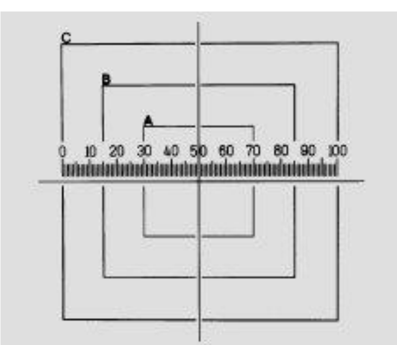

institutobiomedicina.unileon.es

The inverted microscope

Basic Objectives: 10x, 20x, 40x, 100x oil

One eyepiece equipped with a calibrated ocular micrometer

One eyepiece equipped with a graticule®such as a square field or grids



Laboratory facilities

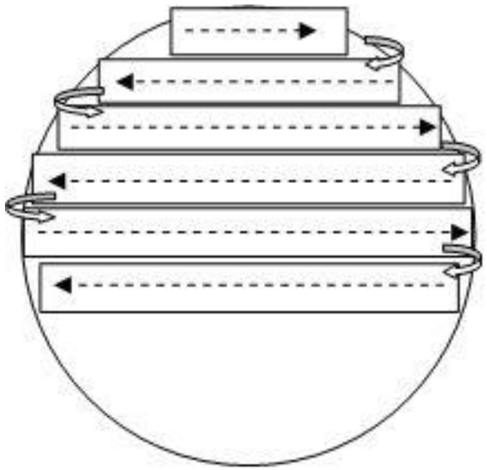
www.marine.ie

Amenities for storing, handling, mixing and pouring samples
For washing sedimentation chambers

Facilities to stored samples in cool and dark contidions

During sedimentation should be placed horizontal and solid surfact to prevent any non random accumulaton of phytoplankton cells

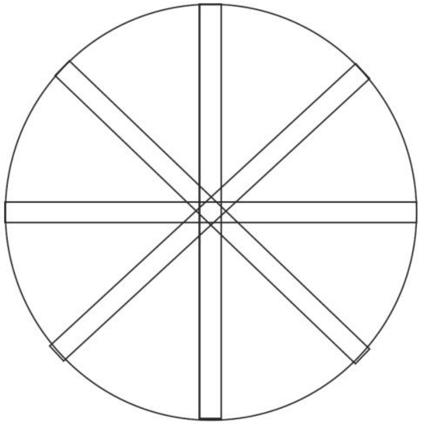
Counting procedure



Counting of the whole chamber bottom with the parallel eyepiece threads indicating the counted area.

Organisms should be identified to the lowest taxonomic level that time and skill permits (Hasle 1978)

Counting procedure



Counting of diameter transects

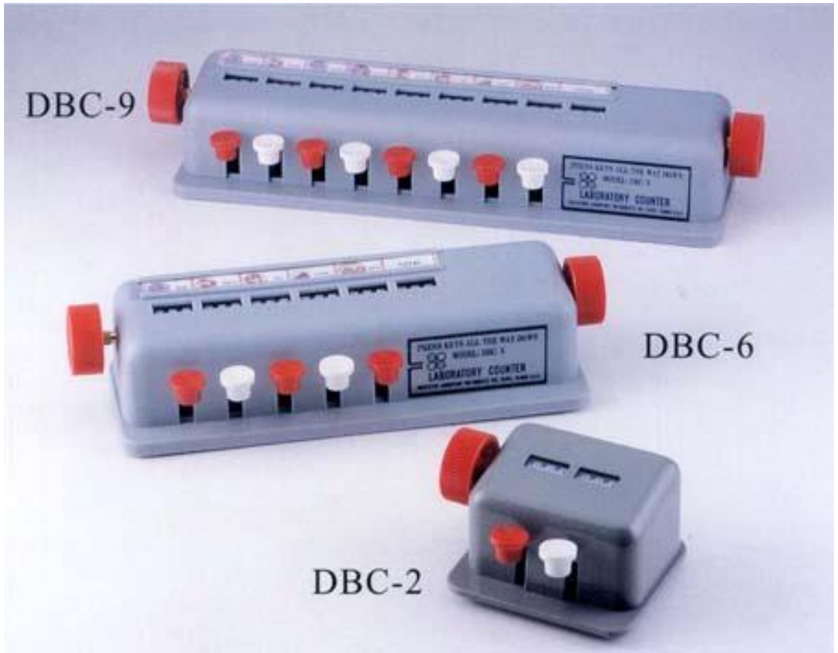
Recommended magnification for counting of different size classes of phytoplankton (Edler, 1979, Andersen and Throndsen 2004)

Counting procedure

Size class	Magnification
0.2-2.0 μm (picoplankton)	1000 x
2.0 – 20.0 μm (nanoplankton)	100 – 400 x
>20 μm (microplankton)	100 x

Recommended magnification for counting of different size classes of phytoplankton (Edler, 1979, Andersen and Throndsen 2004)

Medical blood cell counter

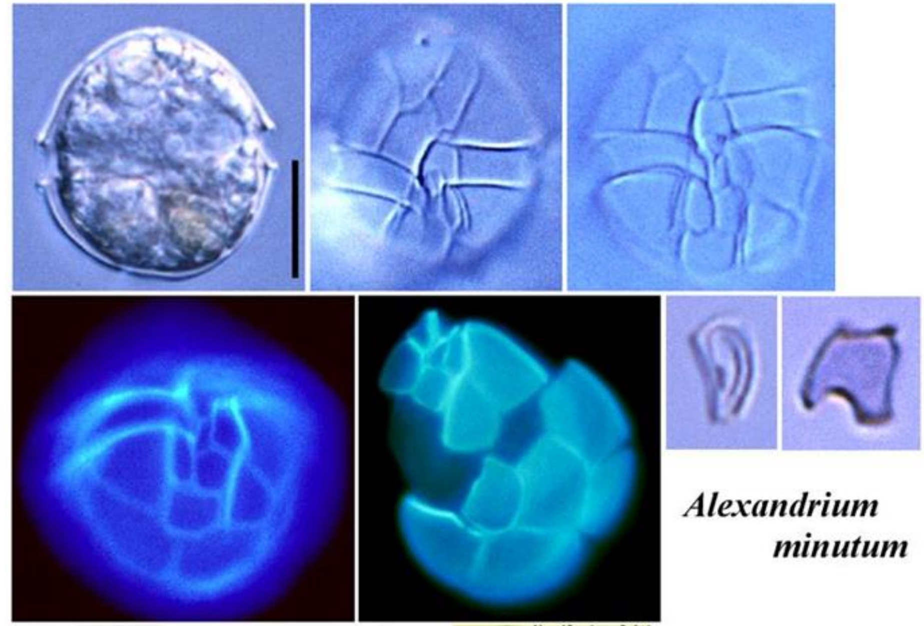


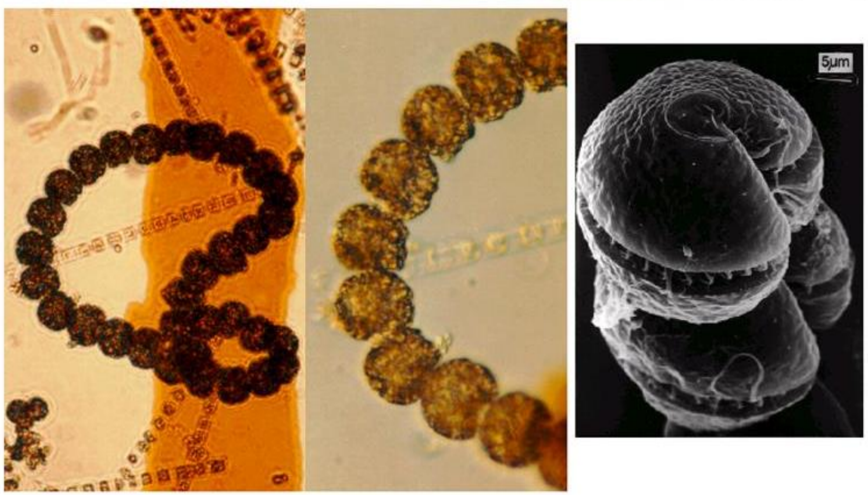
PSP causing *Gymnodinium* and DSP causing *Dinophysis* in Galician waters

Photomicrograph offered by the Marine Environmental Quality Control Center (CCCMM) of Galicia, NW Spain

WESTPAC-HAB
IOC Harmful Algal Bloom Programme

R0014





Gymnodinium catenetum

Photomicrographs by Sadaaki Yoshimatsu
Tomotoshi Okaichi and Haruyoshi Takayam

IN THE GALICIAN RIAS
MONITORING BY INTECMAR:

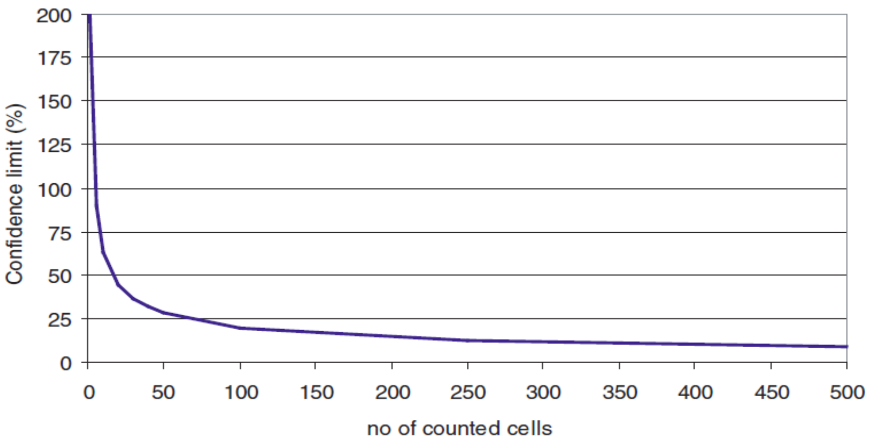
Alexandrium minutum
25 mL 200 X
2 diametral transects

Gymnodinium catenatum
25 mL 100 X
The whole chamber bottom

How many cells to count?

No of counted cells	Confidence limit +/- (%)	Absolute limit if cell density is estimated at 500 cells L^{-1}
1	200	500 ± 1000
2	141	500 ± 705
3	116	500 ± 580
4	100	500 ± 500
5	89	500 ± 445
6	82	500 ± 410
7	76	500 ± 380
8	71	500 ± 355
9	67	500 ± 335
10	63	500 ± 315
15	52	500 ± 260
20	45	500 ± 225
25	40	500 ± 200
50	28	500 ± 140
100	20	500 ± 100
200	14	500 ± 70
400	10	500 ± 50
500	9	500 ± 45
1000	6	500 ± 30

Relationship between number of cells counted and confidence limit at 95% significance level (Edler 1979, Andersen and Throndsen 2004)



Relationship between number of cells counted and confidence limit at the 95% significance level

$$Precision\,\% = \frac{2*100}{\sqrt{number\ of\ cells\ counted}}$$

Final calculations

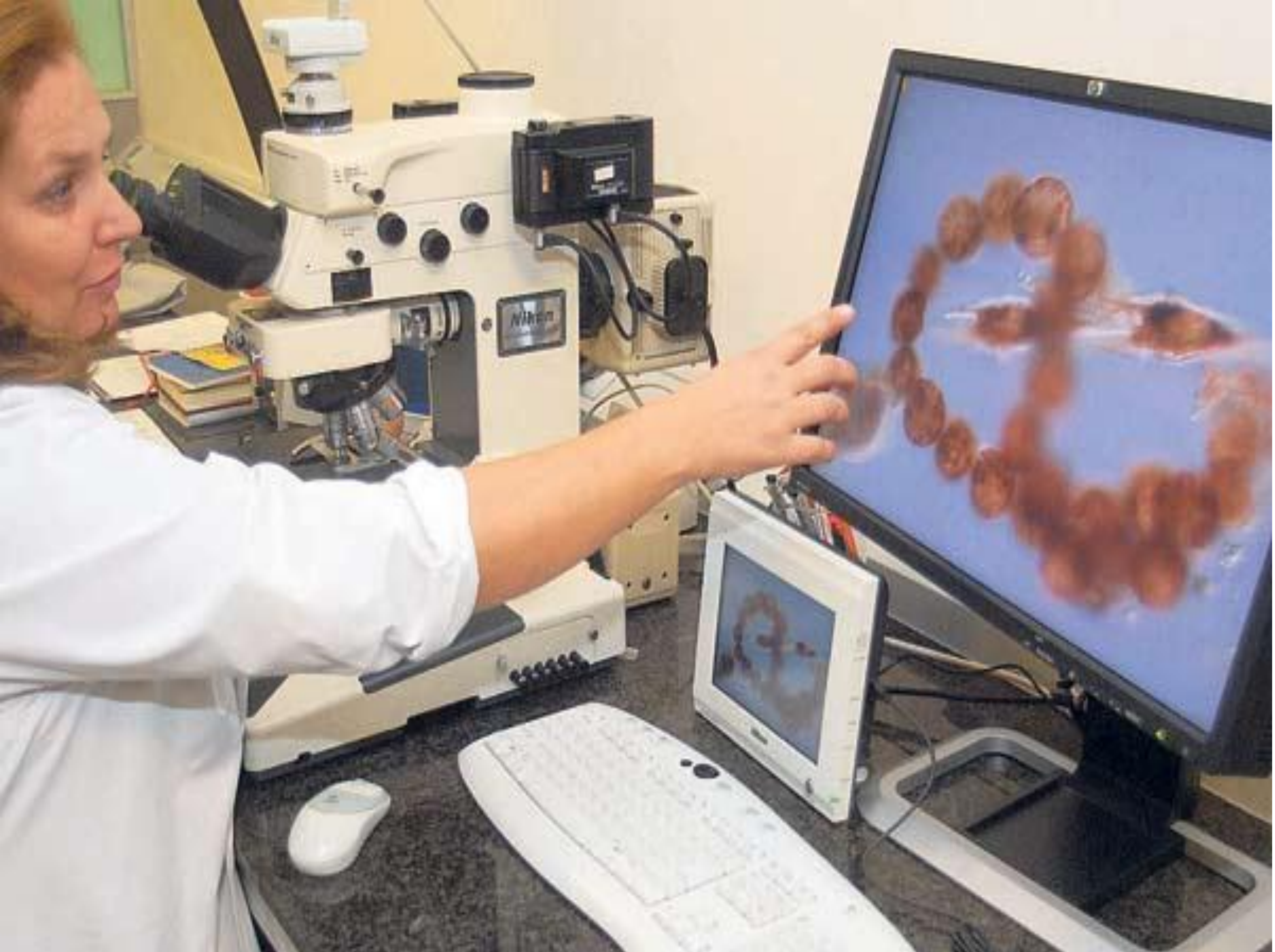
$$Cells\ L^{-1} = N * \left(\frac{A_t}{A_c}\right) * \frac{1000}{V}$$

$$Cells\ mL^{-1} = N * \left(\frac{A_t}{A_c}\right) * \frac{1}{V}$$

V: volume of counting chamber (mL)
At: total area of the counting chamber (mm^2)
Ac: counted area of the counting chamber (mm^2)
N: number of units (cells) of specific species counted
C: concentration (density) of the specific species

Cuidad la posición y la óptica

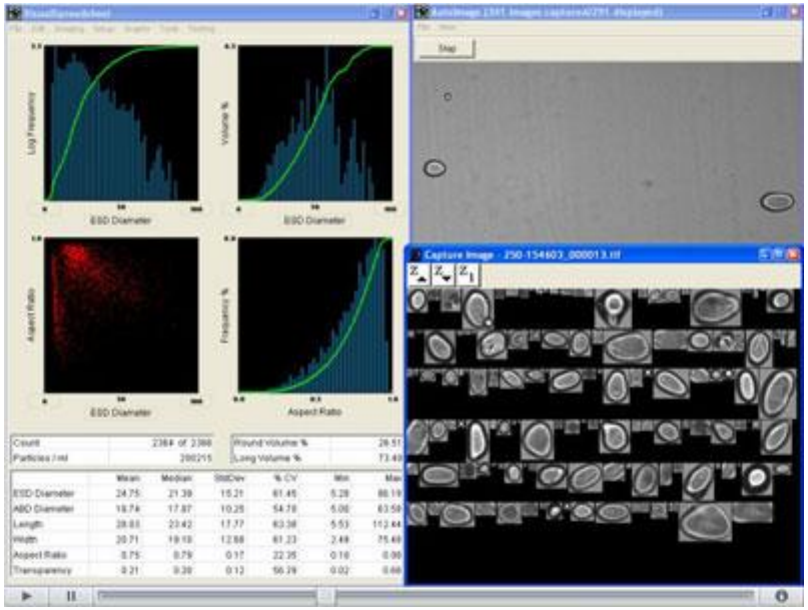
Y. Pazos. Curso COI UNESCO 2012

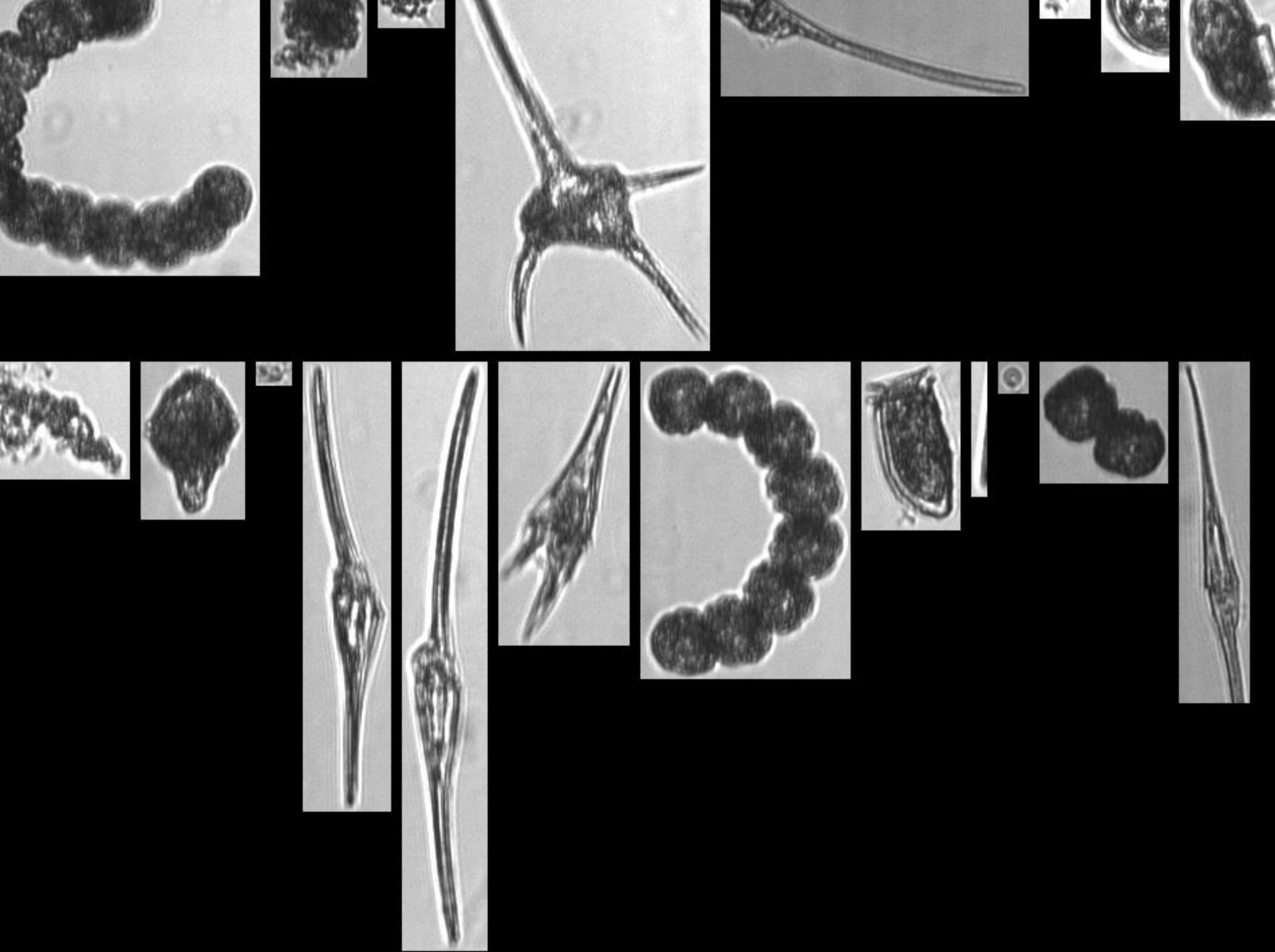


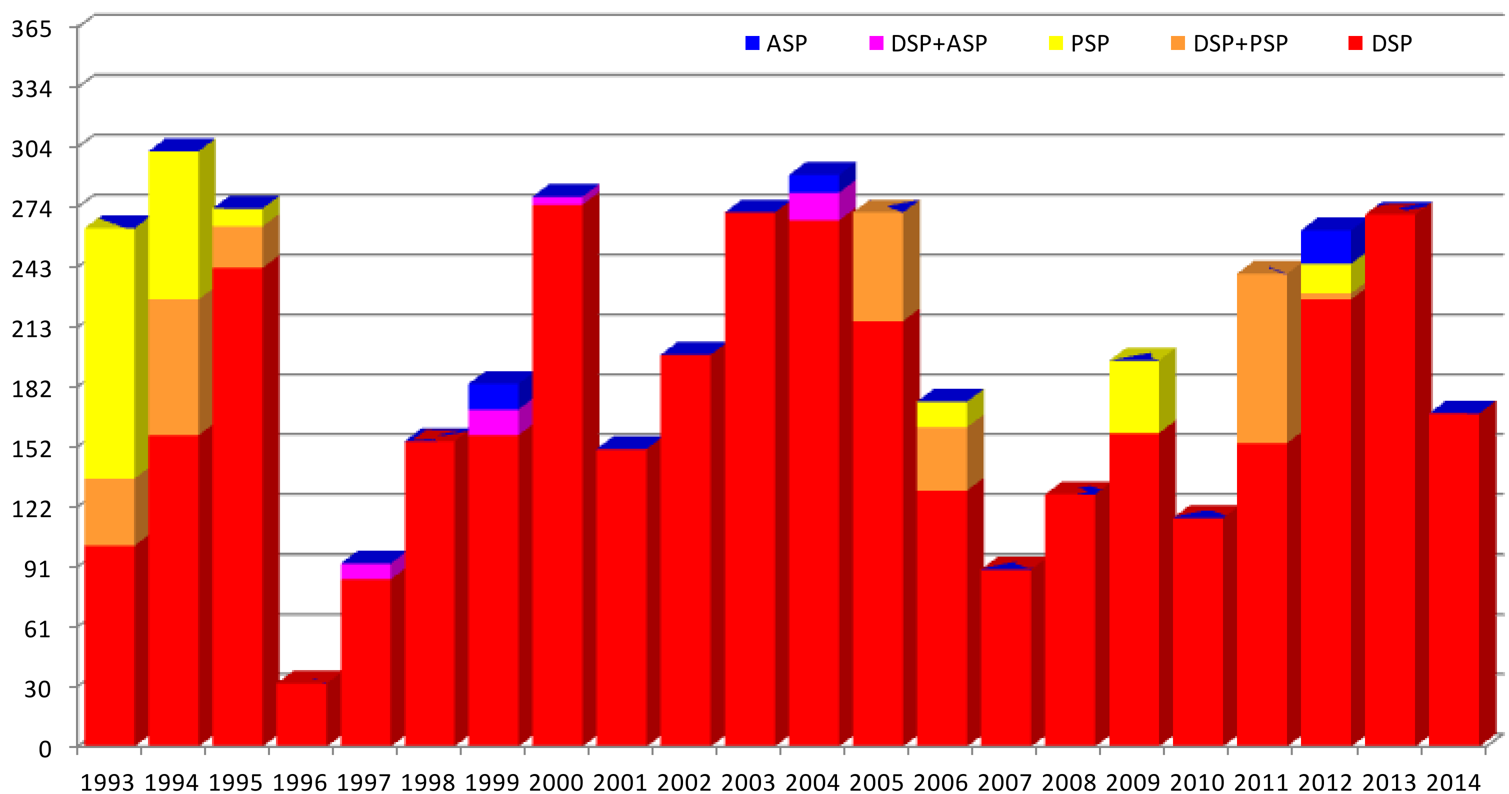
Yolanda Pazos, *Gymnodinium catenatum* and two *Ceratium furca* **Iñaki Abella. FARO DE VIGO**

FlowCAM®

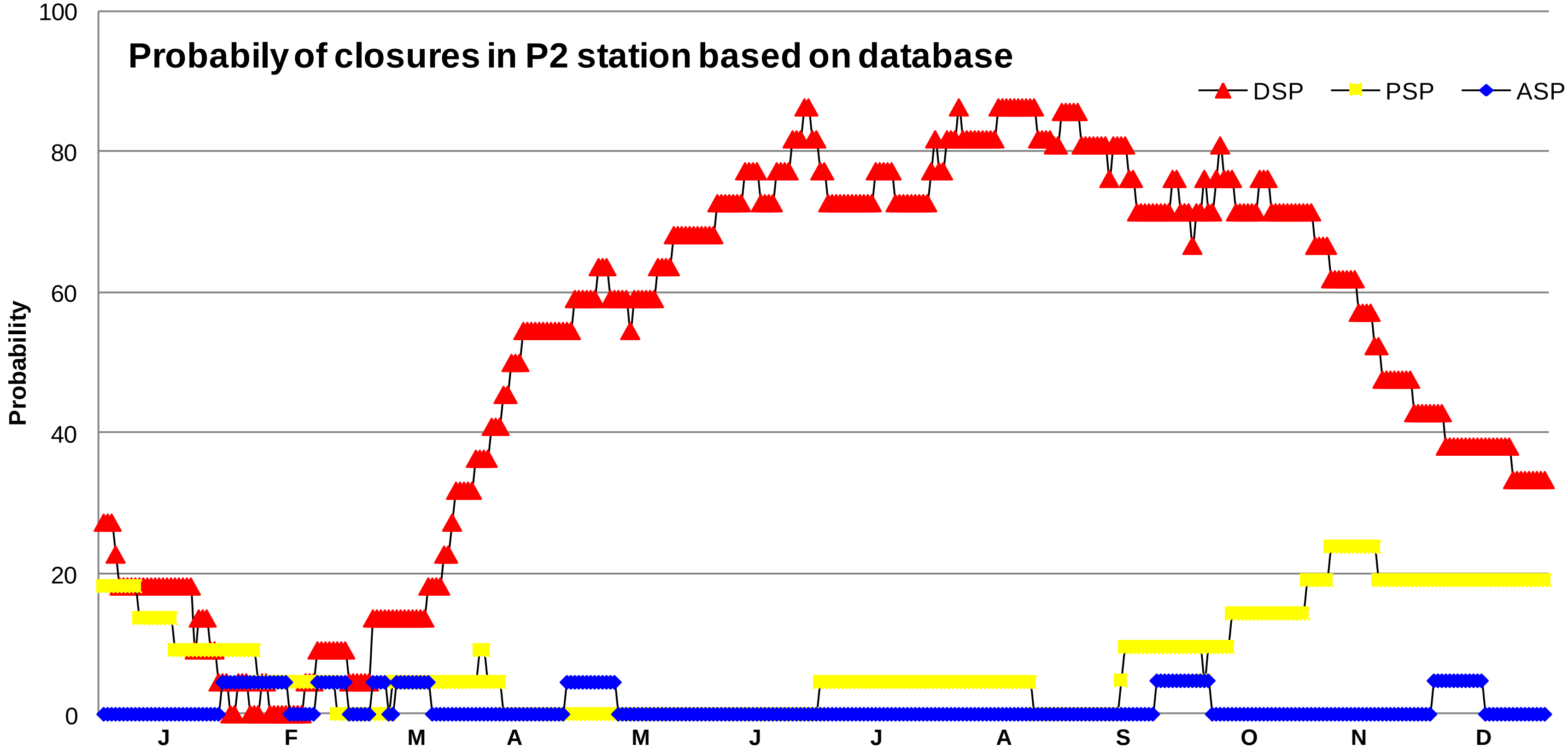
Gathers and stores all passing data, including particle size, particle images, and time of collection






365
334
304
274
243
213
182
152
122
91
61
30
0
ASP
DSP+ASP
PSP
DSP+PSP
DSP
1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

1993- 2017



Probabily of closures in P2 station based on database
DSP
PSP
ASP
Probability
100
80
60
40
20
0
J
F
M
A
M
J
J
A
S
O
N
D

Positive bioassay + Negative bioassay –

Dinophysis acuminata + *D. acuta* (cellL[-1])

Trigger levels?

1-The number of cases analysed for both variables is very high: 7606

2-The mouse bioassay analysis for the mussels and *Dinophysis acuminata* + *D. acuta* cell counts in seawater are analysis completely independent

CONDITIONAL PROBABILITY

$$P(Bioassay^{+}/Dinophysis\ 40) = \frac{P(Bioassay^{+} \cap Dinophysis\ 40)}{P\ (Dinophysis\ 40)}$$

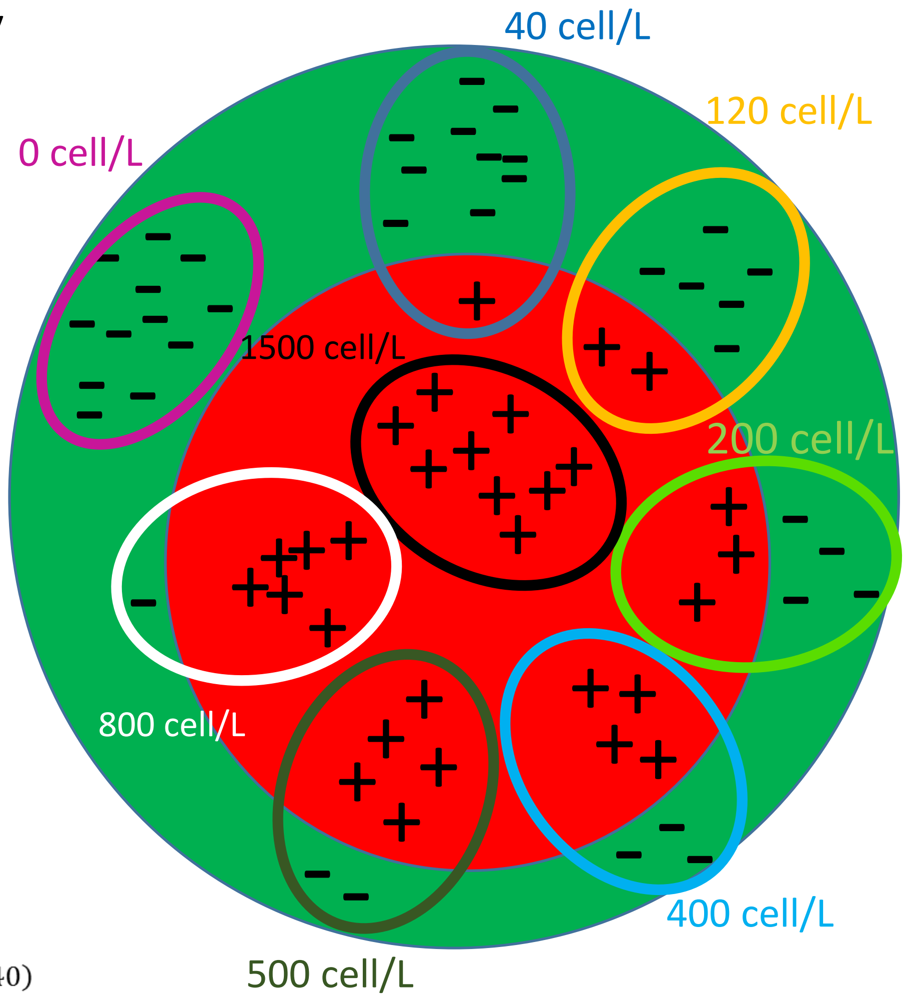
$$P(Bioassay^{+}/Dinophysis\ 120) = \frac{P(Bioassay^{+} \cap Dinophysis\ 120)}{P\ (Dinophysis\ 120)}$$

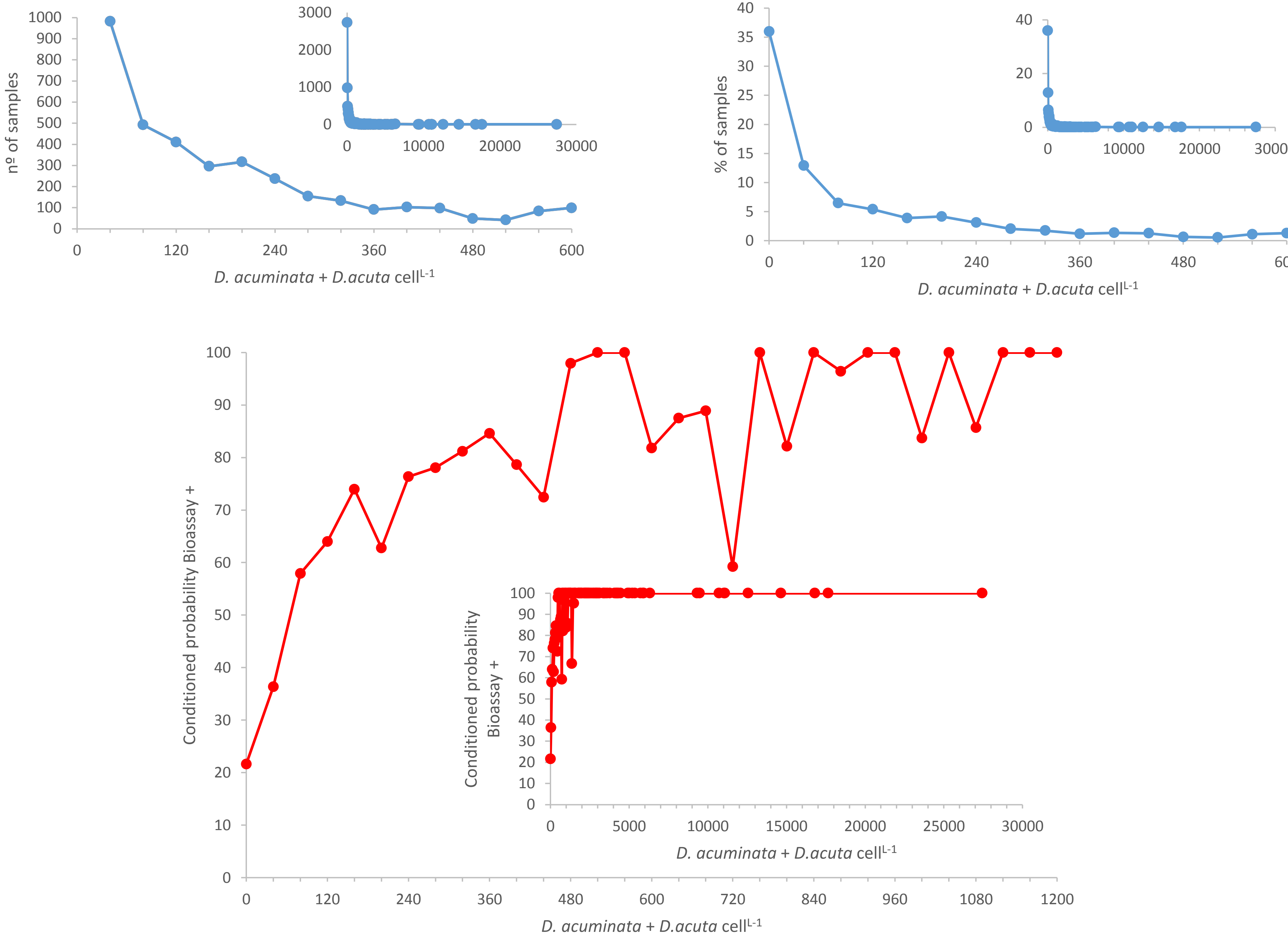
.

.

.

$$P(Bioassay^{+}/Dinophysis\ 27440) = \frac{P(Bioassay^{+} \cap Dinophysis\ 27440)}{P\ (Dinophysis\ 27440)}$$

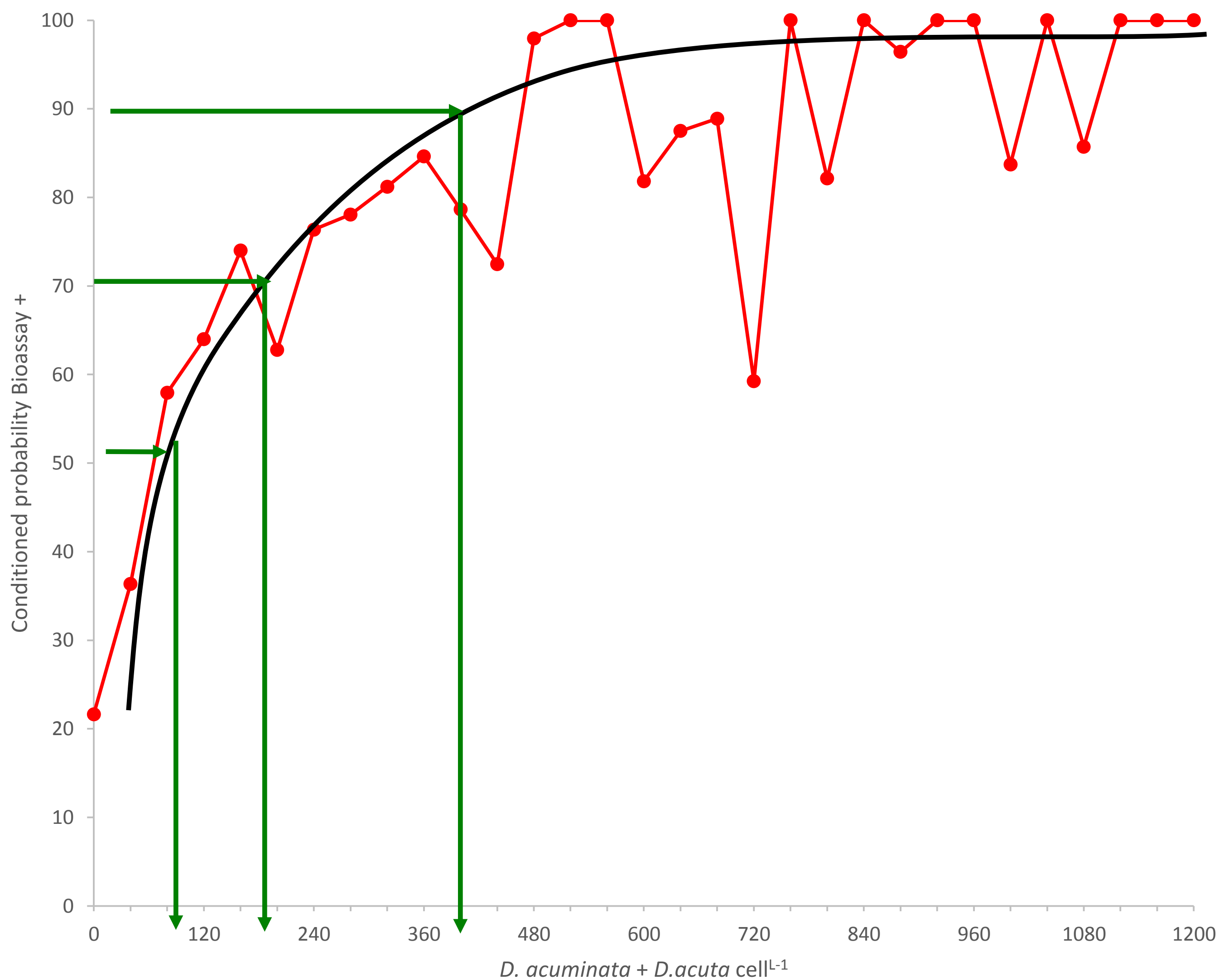




nº of samples
1000
900
800
700
600
500
400
300
200
100
0
0
120
240
360
480
600
D. acuminata + D.acuta cellL-1
3000
2000
1000
0
0
10000
20000
30000
% of samples
40
35
30
25
20
15
10
5
0
0
120
240
360
480
600
D. acuminata + D.acuta cellL-1
40
20
0
0
10000
20000
30000
Conditioned probability Bioassay +
100
90
80
70
60
50
40
30
20
10
0
0
120
240
360
480
600
720
840
960
1080
1200
D. acuminata + D.acuta cellL-1
Conditioned probability Bioassay +
100
90
80
70
60
50
40
30
20
10
0
0
5000
10000
15000
20000
25000
30000
D. acuminata + D.acuta cellL-1

Probability of Bioassay + given
Dinophysis acuminata + *acuta* cell concentration
based on cases in real monitoring

Trigger levels?



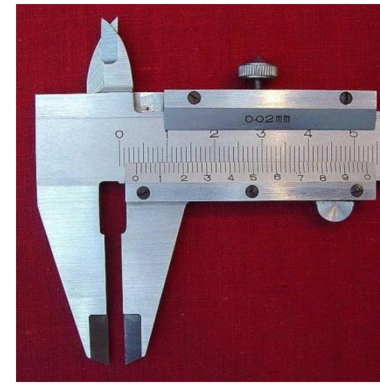
E-EN 15204:2007

Water quality - Guidance standard on the enumeration of phytoplankton using inverted microscopy (Utermöhl technique)

Traceability: certified equipment

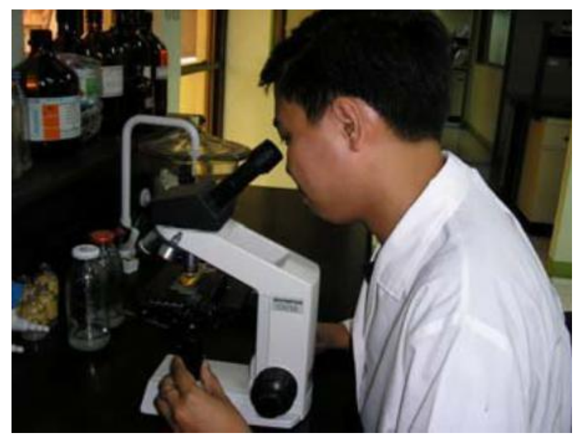
micrometer

precision scale



Caliper

Qualification of workers:
continuous training and evaluation



Quality assurance

The method must be validate :

. Repeteability and reproducibity

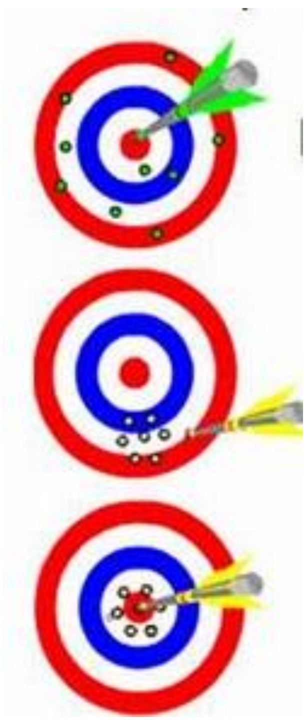
. The distribution in the camber tottom

. The homogenisation of sample

. The setimentation

. blank samples…

Accuracy (mean) versus precision (standard deviation)



Accurate but not precise

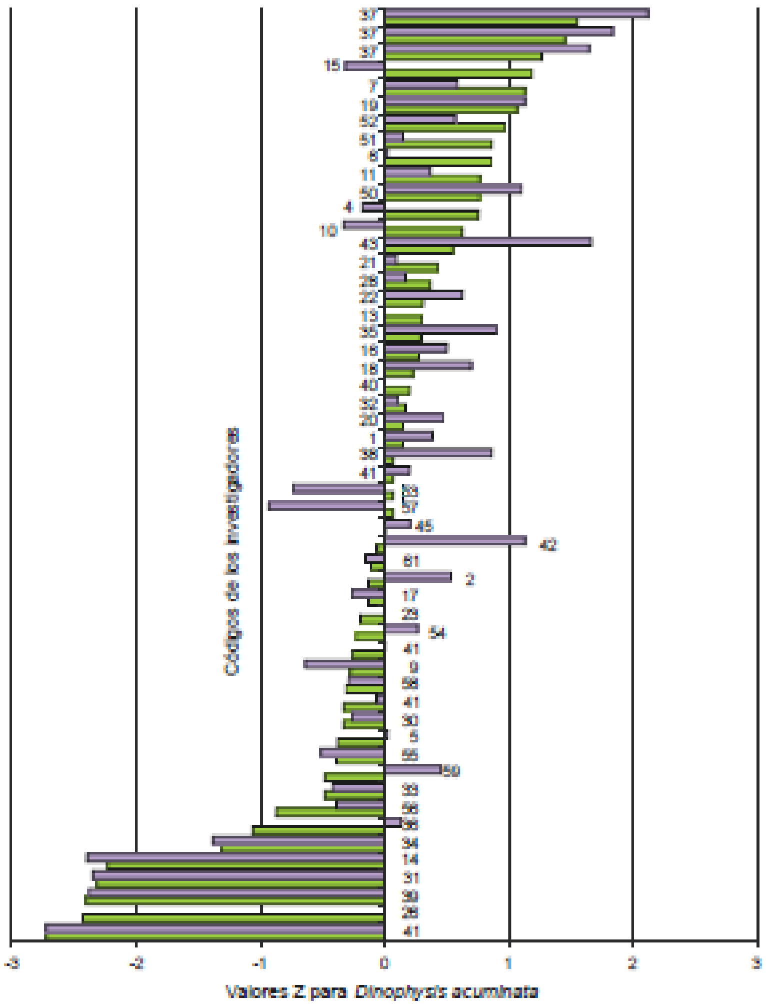
Precise but not accurate

Precise and accurate

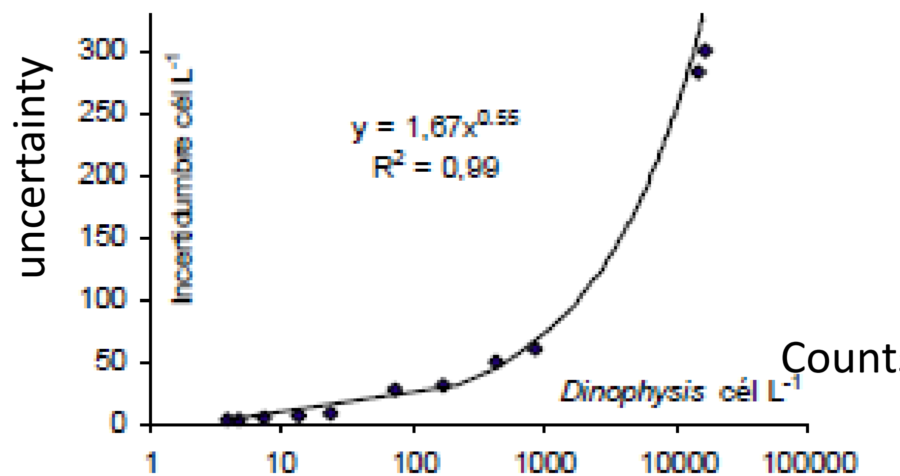
INTERLABORATORY
INTERCALIBRATION
EXERCICES.

Example: Pazos et al

Z scores for *Dinophysis acuminata* counts of the 62 researchers from 13 countries



	Promedio (cel L^{-1})	DESVEST	C.V	N° muestras	Incertidumbre (cel L^{-1})	I relativa %
D. acuminata	14612	2867	20	102	284	2
D. acuta	5	35	742	102	3	73
D. caudata	173	314	182	102	31	18
D. diegensis	24	88	369	102	9	37
D. fortii	7	53	711	102	5	70
D. parvula	4	28	707	102	3	70
D. rotundata	832	614	74	102	61	7
D. sacculus	13	69	513	102	7	51
D. skagii	429	507	118	102	50	12
Dinophysis spp	72	286	396	102	28	39
Total	16170	3042	19	102	301	2



Estimación de incertidumbre de recuentos celulares de *Dinophysis acuminata* por el método Uthermöhl: Resultado de un ejercicio de intercalibración interlaboratorio

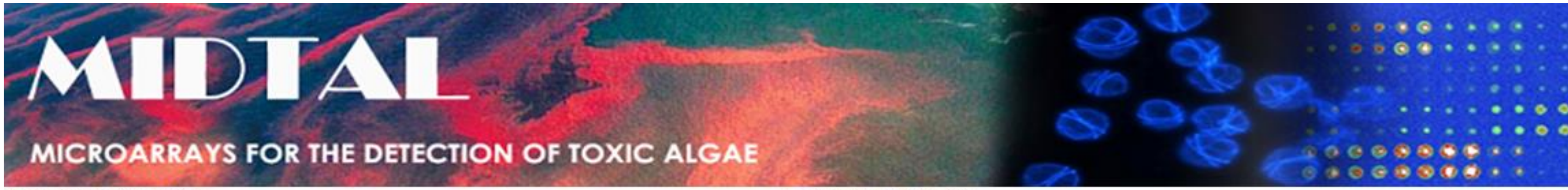
Yolanda Pazos[1], Luz Mamán[2] y Maximino Delgado[3]

(1) Instituto Tecnolóxico para o Control do Medio Mariño de Galicia (INTECMAR) Vilagarcía de Arousa.

(2) Laboratorio de Control de Calidad de los Recursos Pesqueros (L.C.C.RR.PP.). Huelva.

(3) Institut de Recerca i Tecnologia Agroalimentaries (IRTA). Tarragona.

Pazos et al in Gillabert et al 2008



Now: 2010-09-27 08:11:22

Last update: 09/04/2010

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Hit Counts:

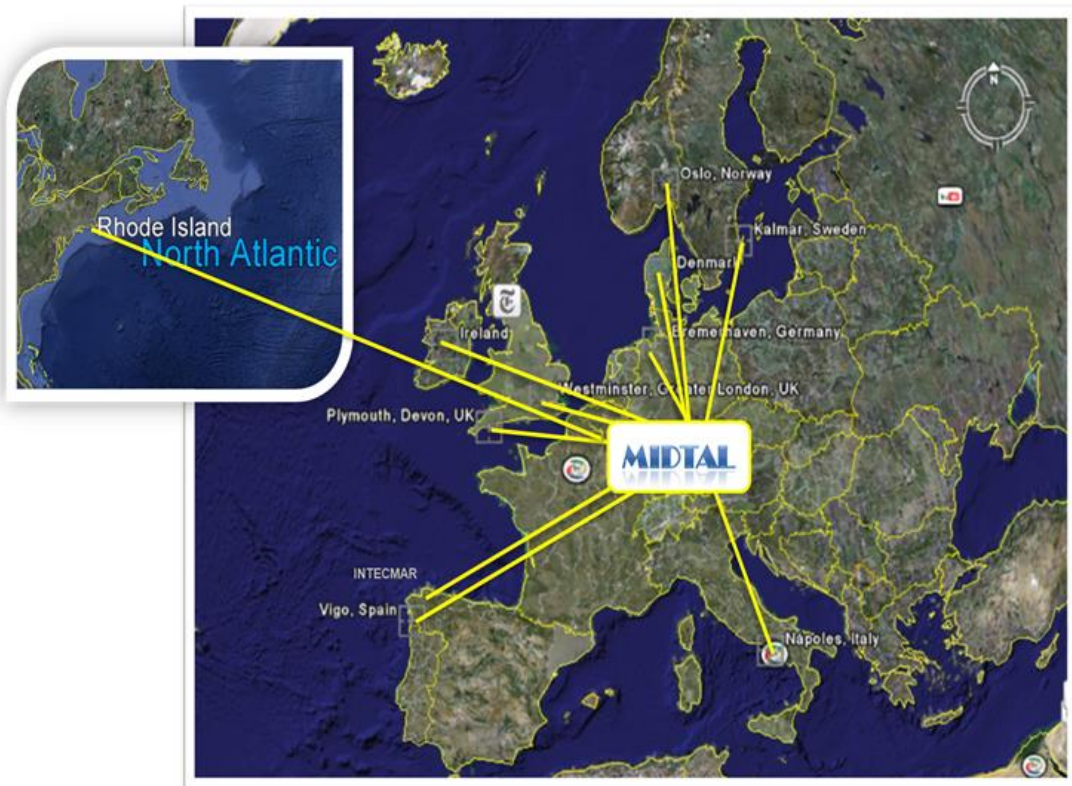
005609

Project acronym: MIDTAL

Project full title: MICROARRAYS FOR THE DETECTION OF TOXIC ALGAE

Grant agreement no.: 201724

MIDTAL is a cooperated project covering several institutes over Europe coastal seas. Ten partners make up the consortium and include scientists from 7 European countries and the USA.



NEWS AND UPDATES

- NEW Vigo meeting reports are uploaded (2010-03-31)
- NEW 15 months report is uploaded in Internal page (2010-03-31)
- NEW Culture list is updated (2010-03-31)
- NEW Probes and primers list is updated (2010-03-08)
- NEW **Periodical meeting was held in Vigo, Spain during 1-3, March** (2010-03-08)
- NEW

More

Midtal Objectives

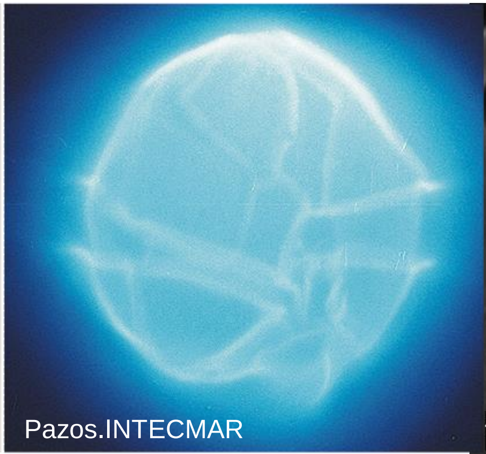
- To **test and optimise existing rRNA probes** for toxic species and antibodies for toxins for their application to a microarray
- To **design** and test the specificity of any **new probe** needed
- To construct **a universal microarray** from the probes tested and optimized by all of the partners for the detection of harmful algae and their toxins
- To provide national monitoring agencies with **a rapid molecular tool** to monitor toxic algae to validate or replace traditional methods for monitoring for toxic algae
- To **integrate** European efforts to monitor coastal waters for toxic algal species

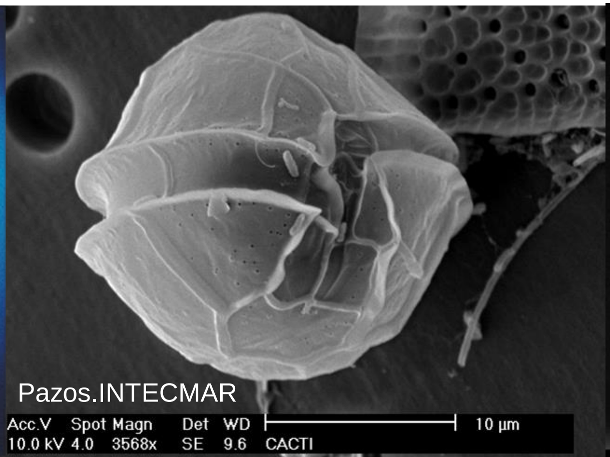
Dittami, Pazos, Laspra, & Medlin **Environ Sci Pollut Res**, 2012
Microarray testing for the presence of toxic algae monitoring programme in Galicia (NW Spain)

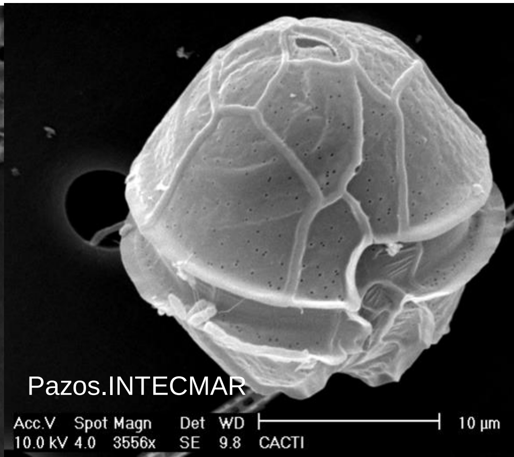
PSP

SPECIES	OPTICAL MICROSCOPE. XUNTA DE GALICIA	ELECTRONIC MICROSCOPE. XUNTA DE GALICIA	MOLECULAR TOOLS. XUNTA DE GALICIA	OPTICAL MICROSCOPE. JUNTA DE ANDALUCÍA	ELECTRONIC MICROSCOPE. JUNTA DE ANDALUCÍA	MOLECULAR TOOLS. JUNTA DE ANDALUCÍA	OPTICAL MICROSCOPE. GENERALITAT DE CATALUNYA	ELECTRONIC MICROSCOPE. GENERALITAT DE CATALUN	MOLECULAR TOOLS. GENERALITAT DE CATALUNYA	OPTICAL MICROSCOPE. BASQUE COUNTRY	ELECTRONIC MICROSCOPE. BASQUE COUNTRY	MOLECULAR TOOLS. BASQUE COUNTRY
Alexandrium andersonii Balech, 1990							yes					
Alexandrium catenella (Whedon & Kofoid) Balech, 1985				yes			yes					
Alexandrium minutum Halim, 1960	yes	SEM	microarray	yes			yes			yes		
Alexandrium ostenfeldii (Paulsen) Balech & Tangen, 1985	yes		microarray				yes					
Alexandrium tamarense complex (Lebour) Balech, emended U. John	yes		microarray	yes			yes			yes		
Gymnodinium catenatum H.W.Graham, 1943	yes	SEM	microarray	yes		qPCR						

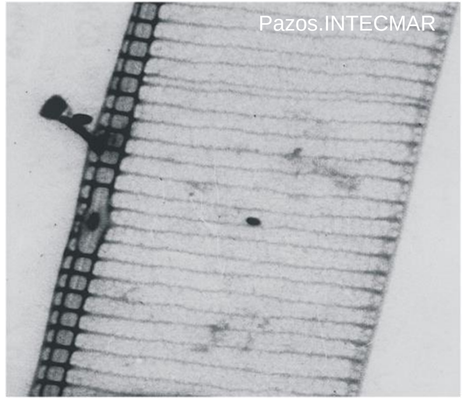
Alexandrium minutum Halim, 1960







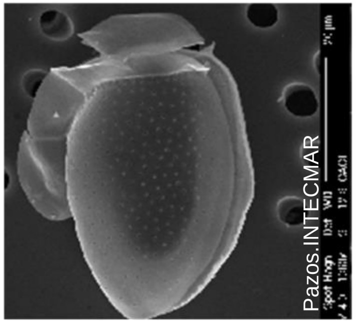
Pseudo-nitzschia sp.
Peragallo in Peragallo & Peragallo, 1900



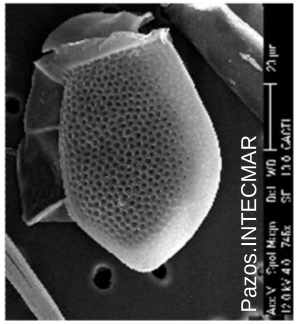
Pseudo-nitzschia australis
Frenguelli, 1939

ASP

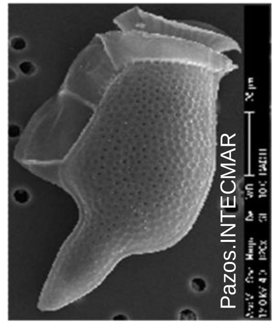
SPECIES	OPTICAL MICROSCOPE. XUNTA DE GALICIA	ELECTRONIC MICROSCOPE. XUNTA DE GALICIA	MOLECULAR TOOLS. XUNTA DE GALICIA	OPTICAL MICROSCOPE. JUNTA DE ANDALUCÍA	ELECTRONIC MICROSCOPE. JUNTA DE ANDALUCÍA	MOLECULAR TOOLS. JUNTA DE ANDALUCÍA	OPTICAL MICROSCOPE. GENERALITAT DE CATALUNYA	ELECTRONIC MICROSCOPE. GENERALITAT DE CATALUN	MOLECULAR TOOLS. GENERALITAT DE CATALUNYA	OPTICAL MICROSCOPE. BASQUE COUNTRY	ELECTRONIC MICROSCOPE. BASQUE COUNTRY	MOLECULAR TOOLS. BASQUE COUNTRY
Pseudo-nitzschia australis Frenguelli, 1939	yes	TEM	microarray	yes	SEM						TEM	yes
Pseudo-nitzschia calliantha Lundholm, Moestrup & Hasle, 2003			microarray					SEM	qPCR			
Pseudo-nitzschia cuspidata (Hasle) Hasle, 1993			microarray								TEM	yes
Pseudo-nitzschia delicatissima (Cleve) Heiden, 1928			microarray					TEM	qPCR		TEM	yes
Pseudo-nitzschia multiseries (Hasle) Hasle, 1995		TEM	microarray									
Pseudo-nitzschia multistriata (Takano) Takano, 1995	yes		microarray	yes	SEM			TEM	qPCR		TEM	yes
Pseudo-nitzschia plurisecta Orive & Pérez-Aicua, 2013											TEM	yes
Pseudo-nitzschia pseudodelicatissima (Hasle) Hasle, 1993			microarray								TEM	yes



Dinophysis acuminata Claparède & Lachmann, 1859



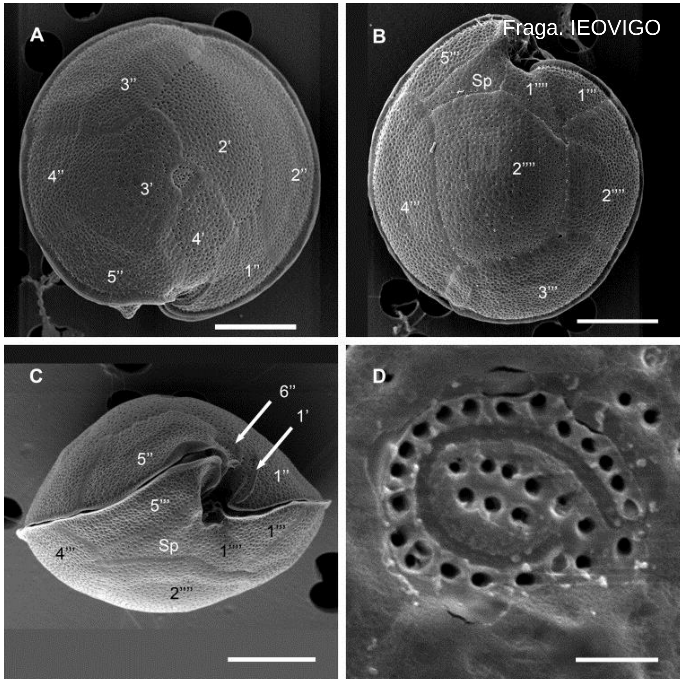
Dinophysis acuta Ehrenberg, 1839



Dinophysis caudata Saville-Kent, 1839

Lipohilic (OA+derivates+AZA+Yesso+Palitoxins)

	OPTICAL MICROSCOPE. XUNTA DE GALICIA	ELECTRONIC MICROSCOPE. XUNTA DE GALICIA	MOLECULAR TOOLS. XUNTA DE GALICIA	OPTICAL MICROSCOPE. JUNTA DE ANDALUCÍA	ELECTRONIC MICROSCOPE. JUNTA DE ANDALUCÍA	MOLECULAR TOOLS. JUNTA DE ANDALUCÍA	OPTICAL MICROSCOPE. GENERALITAT DE CATALUNYA	ELECTRONIC MICROSCOPE. GENERALITAT DE CATALUN	MOLECULAR TOOLS. GENERALITAT DE CATALUNYA	OPTICAL MICROSCOPE. BASQUE COUNTRY	ELECTRONIC MICROSCOPE. BASQUE COUNTRY	MOLECULAR TOOLS. BASQUE COUNTRY
Amphidoma languida Tillmann et al., 2012				yes	SEM		yes					
Azadinium poporum Tillmann & Elbrächter, 2011			microarray									
Azadinium spinosum Elbrächter & Tillmann, 2009												
Coolia tropicalis M.A.Faust, 1995												
Dinophysis acuminata Claparède & Lachmann, 1859	yes	SEM	microarray	yes			yes			yes		
Dinophysis acuta Ehrenberg, 1839	yes	SEM	microarray	yes			yes			yes		
Dinophysis caudata Saville-Kent, 1881	yes	SEM		yes			yes			yes		
Dinophysis fortii Pavillard, 1923	yes		microarray	yes			yes			yes		
Dinophysis infundibula J.Schiller, 1928	yes						yes					
Dinophysis miles Cleve, 1900												
Dinophysis norvegica Claparède & Lachmann, 1859												
Dinophysis ovum (F.Schütt) T.H.Abé	yes						yes					
Dinophysis sacculus Stein, 1883	yes						yes					
Dinophysis tripos Gourret, 1883	yes	SEM		yes			yes			yes		
Gonyaulax spinifera (Claparède & Lachmann) Diesing, 1866	yes			yes			yes			yes		
Lingulodinium polyedrum (F.Stein) J.D.Dodge, 1989 †	yes	SEM	microarray	yes			yes			yes		
Ostreopsis ovata Fukuyo, 1981				yes			yes		qPCR			
Ostreopsis siamensis Schmidt, 1901	yes			yes		qPCR	yes			yes	SEM	yes
Phalacroma mitra F.Schütt, 1895	yes			yes			yes			yes		
Phalacroma rotundatum (Claparéde & Lachmann) Kofoid & Michener, 1911	yes	SEM	microarray	yes			yes			yes		
Prorocentrum lima (Ehrenberg) F.Stein, 1878	yes		microarray	yes			yes			yes	SEM	yes
Prorocentrum maculosum M.A.Faust, 1993				yes								
Prorocentrum rhathymum Loeblich, Sherley & Schmidt, 1979	yes		microarray	yes			yes			yes	SEM	yes
Protoceratium reticulatum (Claparède & Lachmann) Butschli, 1885	yes	SEM		yes			yes			yes		

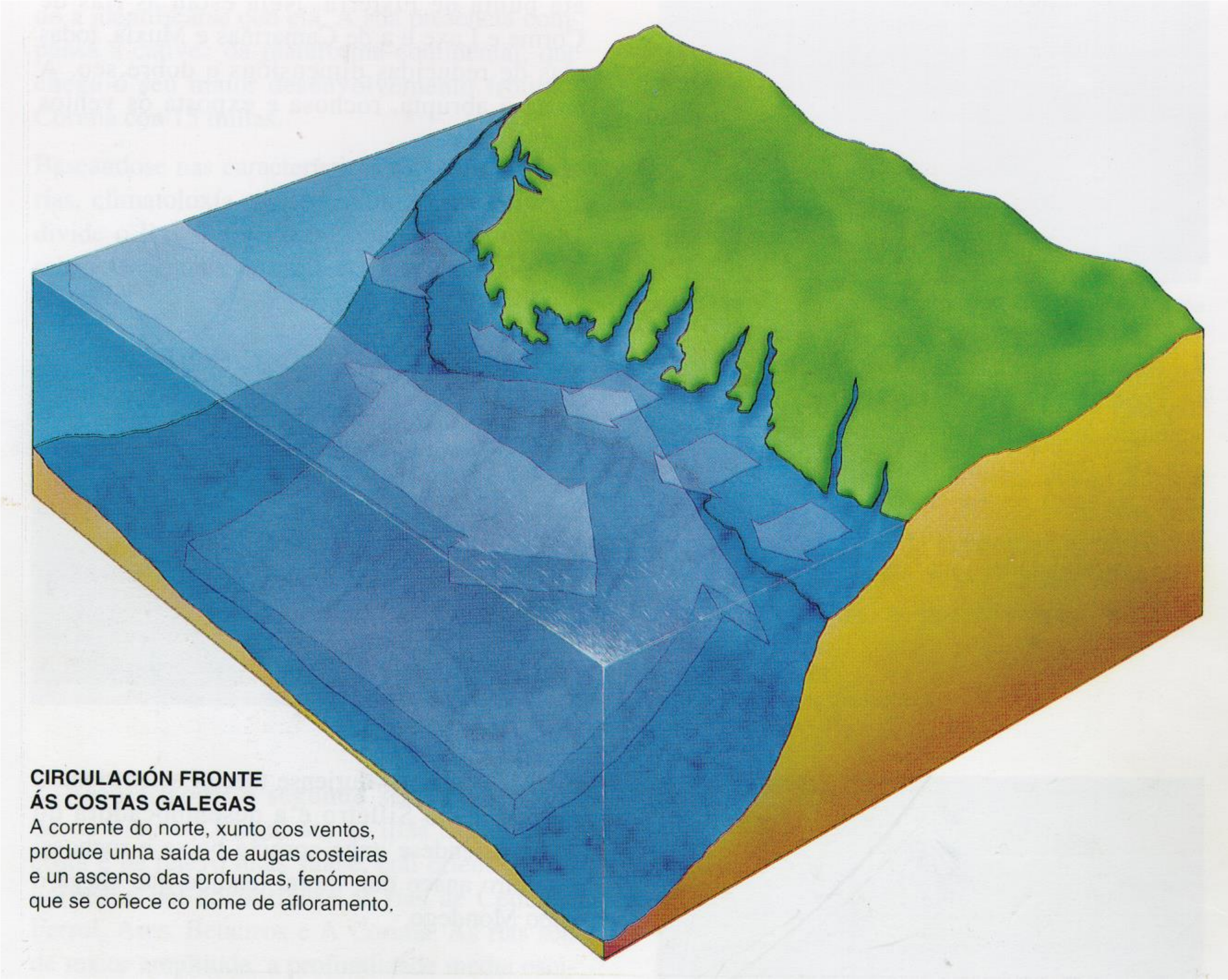


Ciguatera	ELECTRONIC MICROSCOPE. CANARY ISLANI	MOLECULAR TOOLS. CANARY ISLANDS
Gambierdiscus australes M.Chinian & M.A.Faust, 1999	SEM	yes
Gambierdiscus excentricus S.Fraga, 2011	SEM	yes
Gambierdiscus silvae Fraga S. & F. Rodríguez, 2014	SEM	yes

Marine cyanotoxins Galicia

Nodularia spumigena Mertens ex Bornet & Flahault, 1886
Phormidium formosum (Bory de Saint-Vincent ex Gomont) Anagnostidis & Komárek, 1988

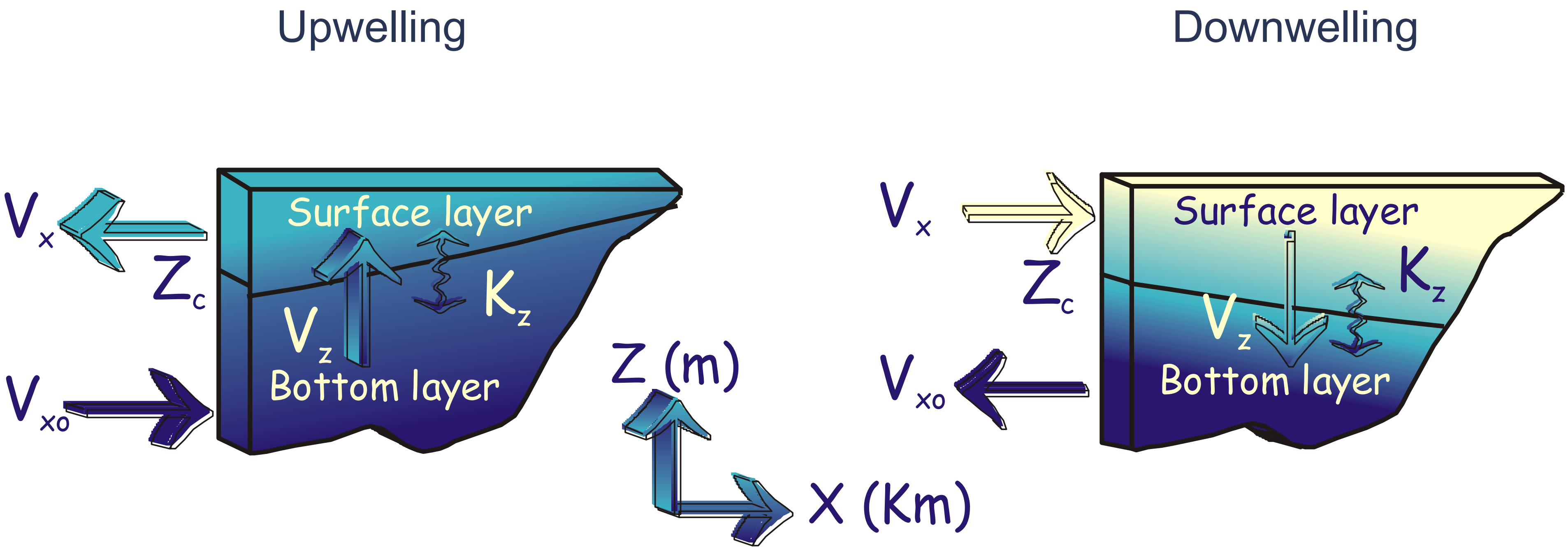
UPWELLING SYSTEM



CIRCULACIÓN FRONTE ÁS COSTAS GALEGAS

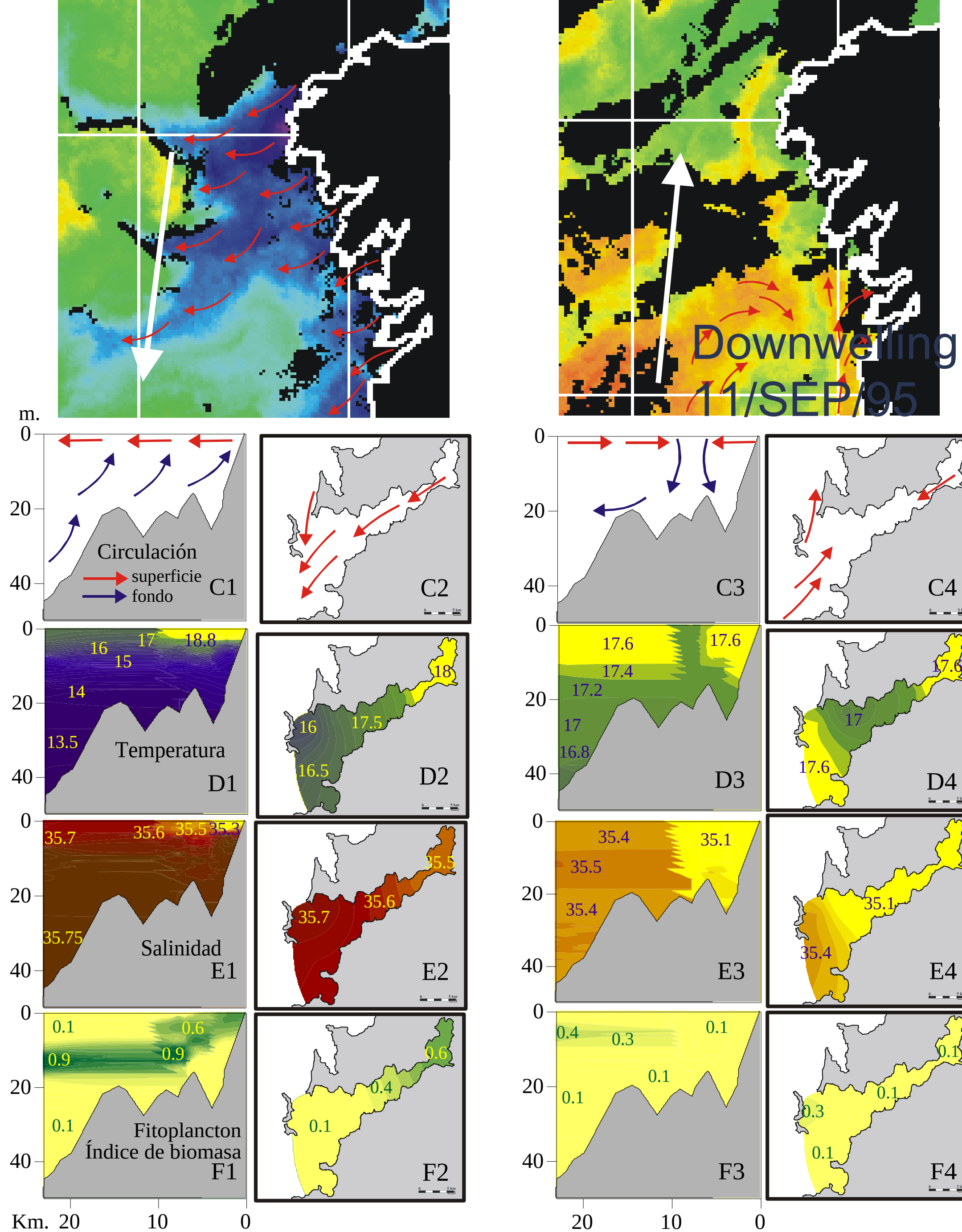
A corrente do norte, xunto cos ventos, produce unha saída de augas costeiras e un ascenso das profundas, fenómeno que se coñece co nome de afloramento.

UPWELLING SYSTEM

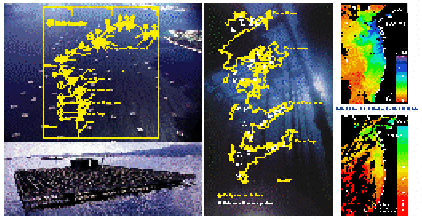


UPWELLING SYSTEM

Upwelling
26/AUG/95

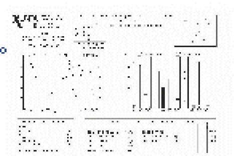


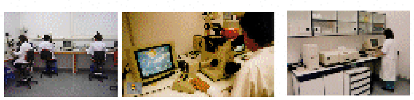
Condicións oceanográficas e microalgas tóxicas e/ou nocivas en Galicia



As variables oceanográficas: temperatura, salinidade, osíxeno, pH, fluorescencia e transmitancia, mídense en toda a profundidade da auga empregando sondas CTD.
A salinidade e a temperatura indican movementos ou estabilidade das augas. O pH e o osíxeno indican fotosíntese e polo tanto abundancia de fitoplancto. A fluorescencia e a transmitancia indican biomasa fitoplanctónica e abundancia de todo tipo de partículas en suspensión.

As análises de sales nutrientes e de carbono orgánico disolto indican alimento dispoñible para o fitoplancto e procesos de rexeneración. Os principais pigmentos fotosintéticos (clorofilas a, b e c) analízanse nun espectrofluorímetro. Indican abundancia e diversidade de fitoplancto.

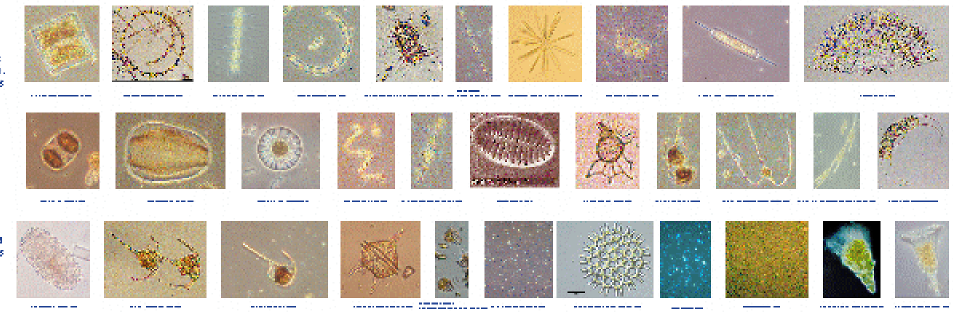




O microplancto identifícase e cóntase en microscopios ópticos invertidos; tanto as especies tóxicas ou potencialmente daniñas como as que non o son.

Floracións de microalgas

O fitoplancto das Rías Galegas inclúe un grupo variado de microorganismos que teñen en común seren levados polas masas de auga nas que viven. Os grupos máis comúns son as diatomeas (*Bacillariophyceae*) e os dinoflaxelados (*Dinophyceae*). No microplancto tamén aparecen outros flaxelados moi comúns como os cocolitofóridos, as raidofíceas, os silicoflaxelados; o bacterioplancto e o microzooplancto, representado polos ciliados nús, tintínidos, larvas e ovos de outros organismos.

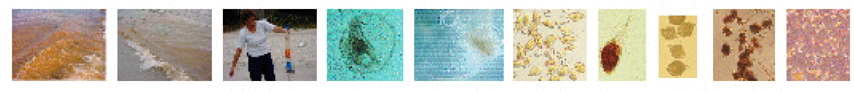


Inócuas

A maior parte do fitoplancto está formado por especies inofensivas. Constitúen o primeiro nivel da rede trófica do ecosistema das Rías sendo o principal alimento dos moluscos bivalvos (mexillón, ameixa, vieira....). A elevada productividade marisqueira das Rías, débese ás floracións de fitoplancto que medra en base ás sales nutrientes, aportadas fundamentalmente polo afloramento costeiro.

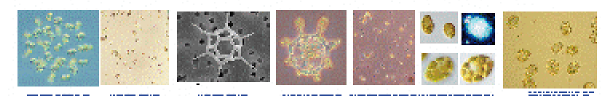
Mareas vermellas

En determinadas condicións oceanográficas, o fitoplancto pode proliferar masivamente ata producir coloración visible a simple vista na auga, debido ós pigmentos fotosintéticos que conteñen. Na maioría dos casos, a "purga de mar", é debida a organismos que non producen ningunha toxina, sen embargo poden ser nocivas pola alarma social e a súa incidencia no turismo.



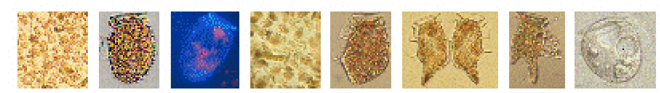
Ictiotóxicas

Os mecanismos de acción das especies que afectan ós cultivos de peixes son variados. *Heterosigma akashiwo* produce toxinas hemolíticas. *Phaeocystis pouchetii* produce mucosas que obstruen as branquias levando á asfixia. Os silicoflaxelados do xénero *Dictyocha* producen un dano físico nas vías respiratorias dos peixes facendoos susceptibles de infeccións. A elevada taxa de renovación da auga nas rías fai que non sexan frecuentes os problemas de ictiotoxicidade.



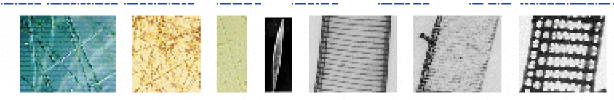
Lipofílicas (DSP)

As especies relacionadas coa presencia de toxinas diarreicas nos moluscos das Rías son, básicamente, as do xénero *Dinophysis*. Non é necesario que acaden concentracións moi elevadas para que supoñan un risco para a saúde pública. *Dinophysis acuminata* é a especie que causa a maior parte, e máis prolongadas, das prohibicións de extracción de mexillón en Galicia.



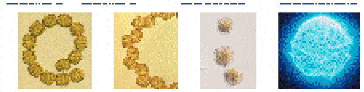
Amnésicas (ASP)

As especies relacionadas coa presencia das recentemente descritas (1987), toxinas amnésicas pertencen ó xénero *Pseudo-nitzschia*. A principal especie causante das prolongadas prohibicións de extracción de vieira en Galicia é *Pseudo-nitzschia australis*.



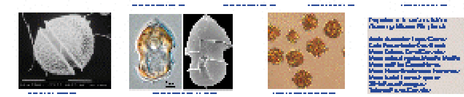
Paralizantes (PSP)

A acumulación de toxinas paralizantes nos moluscos das Rías Galegas é debida sobre todo a dúas especies: *Gymnodinium catenatum* e *Alexandrium minutum*. A pesar da súa gravidade nos últimos anos estes episodios foron moi escasos.



Novas toxinas (AZP, YTX, PTX)

Síndromes que anteriormente resultaban estraños ou descoñecidos, vanse asociando a especies de fitoplancto que existen habitualmente nas augas mariñas. A Unión Europea ven de publicar novas decisións neste senso.



MAREAS ROJAS

En determinadas condiciones oceanográficas, el fitoplancton puede proliferar masivamente hasta producir coloración visible a simple vista en el agua, debido a los pigmentos fotosintéticos que contienen. En la mayoría de los casos esta "purga del mar" es debida a organismos que no producen ninguna toxina pero pueden ser nocivas por la alarma social y su incidencia en el turismo.

Foto Iñaki Abella. Faro de Vigo

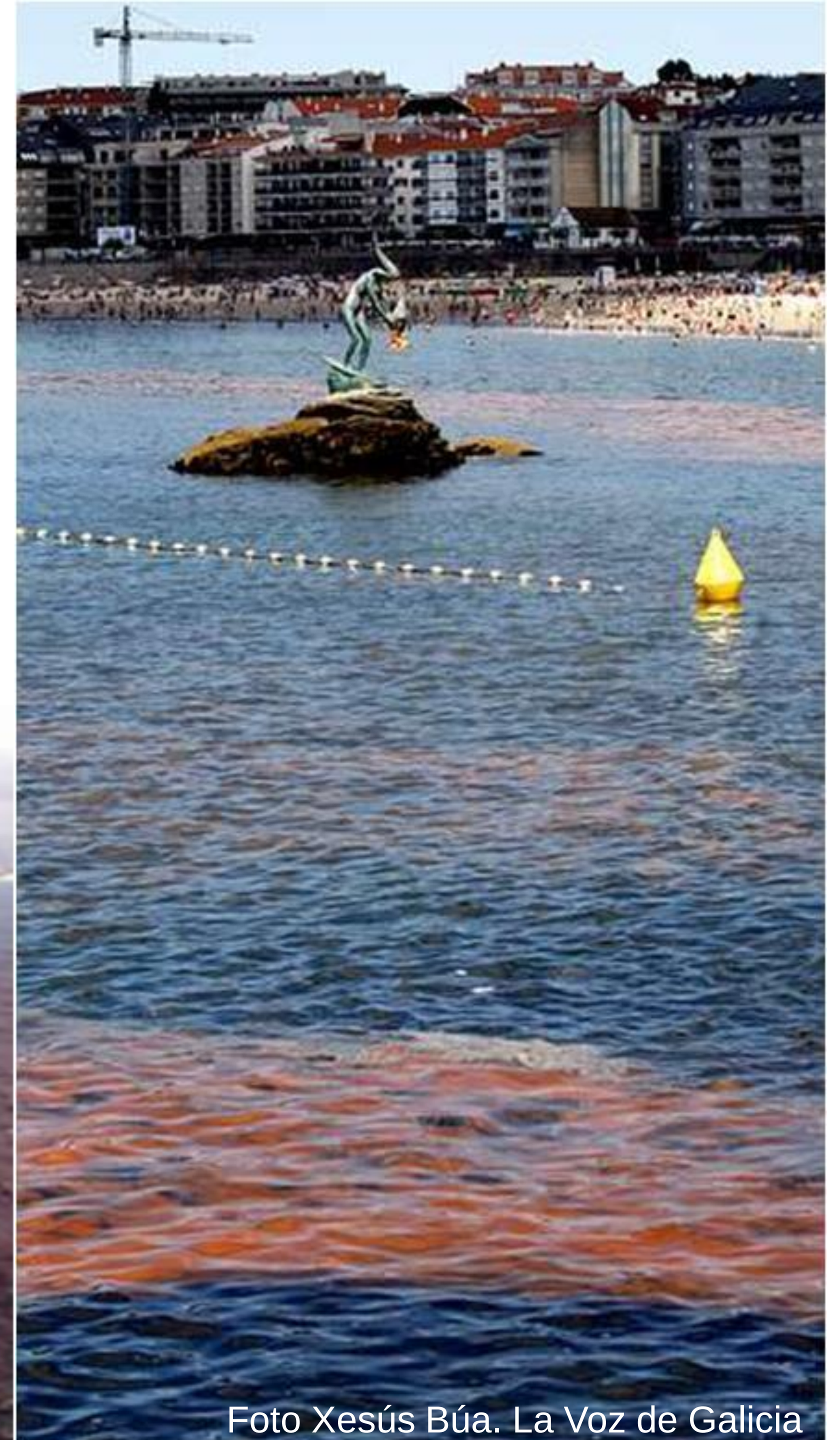


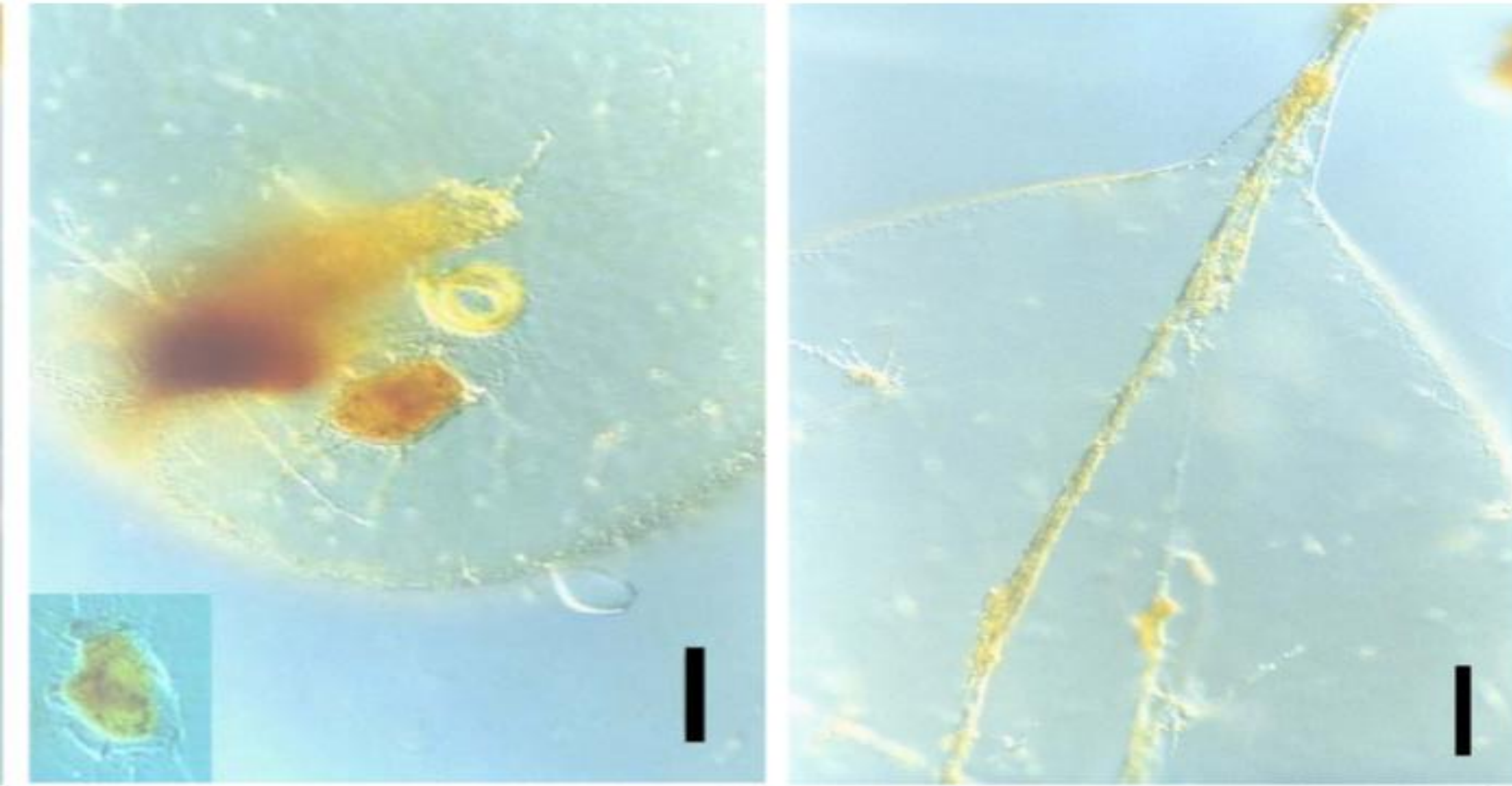
Foto Xesús Búa. La Voz de Galicia

Clase Noctilucaceae

Noctiluca scintillans (Mcartney) Kofoid & Swezy, 1921

Dinoflagelado?

Marea roja

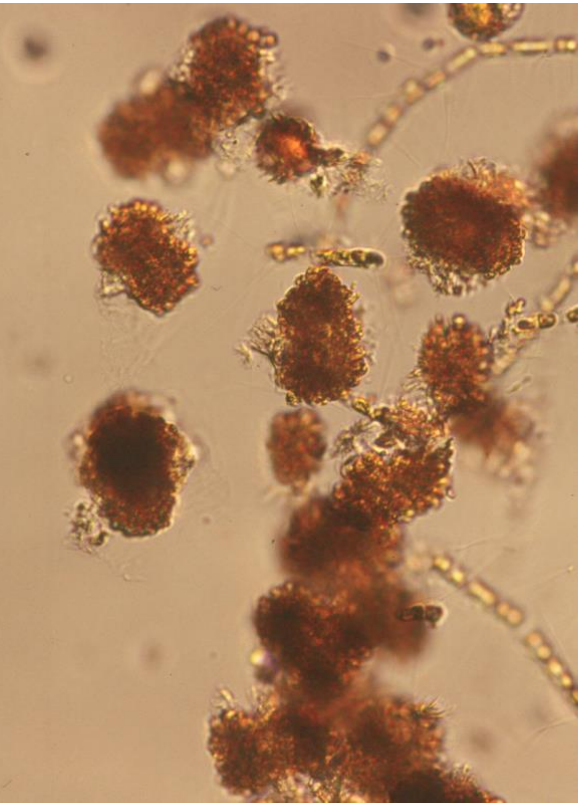


(B) (C)

Noctiluca scintillans may act as a vector of toxigenic microalgae

Laura Escalera[a,*], Yolanda Pazos[b], Ángeles Moroño[b], Beatriz Reguera[a]

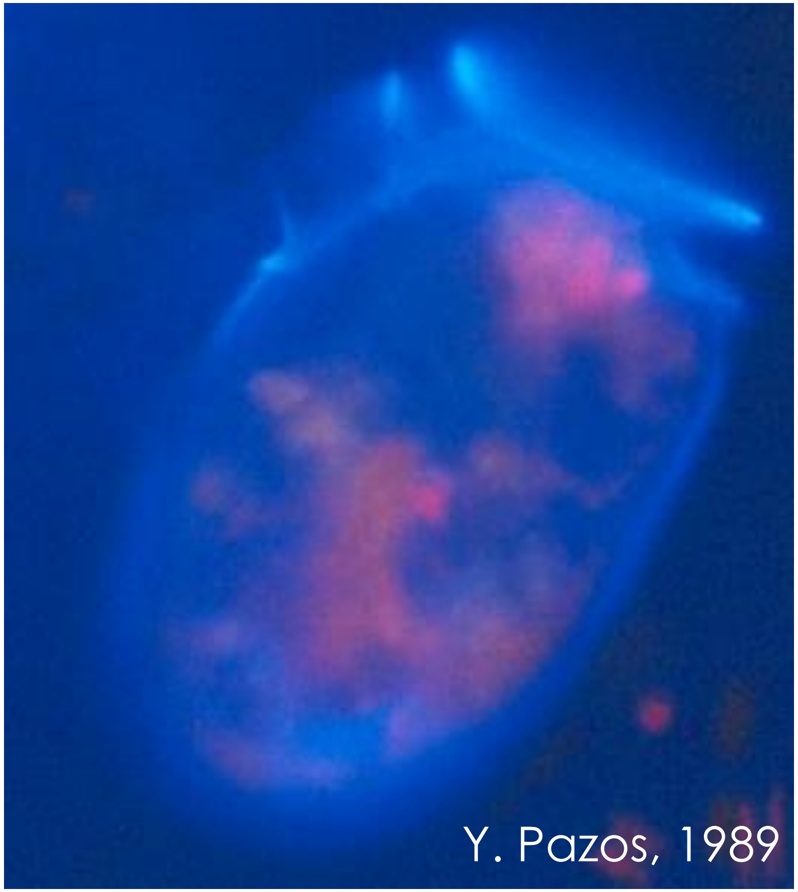
Harmful Algae, 2007



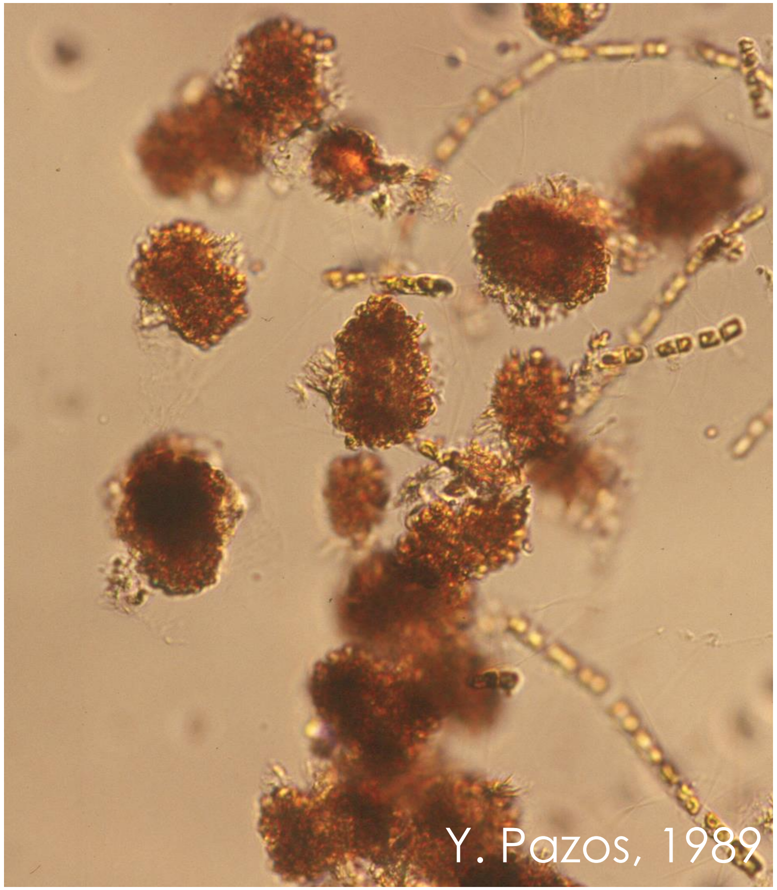
Mesodinium rubrum (Lohmann 1908) Jankowski 1976

Foto Iñaki Abella. Faro de Vigo

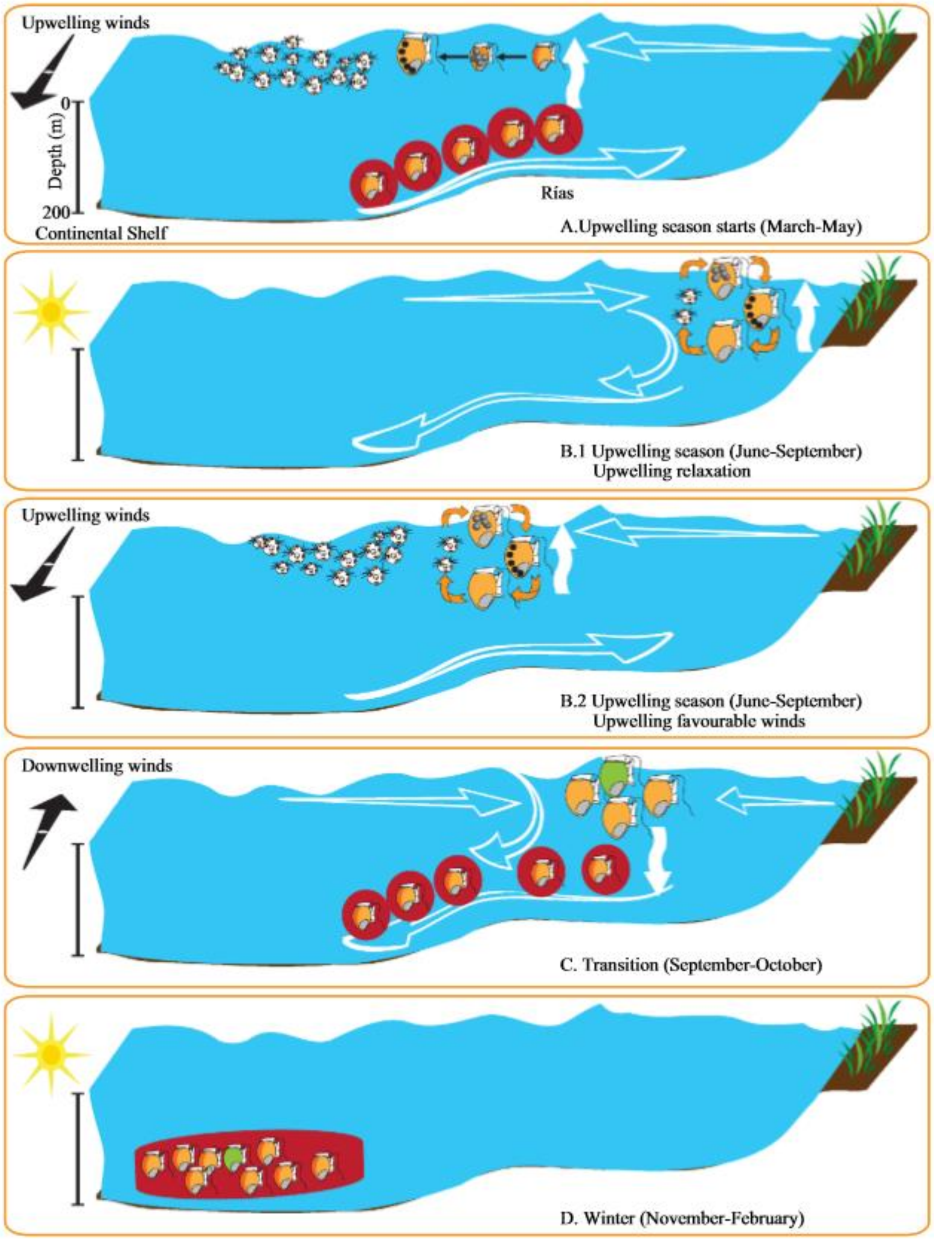
Ciliado



Dinophysis acuminata
Epifluorescence B2



Messodinium rubrum
Lugol



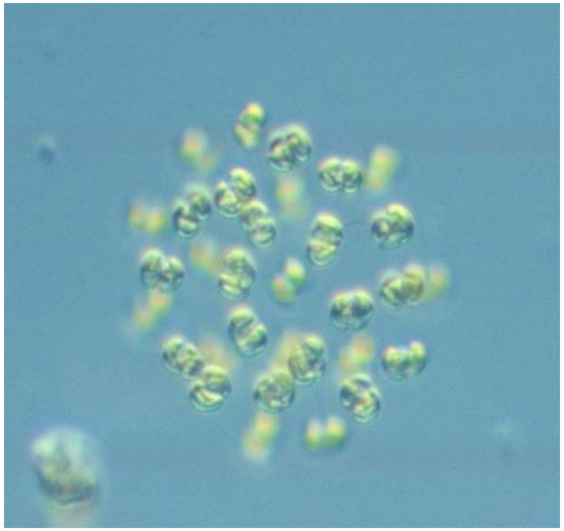
Velo, González-Gil , Pazos, Reguera
Deep Sea Resarch, 2014

youtube.com/watch?v=GZo5gMVYTS4

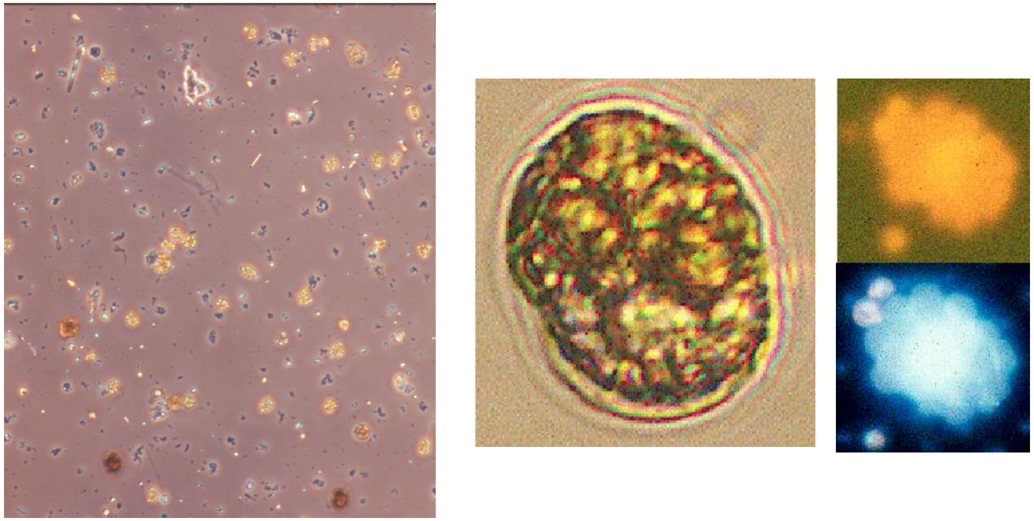
www.soychile.cl/Chiloe/Sociedad/2016/04/27/389854/Armada-coordino-el-retiro-de-machas-varadas-en-Cucao.aspx?fb_comment_id=1241079295921216_1241098522585960

Ictiotóxicas

Los mecanismos de acción de las especies que afectan a los cultivos de peces son variados. *Heterosigma akashiwo* produce toxinas hemoíticas, *Phaeocystis pouechetii* produce mucus que obtura las branquias llevándolos a la asfixia. Los silicoflagelados del género *Dictyocha* producen un daño físico en las vías respiratorias de los peces haciéndolos susceptibles de infecciones. La elevada tasa de renovación del agua en las rías hace que no sean frecuentes.



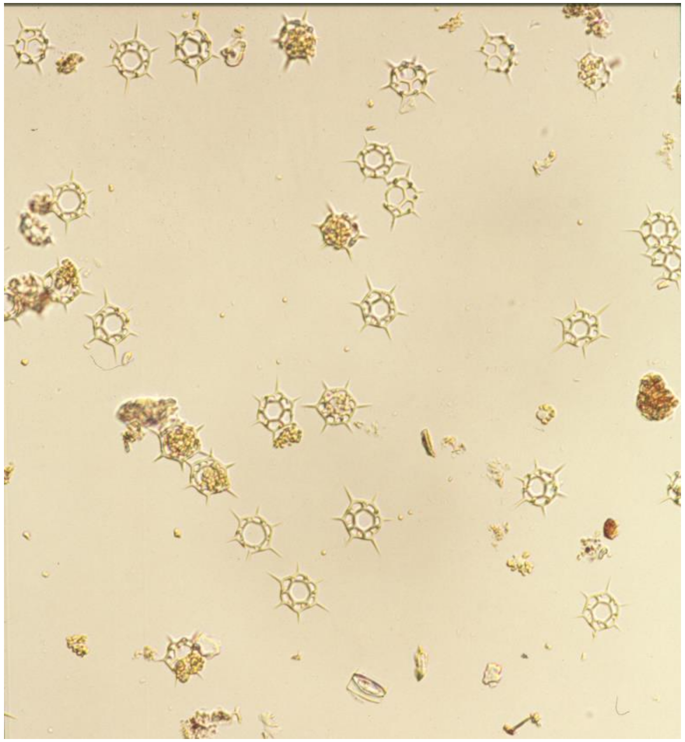
Phaeocystis pouechetii (Hariot) Lagerheim, 1893



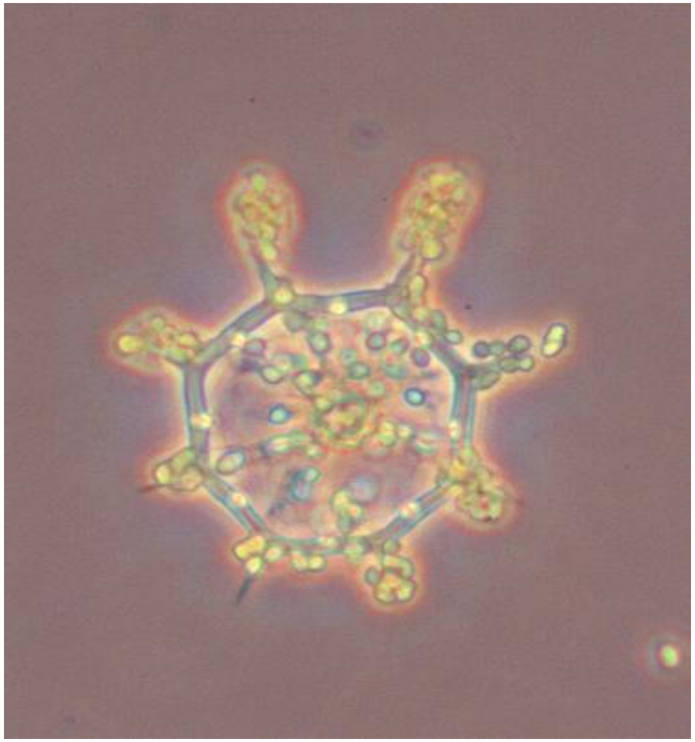
Heterosigma akashiwo (Hada) Hada, 1968 ex Sournia

flageladas

Ictiotóxicas



Dictyocha speculum Ehrenberg, 1839



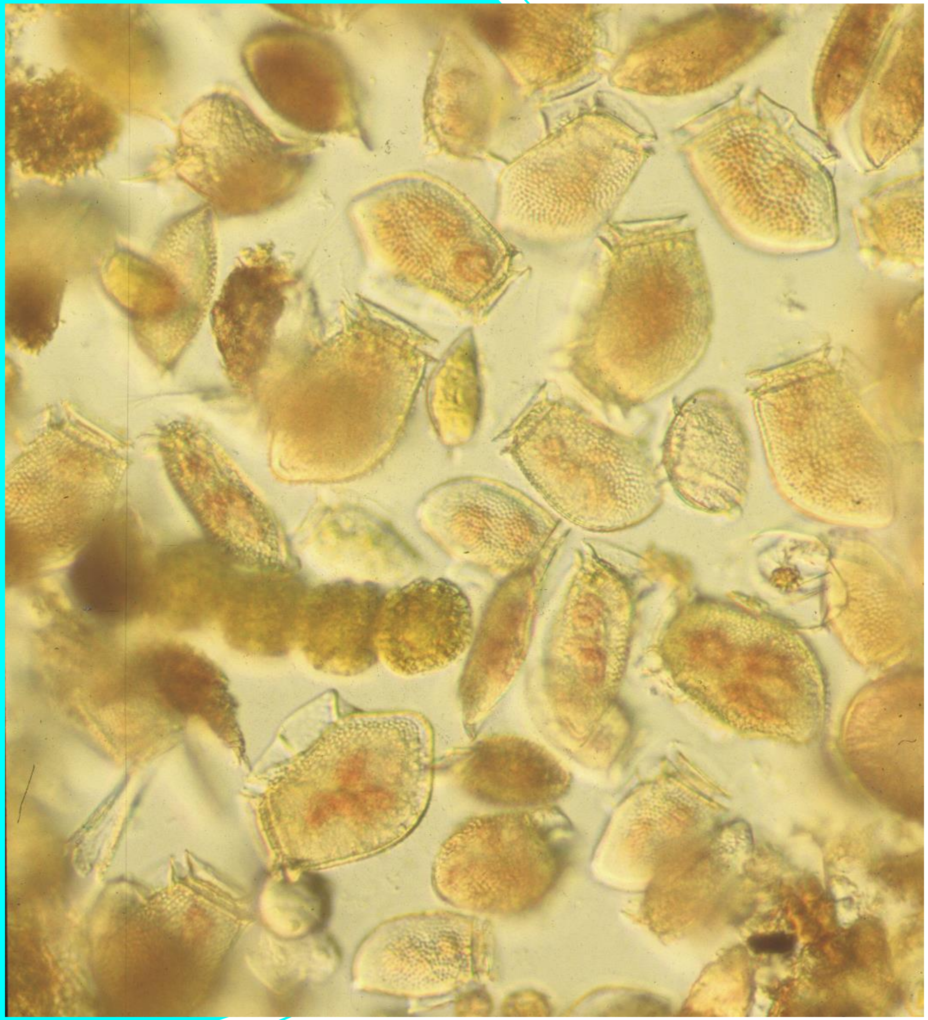
Octatis octonaria (Ehrenberg) Hovasse, 1946

Prego, Pazos, Varela 1997 Harmful Algae Blooms

silicoflageladas

Ictiotóxicas

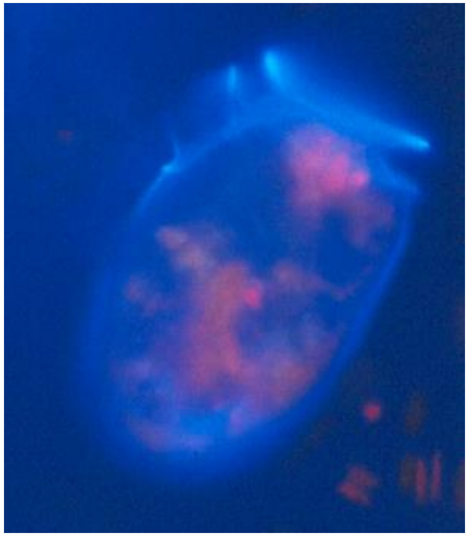
The famous mother-in-law soup



Phalacroma rotundatum (Claparède & Lachmann) Kofoid & Michener, 1911

Dinophysis tripos Gourret, 1883

Clase Dinophyceae



Dinophysis acuminata Claparède & Lachmann, 1859

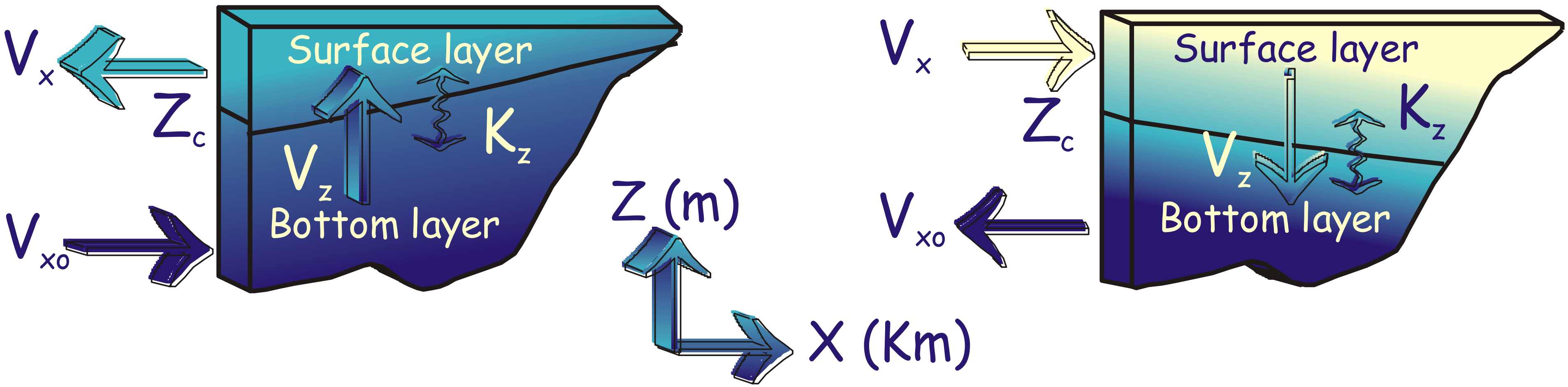
Dinophysis acuta Ehrenberg, 1839

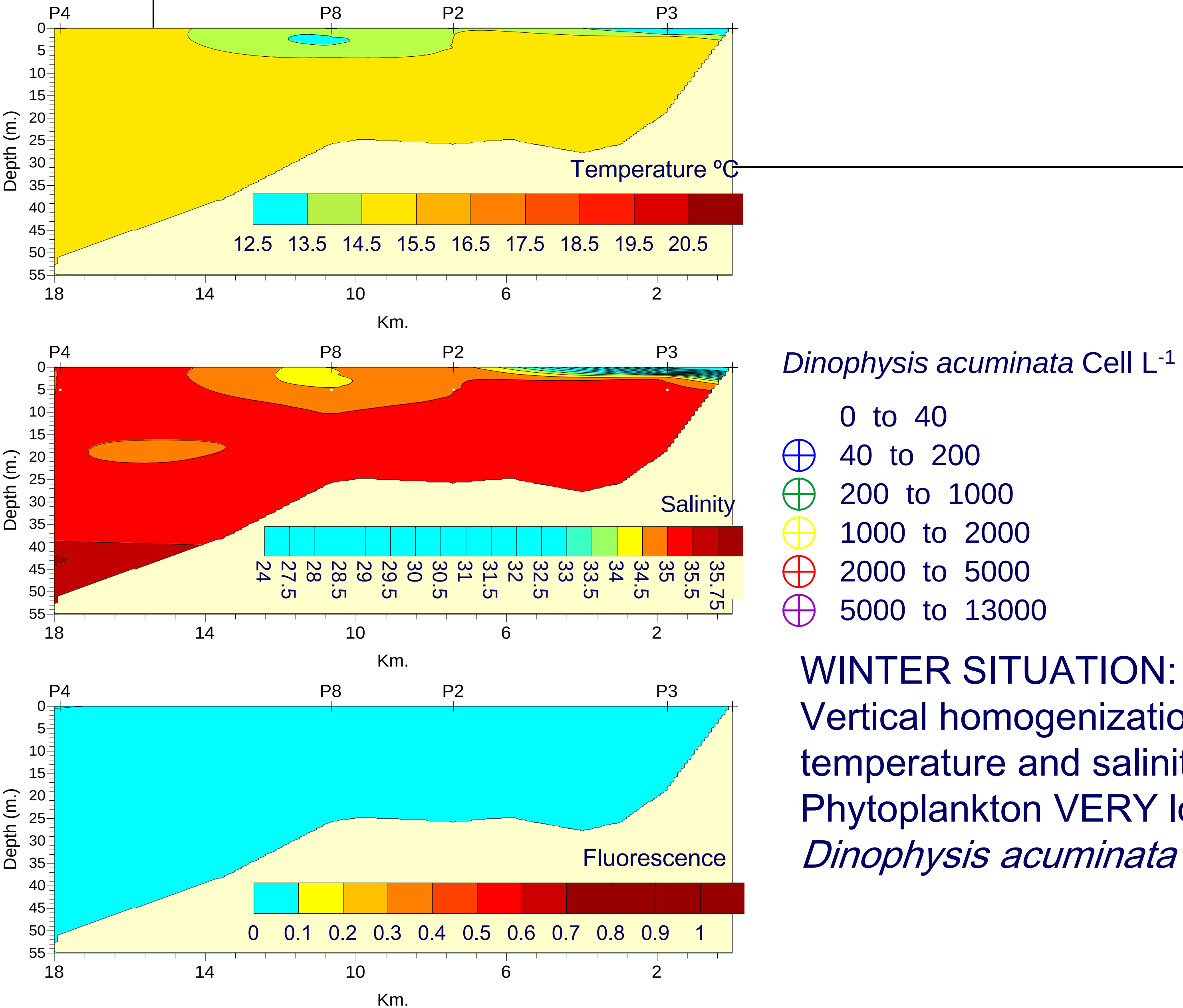
Dinophysis caudata Saville-Kent, 1881

Dinoflagelados **Lipofílicas (DSP)**

UPWELLING SYSTEM

Upwelling Downwelling



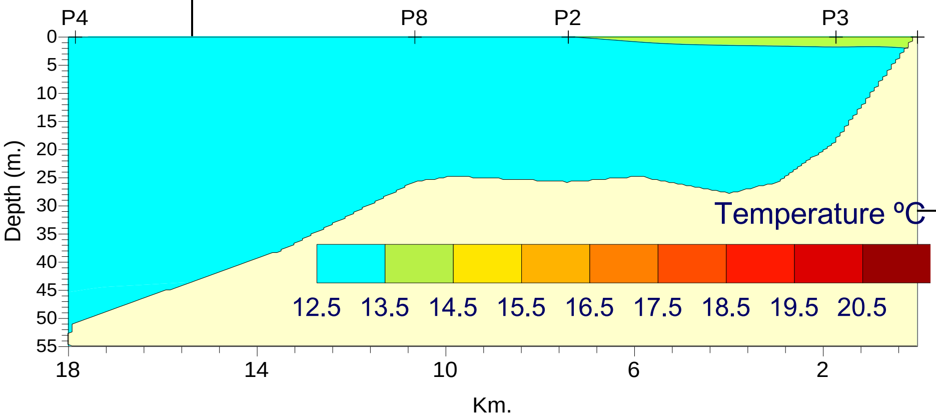


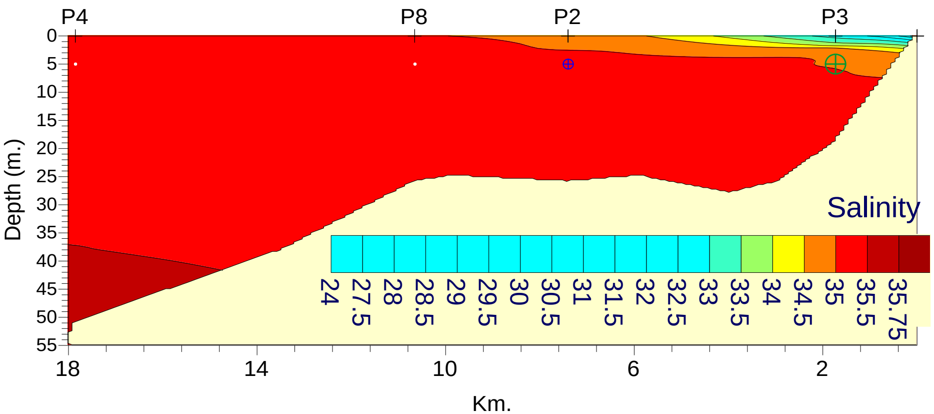
WINTER SITUATION:

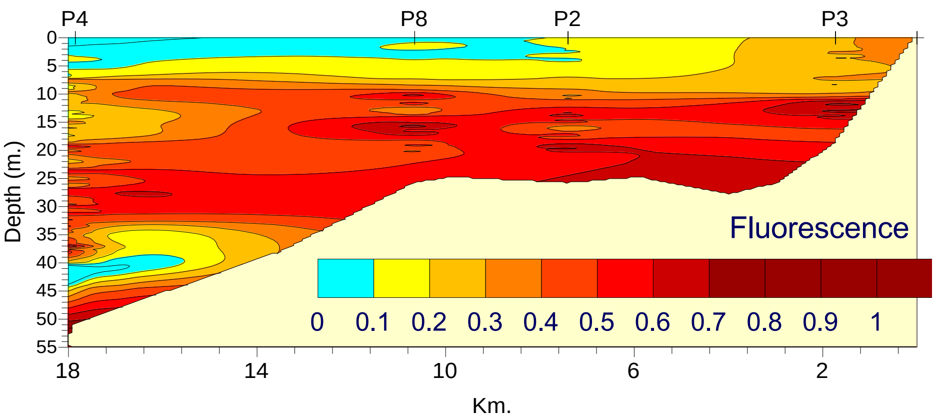
Vertical homogenization of temperature and salinity

Phytoplankton VERY low

Dinophysis acuminata N/D







Dinophysis acuminata Cell L^{-1}

- 0 to 40
- 40 to 200
- 200 to 1000
- 1000 to 2000
- 2000 to 5000
- 5000 to 13000

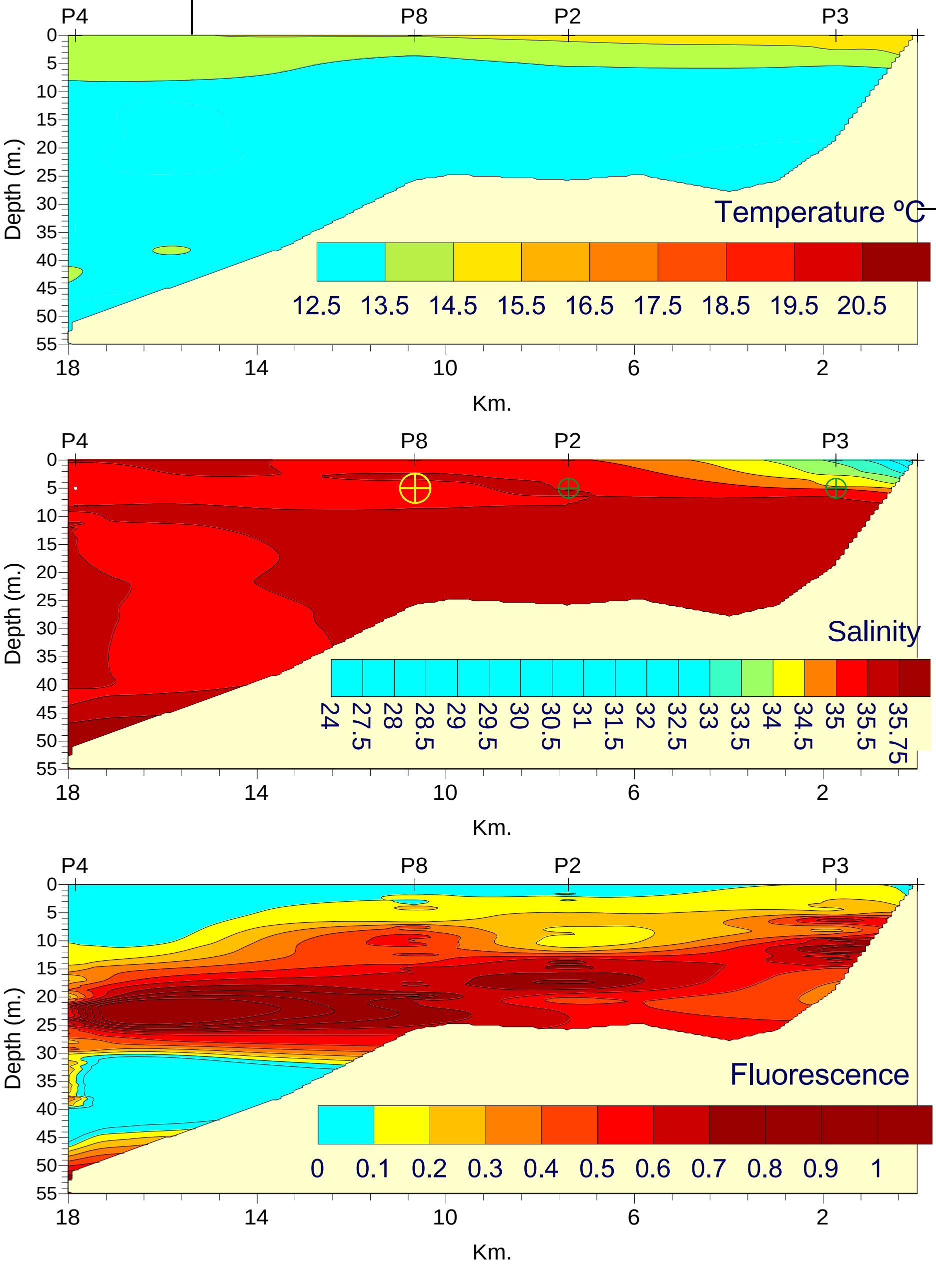
EARLY SPRING: Upwelling

Homogenization of temperature

First phytoplankton bloom

Halocline in the innermost station

Dinophysis acuminata maximum in the halocline spreads offshore



Dinophysis acuminata Cell L^{-1}

- 0 to 40
- 40 to 200
- 200 to 1000
- 1000 to 2000
- 2000 to 5000
- 5000 to 13000

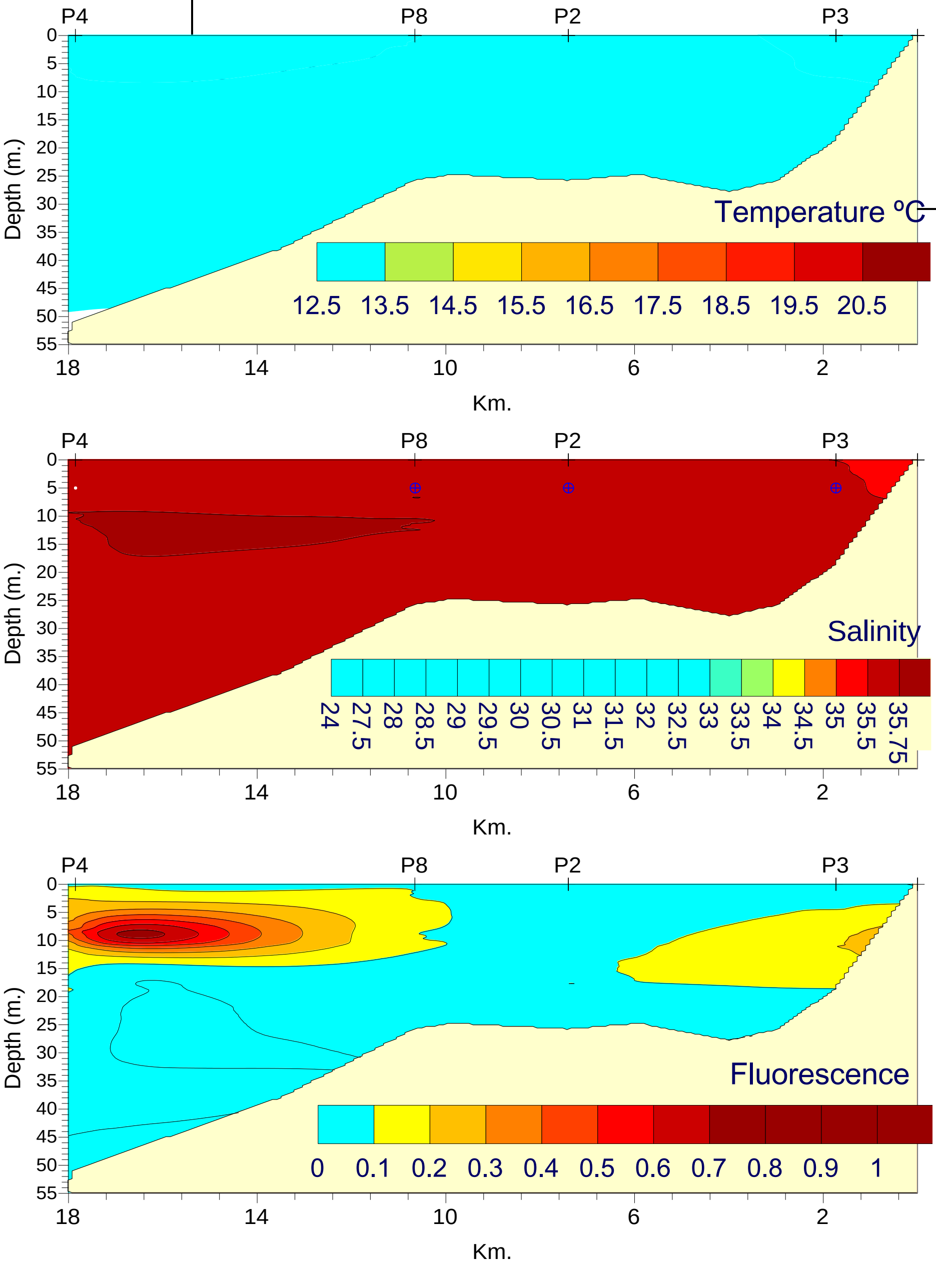
SPRING: Upwelling

Light thermocline

Halocline in the inner part

Phytoplankton subsuface bloom

In situ growth of *Dinophysis acuminata*



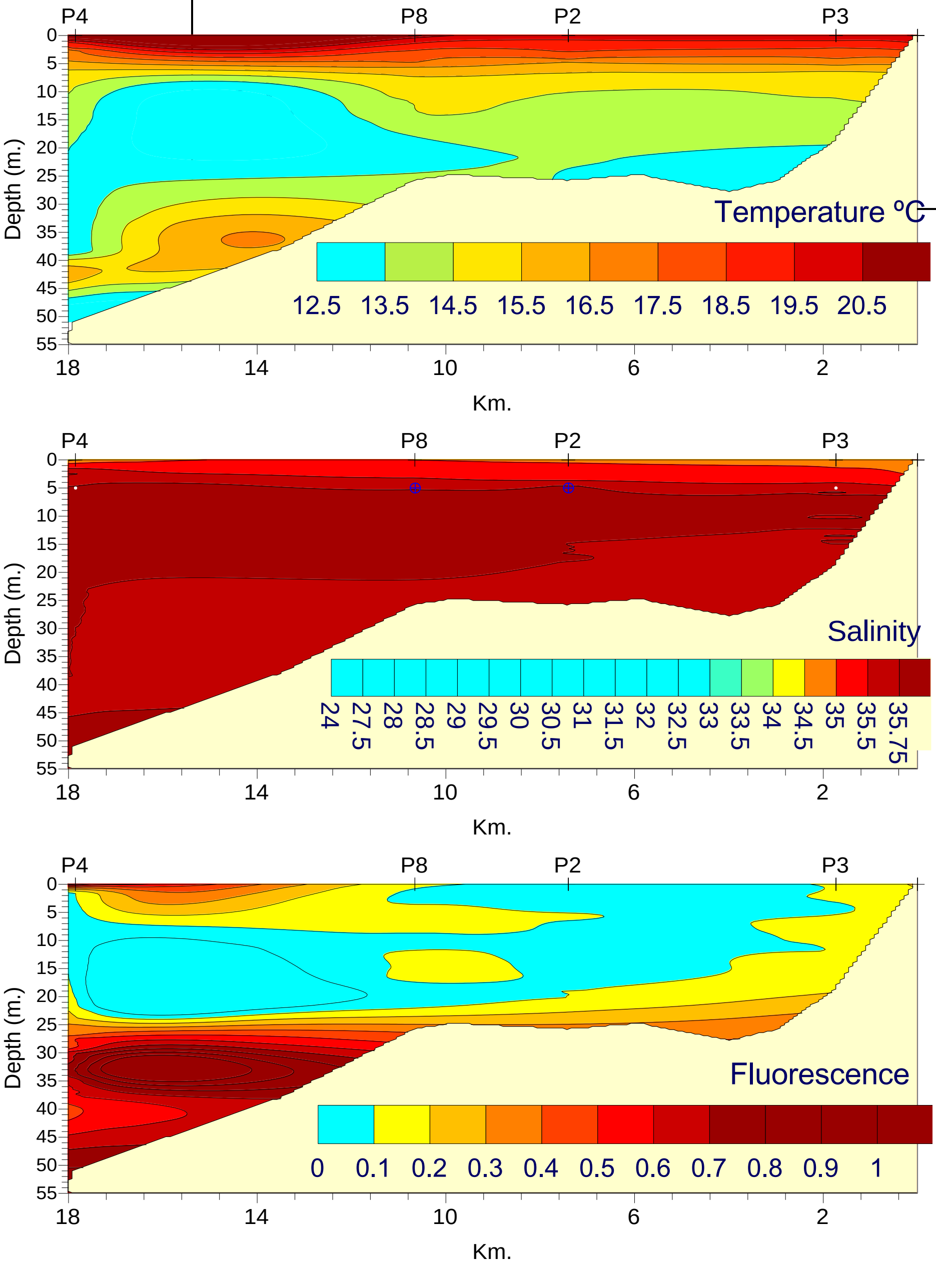
Dinophysis acuminata Cell L^{-1}

- 0 to 40
- 40 to 200
- 200 to 1000
- 1000 to 2000
- 2000 to 5000
- 5000 to 13000

SPRING: Strong Upwelling

Low levels of Dinophysis acuminata

remain in the upper layers



Dinophysis acuminata Cell L^{-1}

- 0 to 40
- 40 to 200
- 200 to 1000
- 1000 to 2000
- 2000 to 5000
- 5000 to 13000

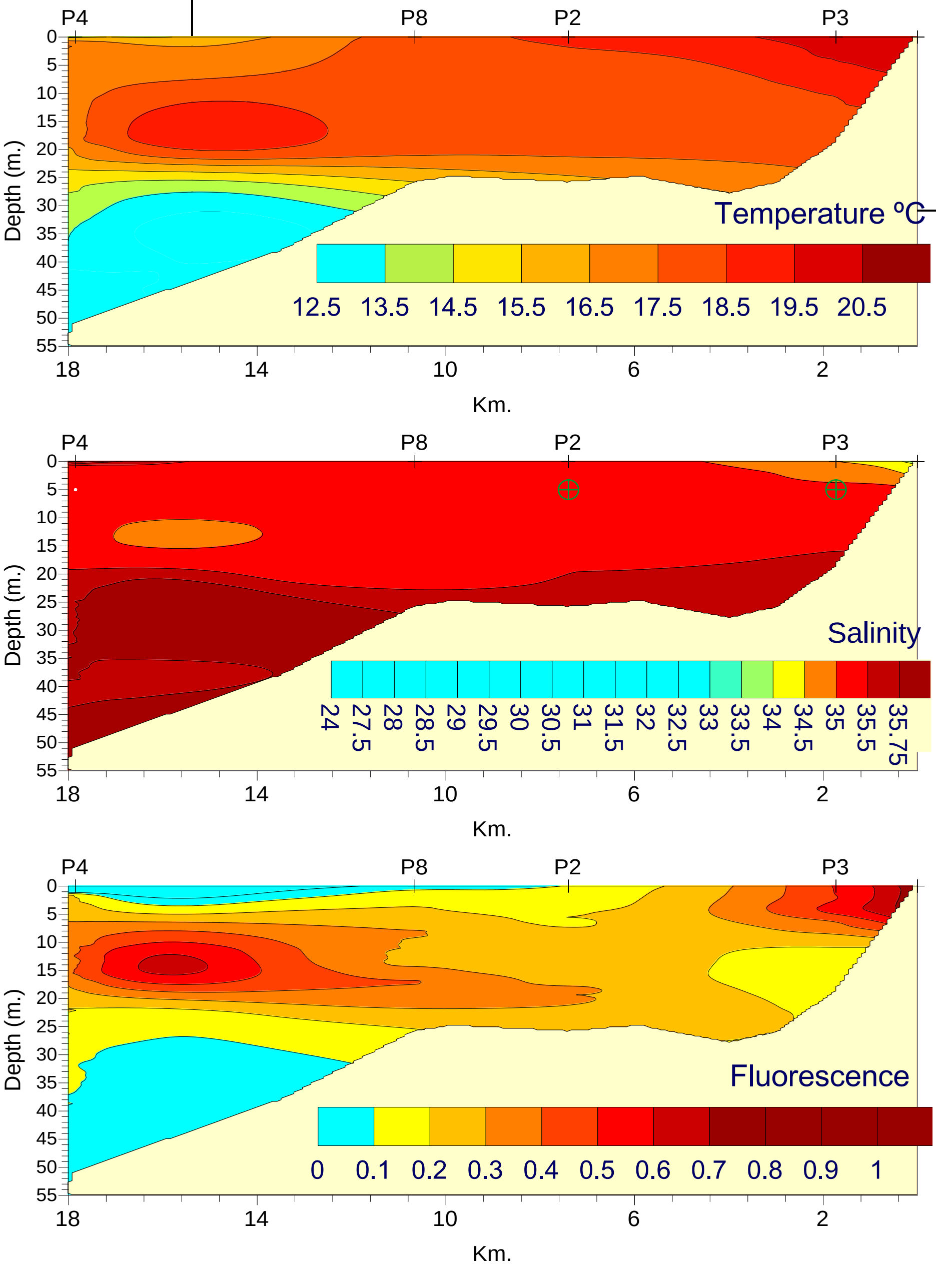
SUMMER: Upwelling relaxation

Strong thermocline

Intrusion of surface oceanic water

Phytoplankton suface patches

Dinophysis acuminata in situ growth



Dinophysis acuminata Cell L^{-1}

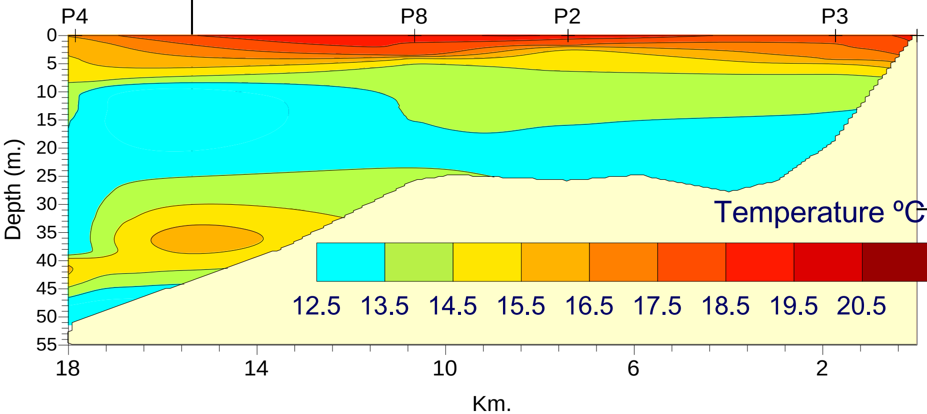
- 0 to 40
- 40 to 200
- 200 to 1000
- 1000 to 2000
- 2000 to 5000
- 5000 to 13000

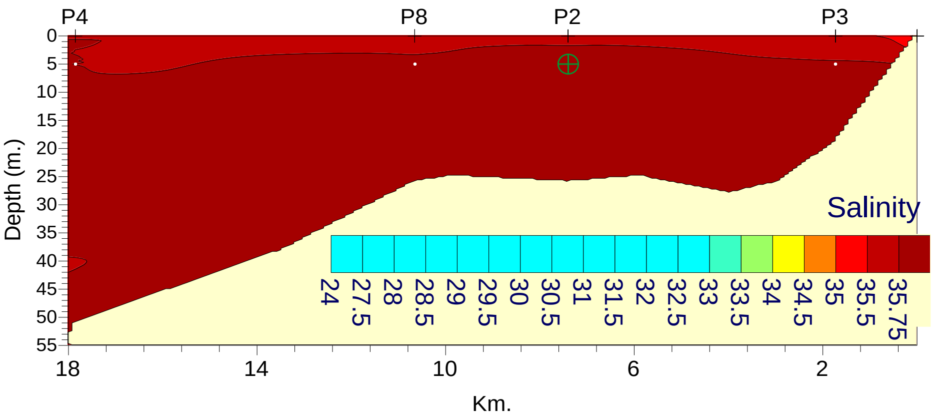
SUMMER: Stratification

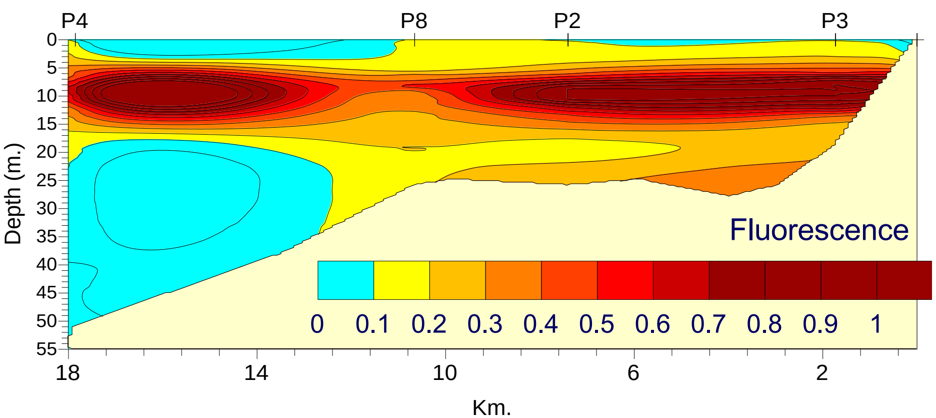
Deepening of the thermocline

Phytoplankton patches

Dinophysis acuminata growing

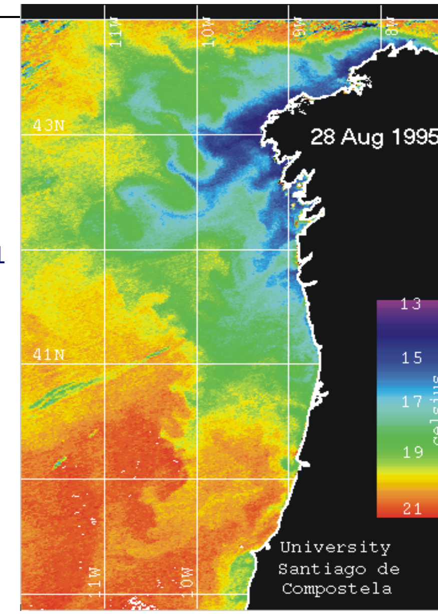






Dinophysis acuminata Cell L^{-1}

0 to 40
40 to 200
200 to 1000
1000 to 2000
2000 to 5000
5000 to 13000

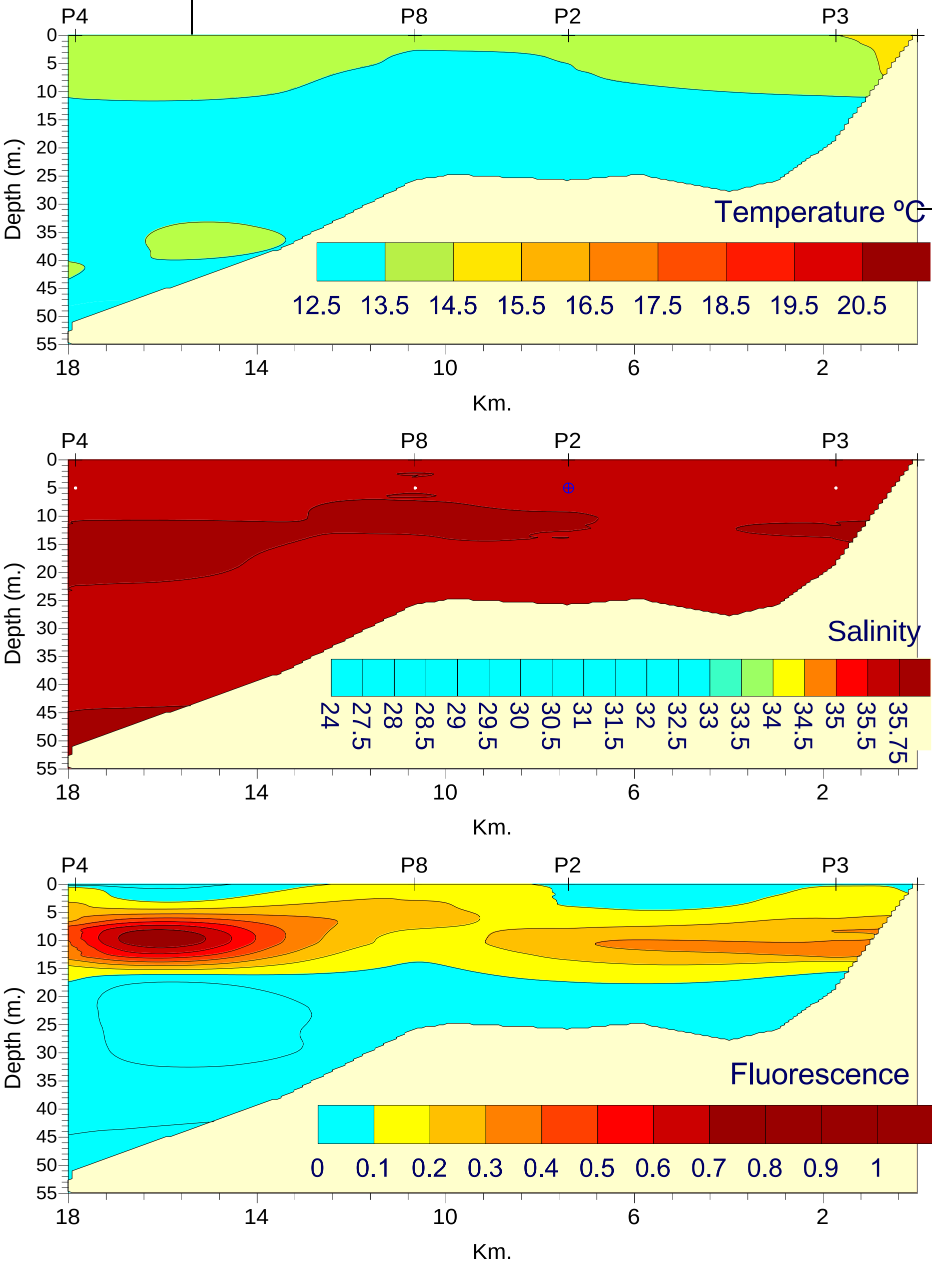


SUMMER: Upwelling

Strong compression of the thermocline

Phytoplankton subsurface bloom

Dinophysis acuminata persistence



Dinophysis acuminata Cell L^{-1}

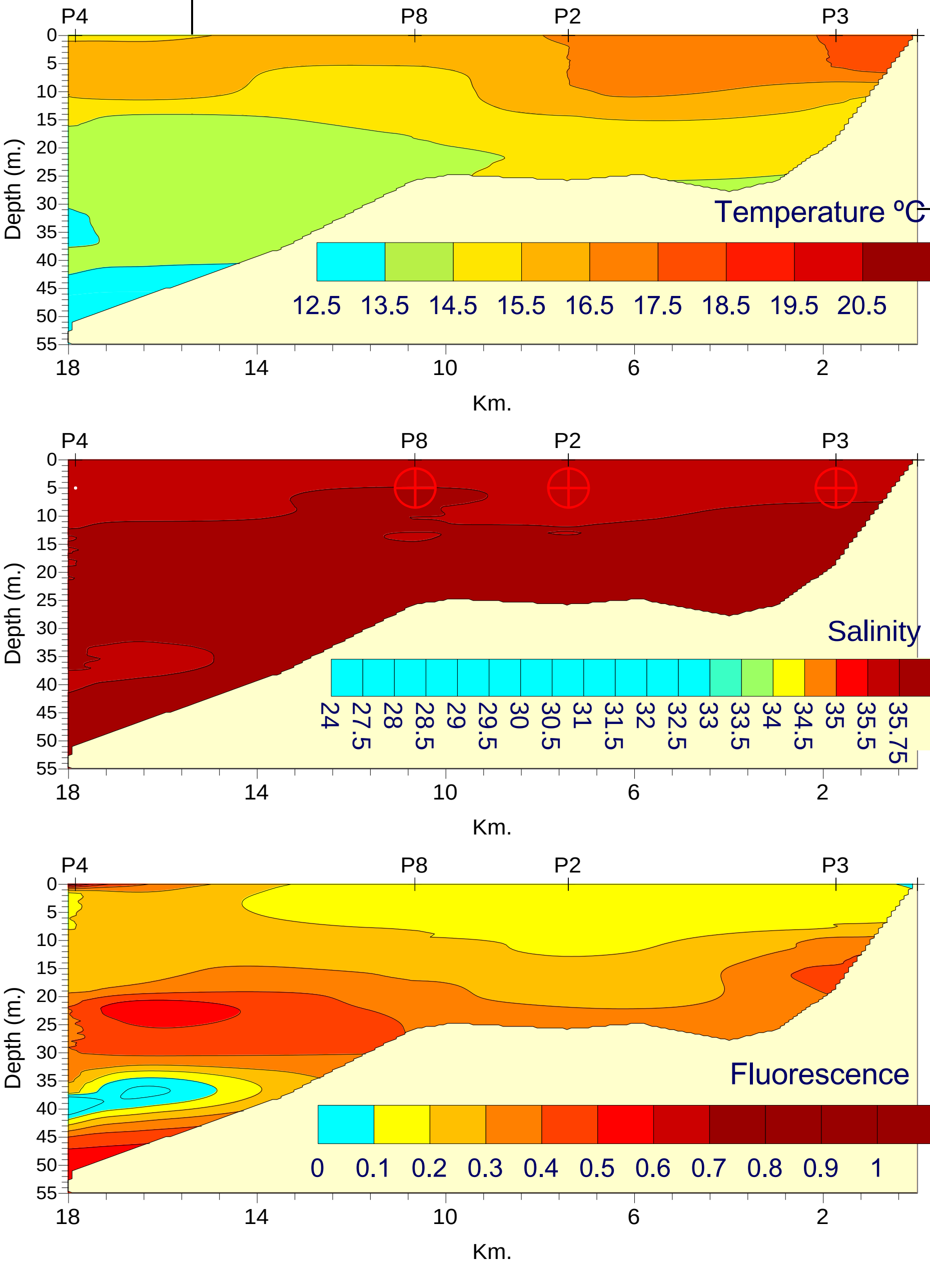
0 to 40
40 to 200
200 to 1000
1000 to 2000
2000 to 5000
5000 to 13000

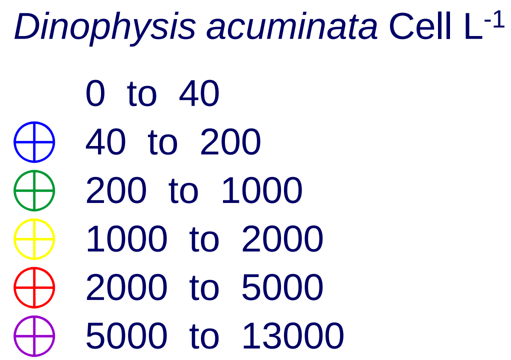
SUMMER: Moderate downwelling

Intrusion of oceanic surface water

Phytoplankton patches

Dinophysis acuminata presence

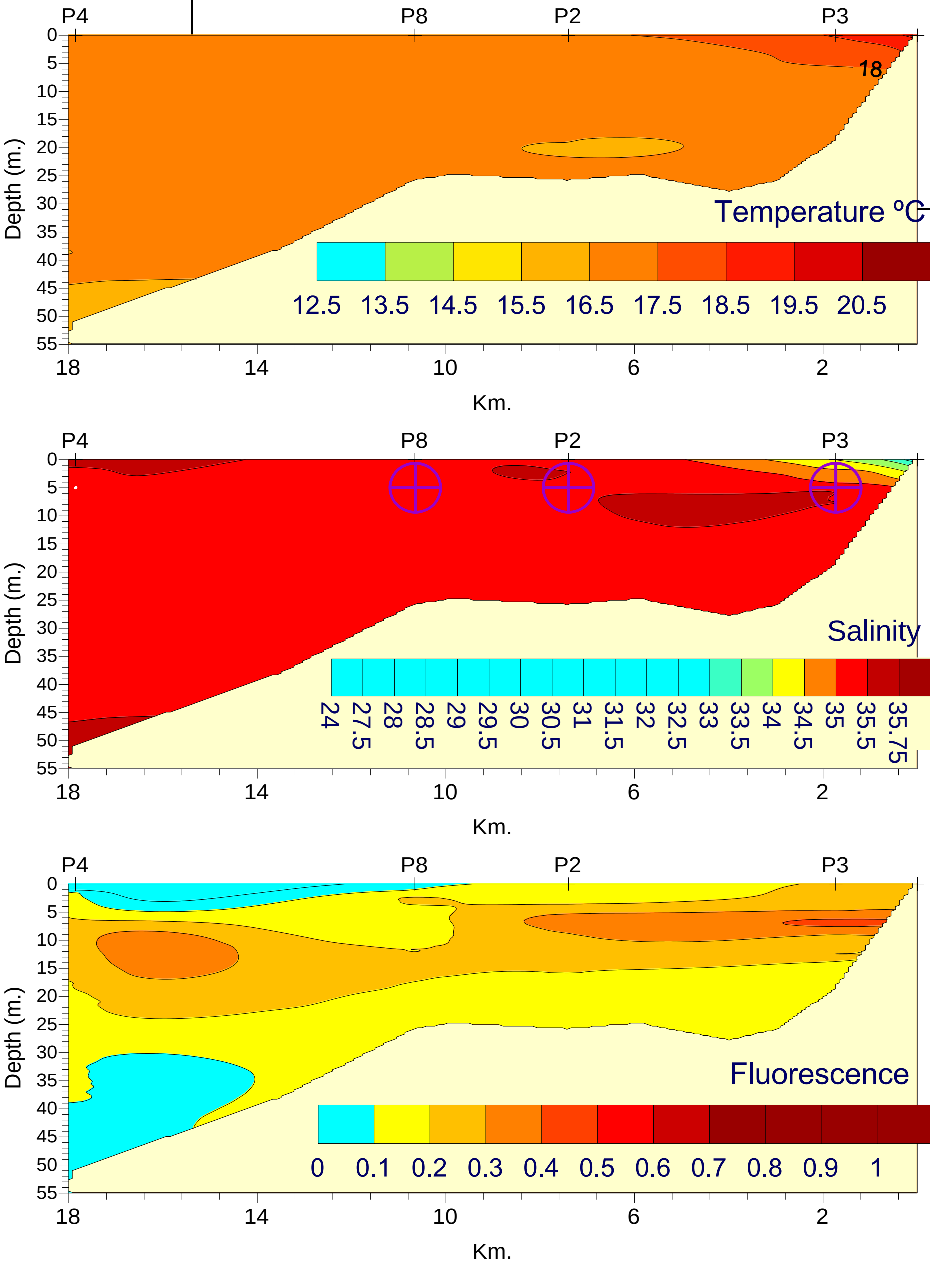




SUMMER: Moderate Downwelling

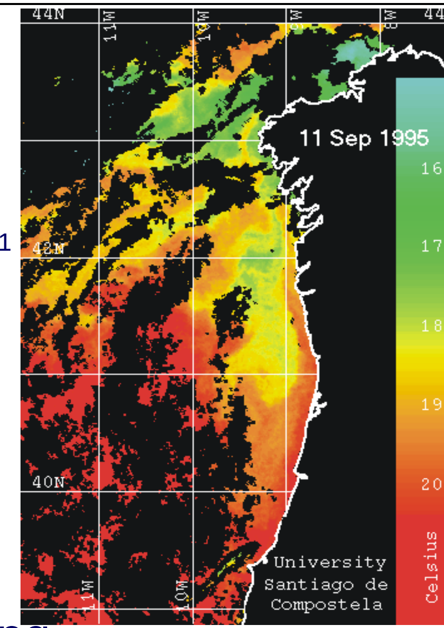
Intrusion of oceanic surface water

Dinophysis acuminata accumulation and growth



Dinophysis acuminata Cell L[-1]

- 0 to 40
- 40 to 200
- 200 to 1000
- 1000 to 2000
- 2000 to 5000
- 5000 to 13000

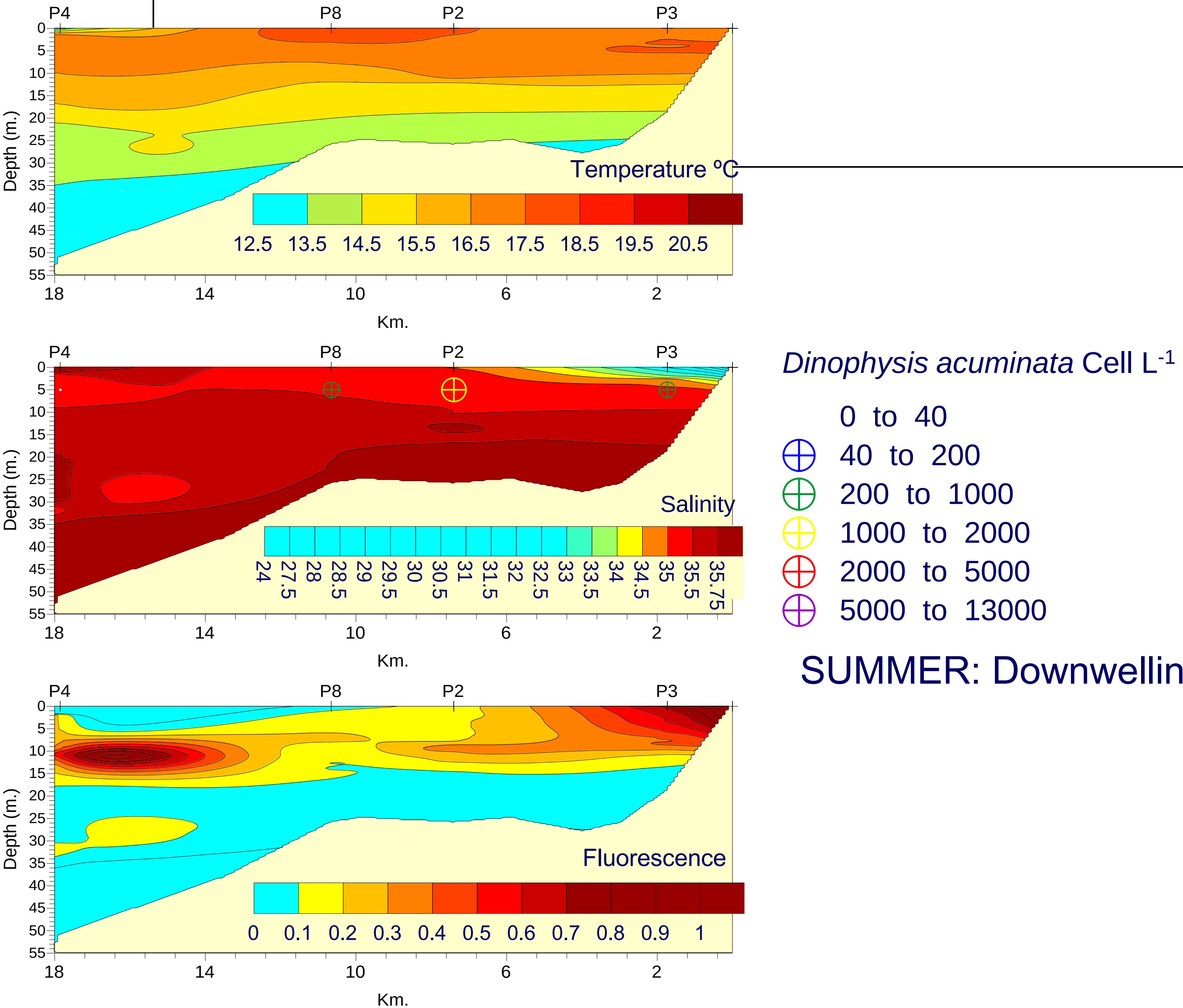


SUMMER: Downwelling

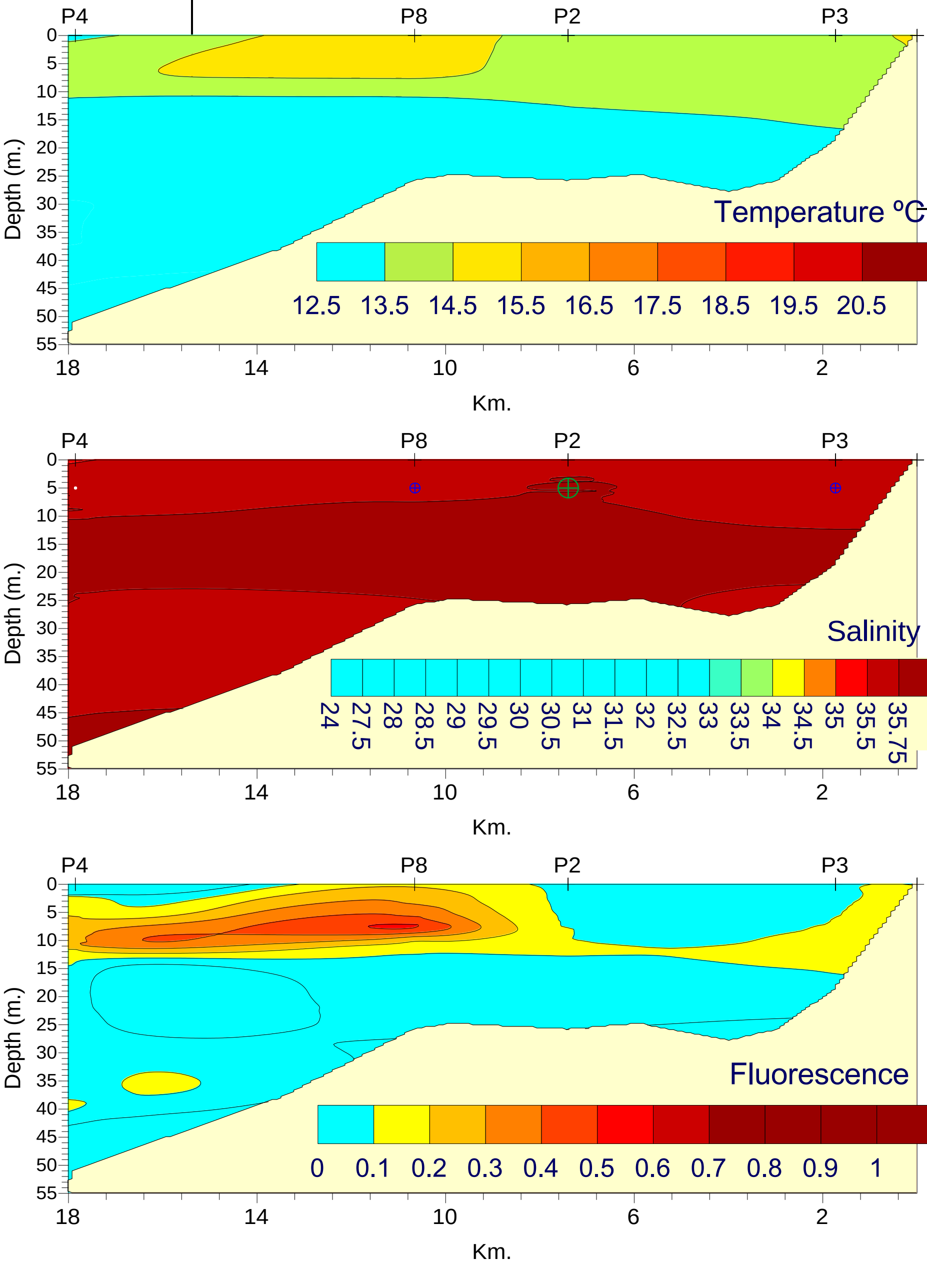
Intrusion of oceanic surface water

T= 17ºC S= 35.0

Dinophysis acuminata annual máximum

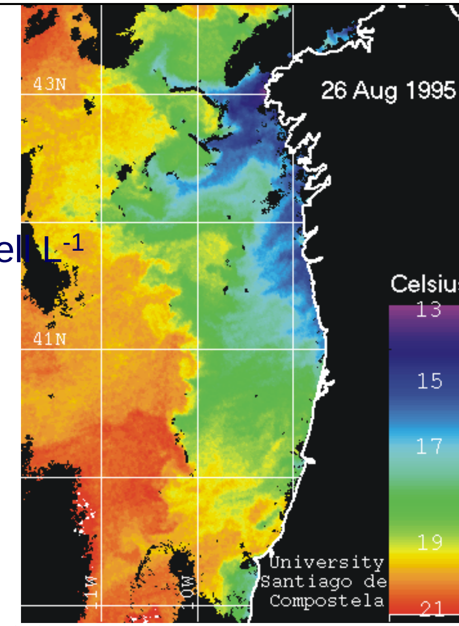


SUMMER: Downwelling relaxation



Dinophysis acuminata Cell L^{-1}

- 0 to 40
- ⊕ 40 to 200
- ⊕ 200 to 1000
- ⊕ 1000 to 2000
- ⊕ 2000 to 5000
- ⊕ 5000 to 13000

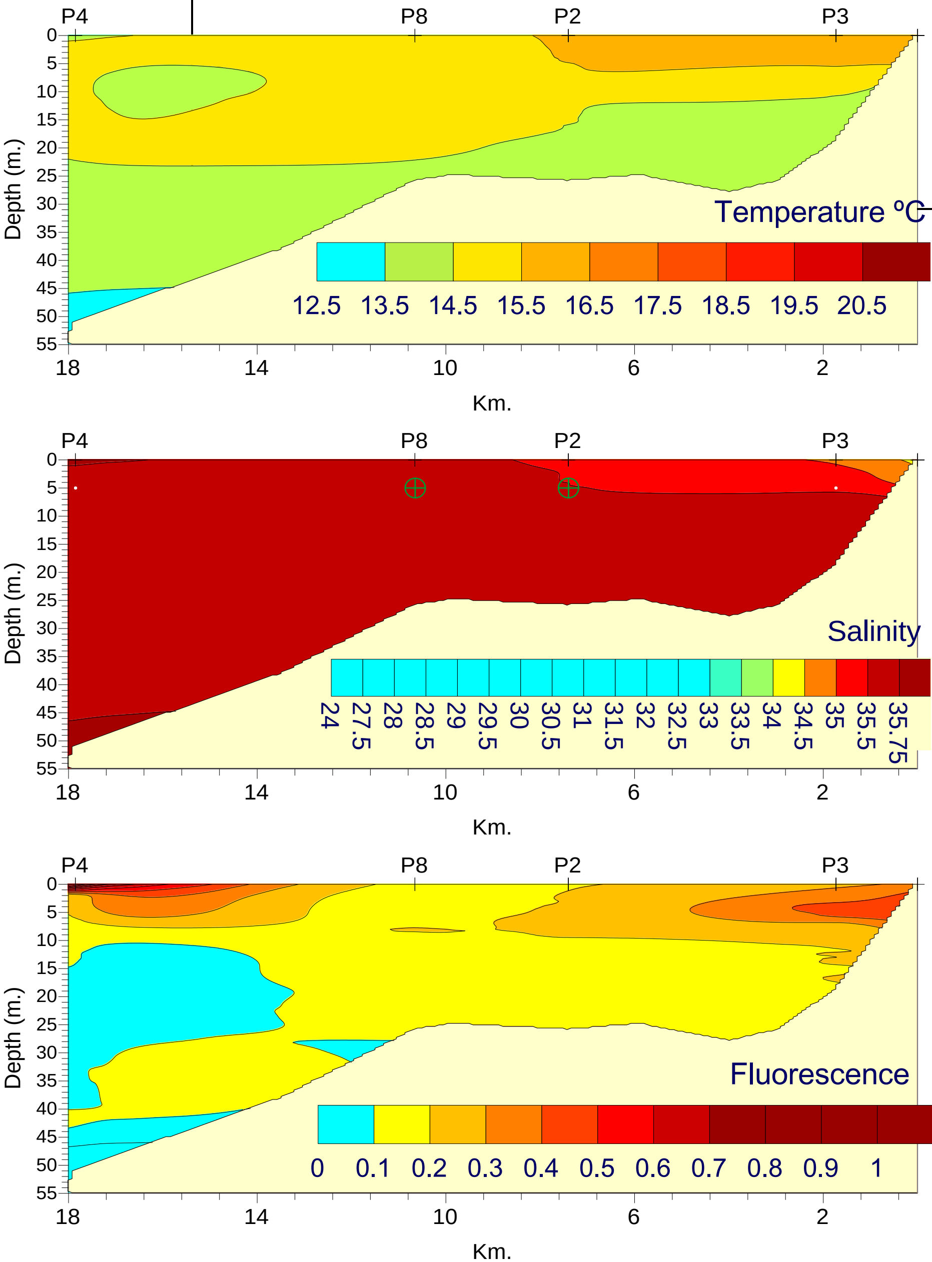


AUTUMN: Upwelling

Bottom intrusion of colder &saltier water

Phytoplankton exportation offshore

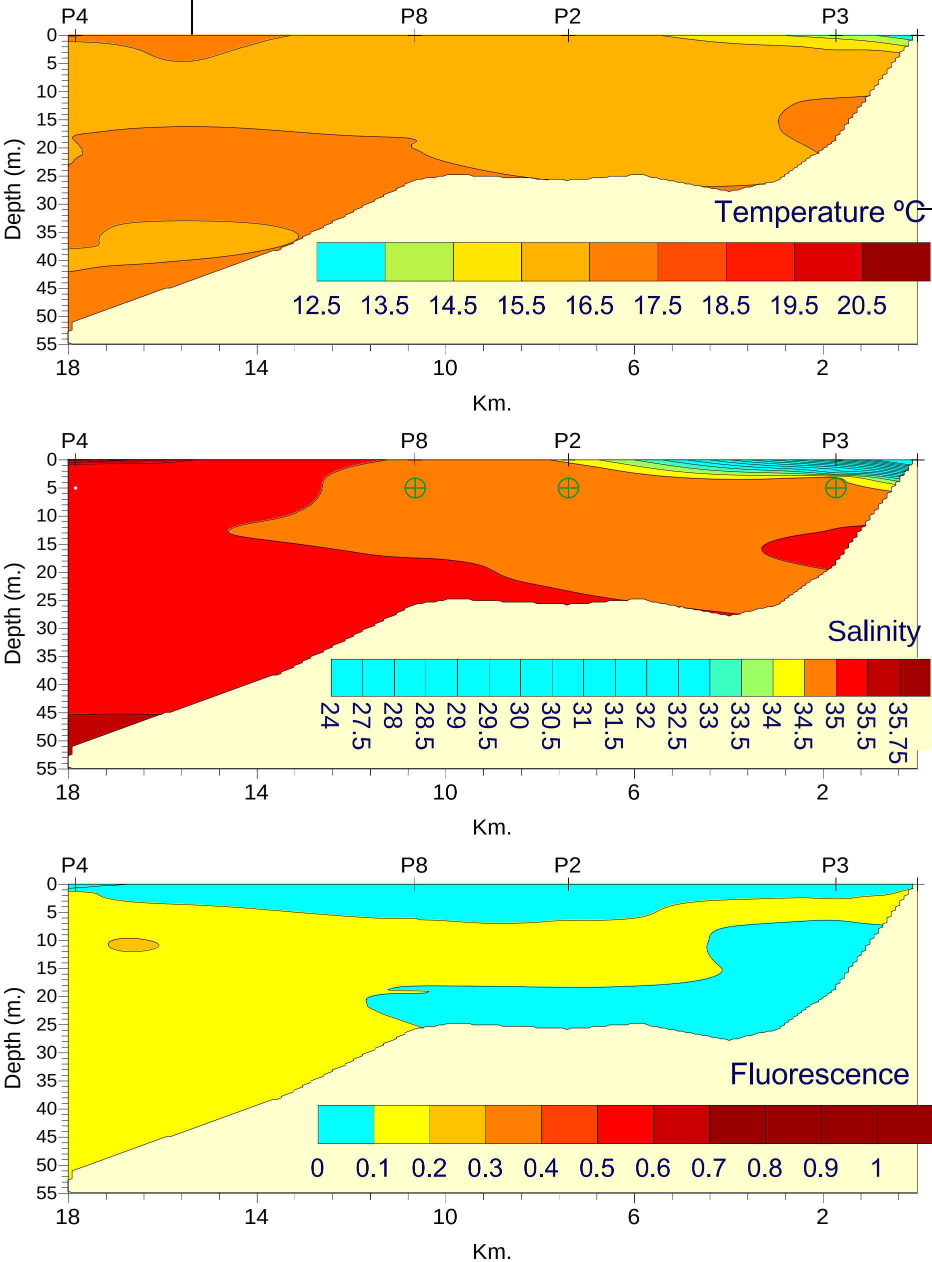
Dinophysis acuminata persistence



Dinophysis acuminata Cell L^{-1}

- 0 to 40
- 40 to 200
- 200 to 1000
- 1000 to 2000
- 2000 to 5000
- 5000 to 13000

AUTUMN: Upwelling relaxation
Dinophysis acuminata persistence



Dinophysis acuminata Cell L^{-1}

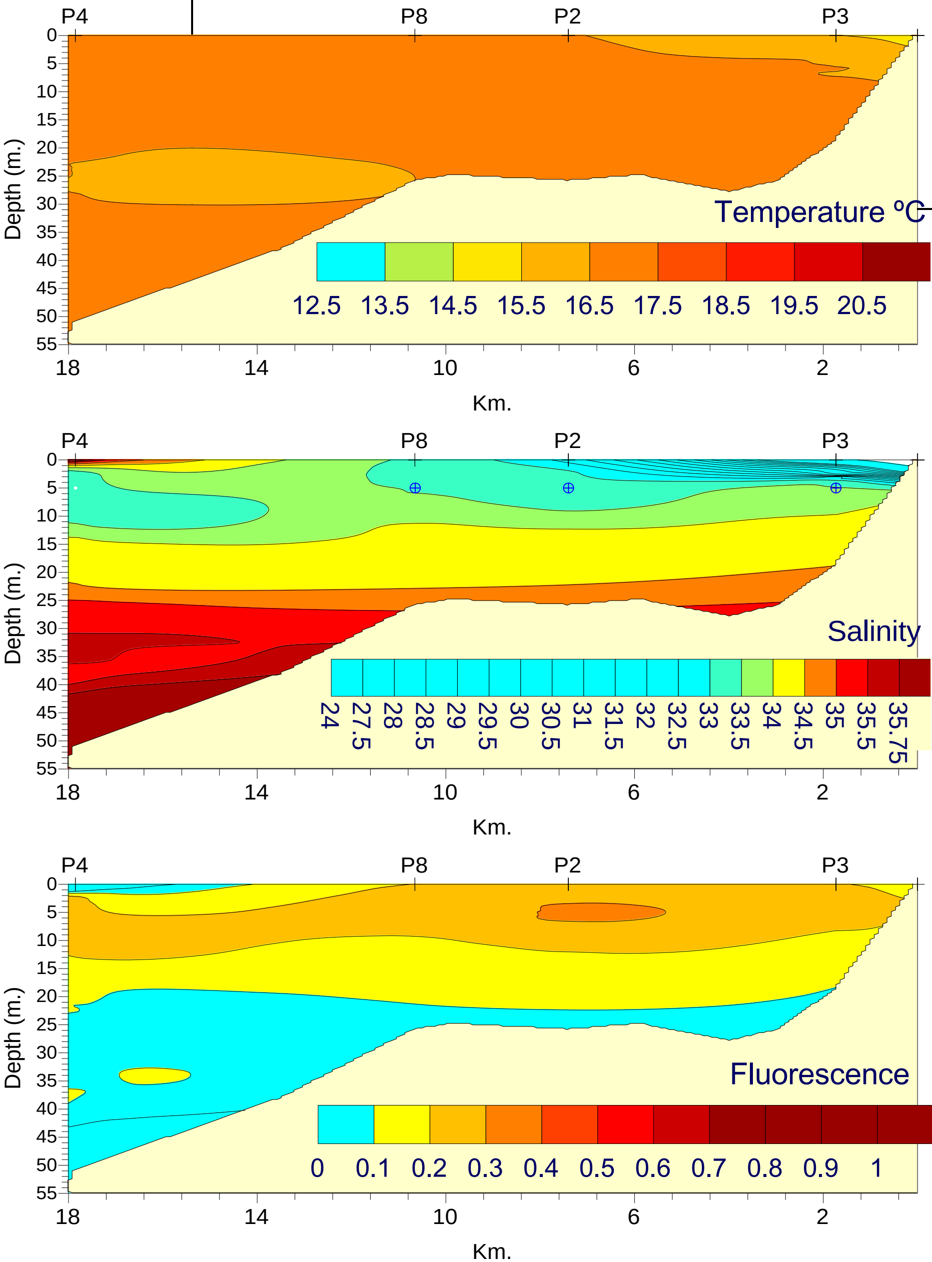
0 to 40
40 to 200
200 to 1000
1000 to 2000
2000 to 5000
5000 to 13000

AUTUMN: Initiation of downwelling

Temperature and salinity homogenization except in the innermost part of the ría

Almost no phytoplankton

Dinophysis acuminata advection



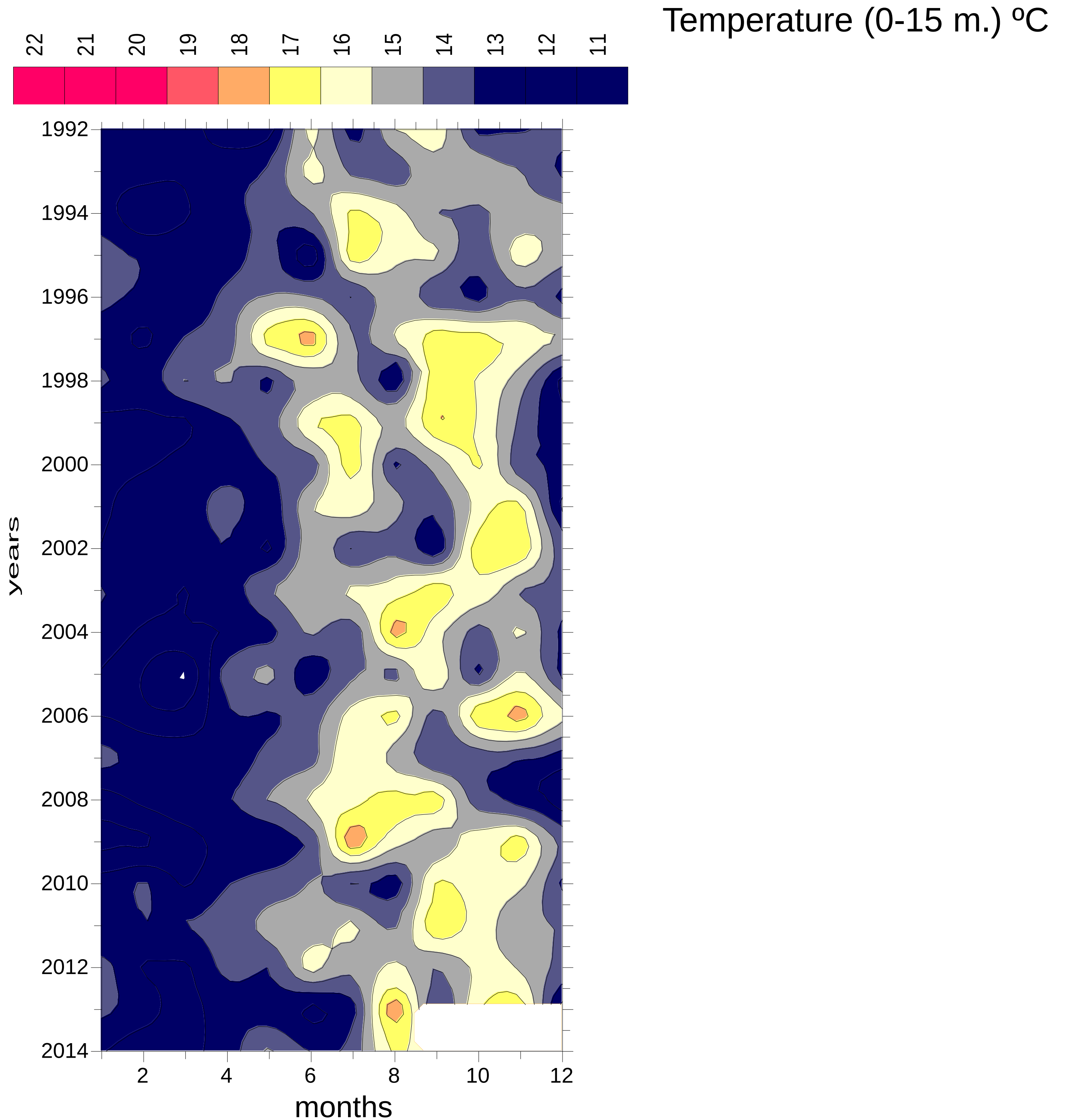
Dinophysis acuminata Cell L^{-1}

- 0 to 40
- 40 to 200
- 200 to 1000
- 1000 to 2000
- 2000 to 5000
- 5000 to 13000

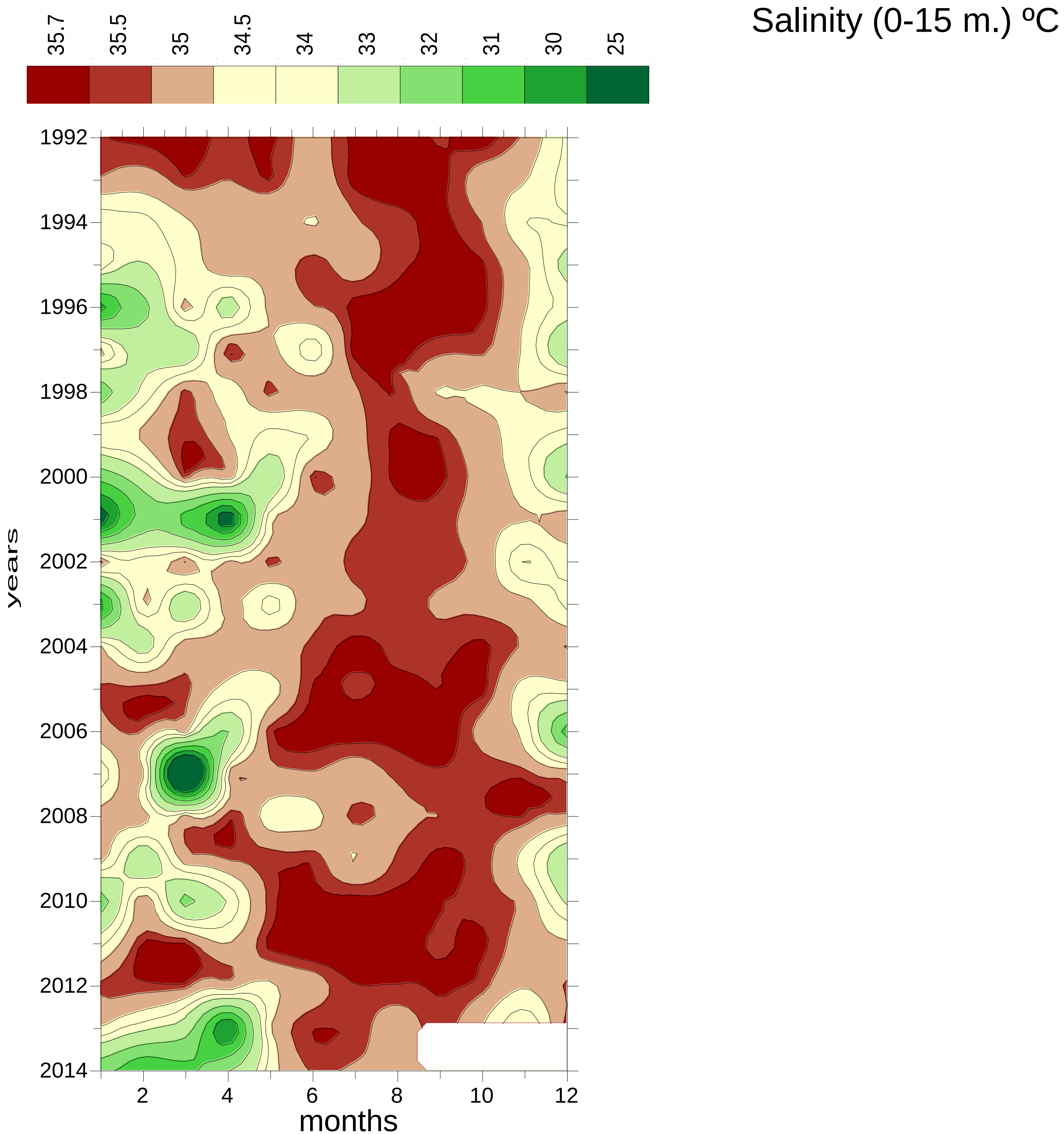
WINTER CONDITIONS: Downwelling & rainfall

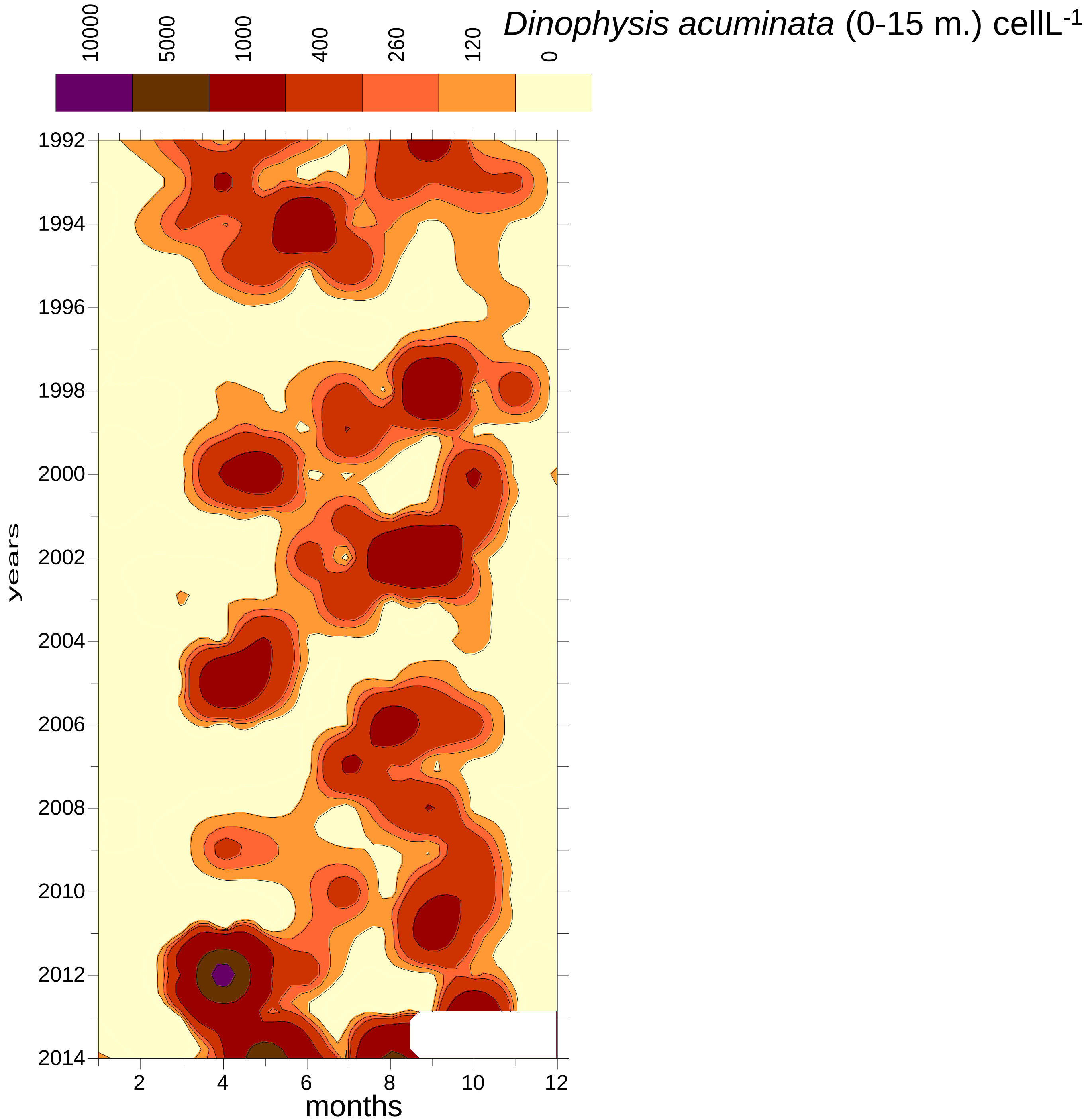
Almost phytoplankton absence

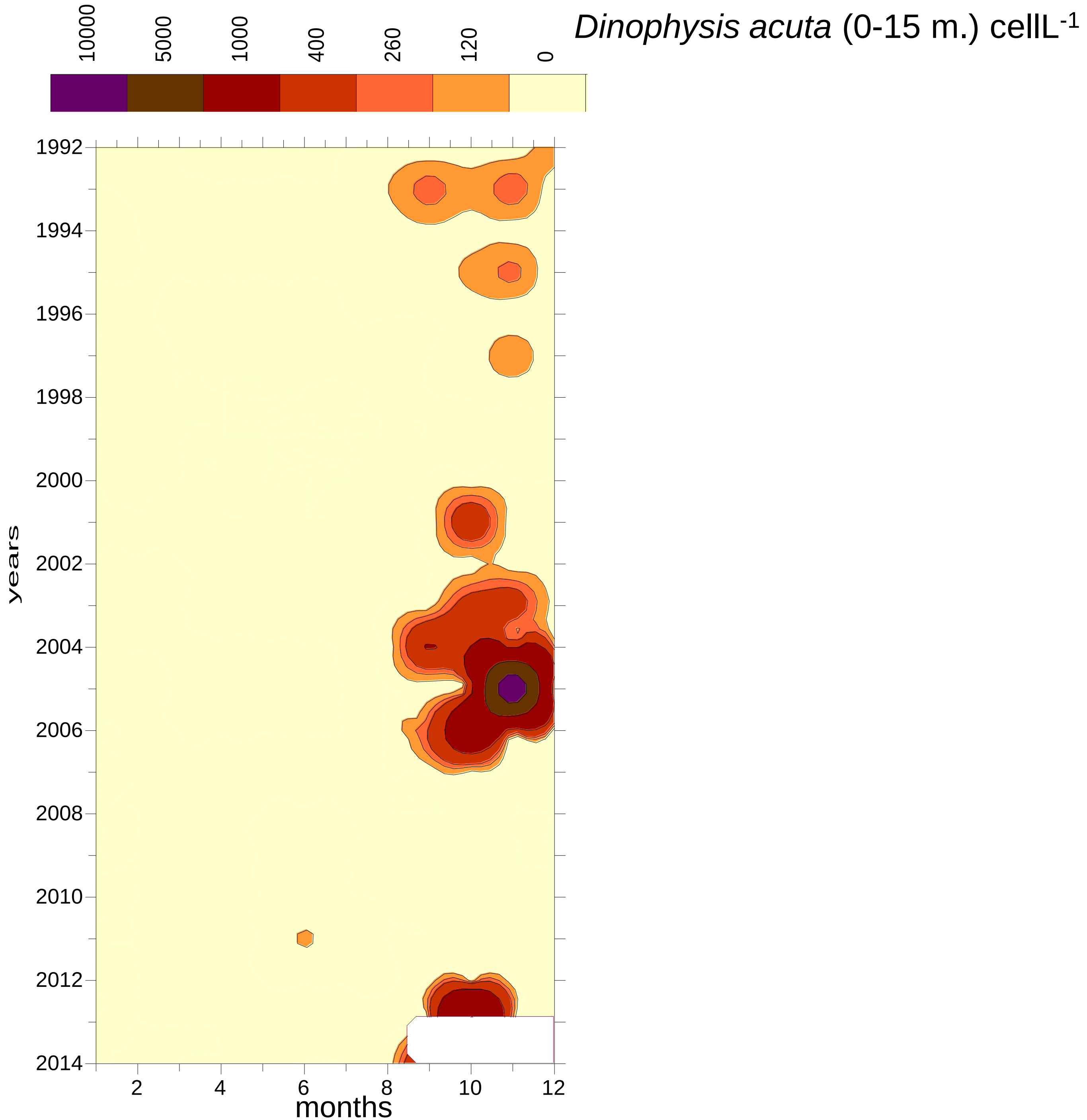
Dinophysis acuminata disappearing



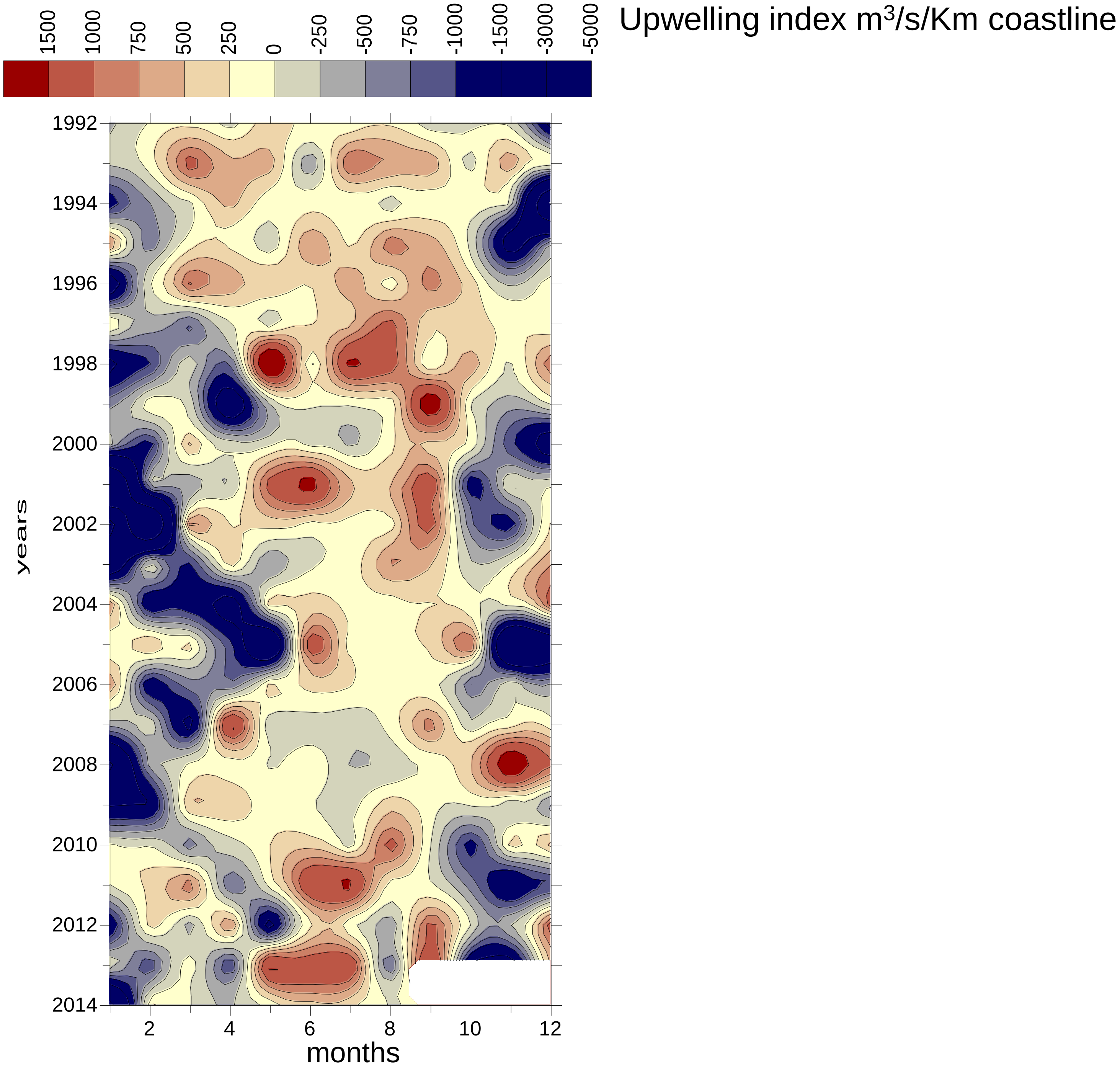
Temperature (0-15 m.) ºC
22
21
20
19
18
17
16
15
14
13
12
11
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
years
2
4
6
8
10
12
months

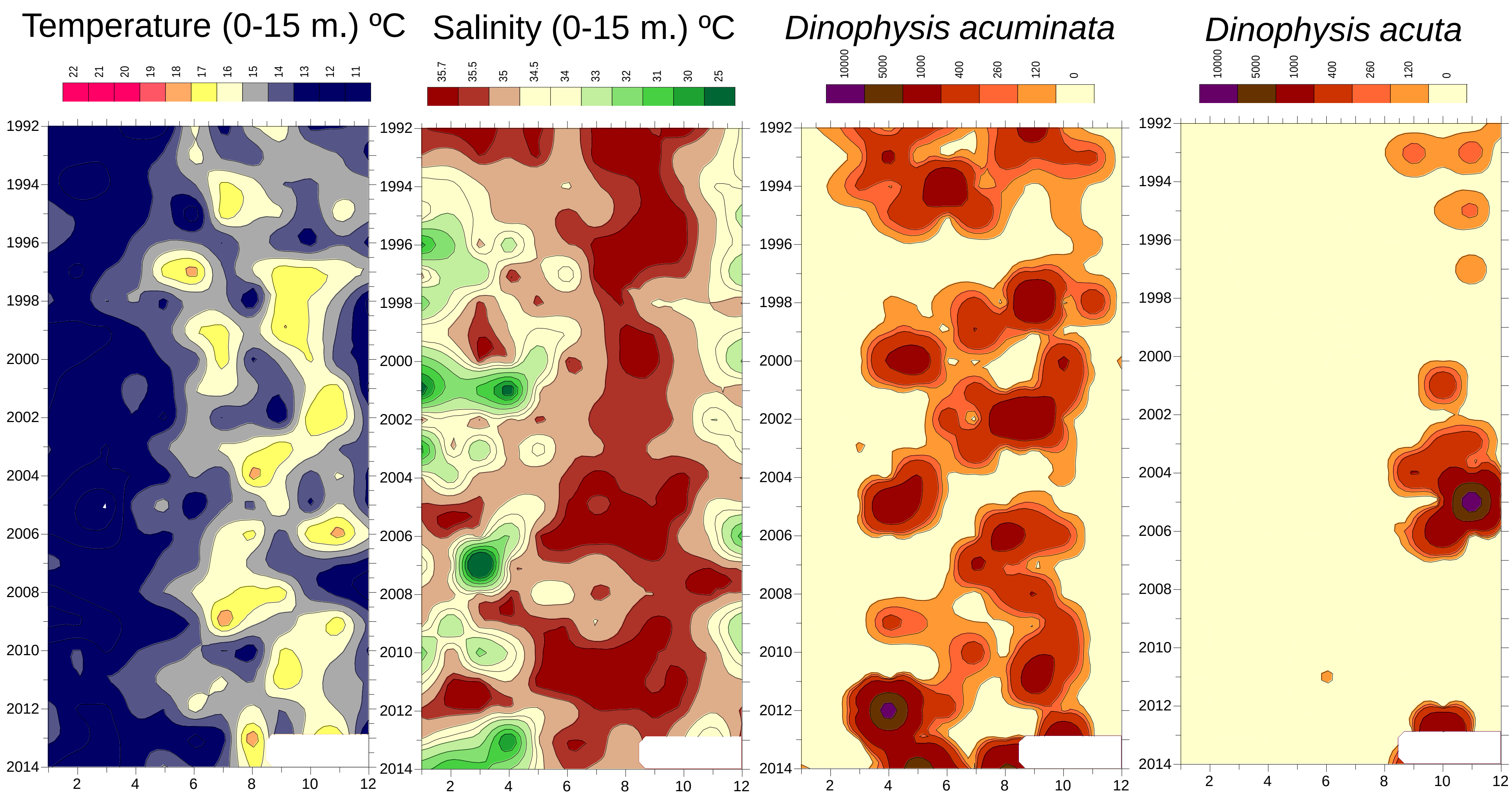

Salinity (0-15 m.) ºC
35.7
35.5
35
34.5
34
33
32
31
30
25
years
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2
4
6
8
10
12
months


Dinophysis acuminata (0-15 m.) cellL-1
10000
5000
1000
400
260
120
0
years
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2
4
6
8
10
12
months

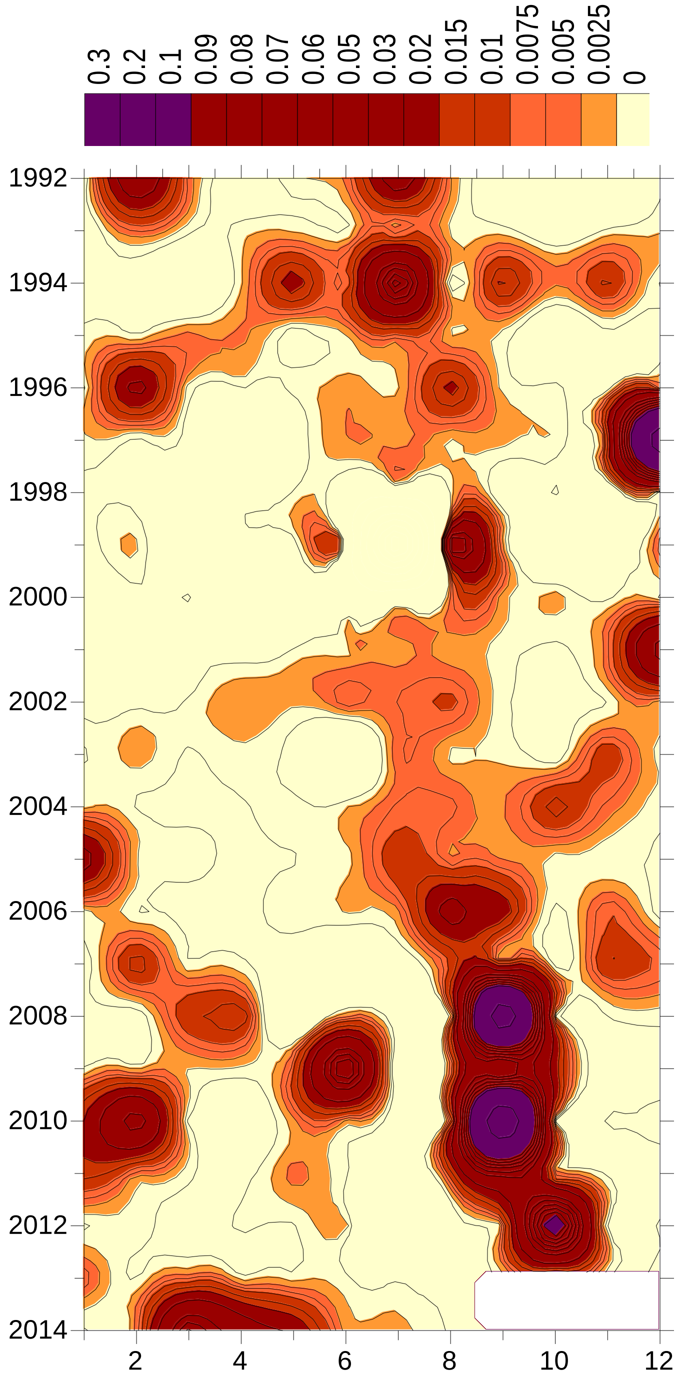


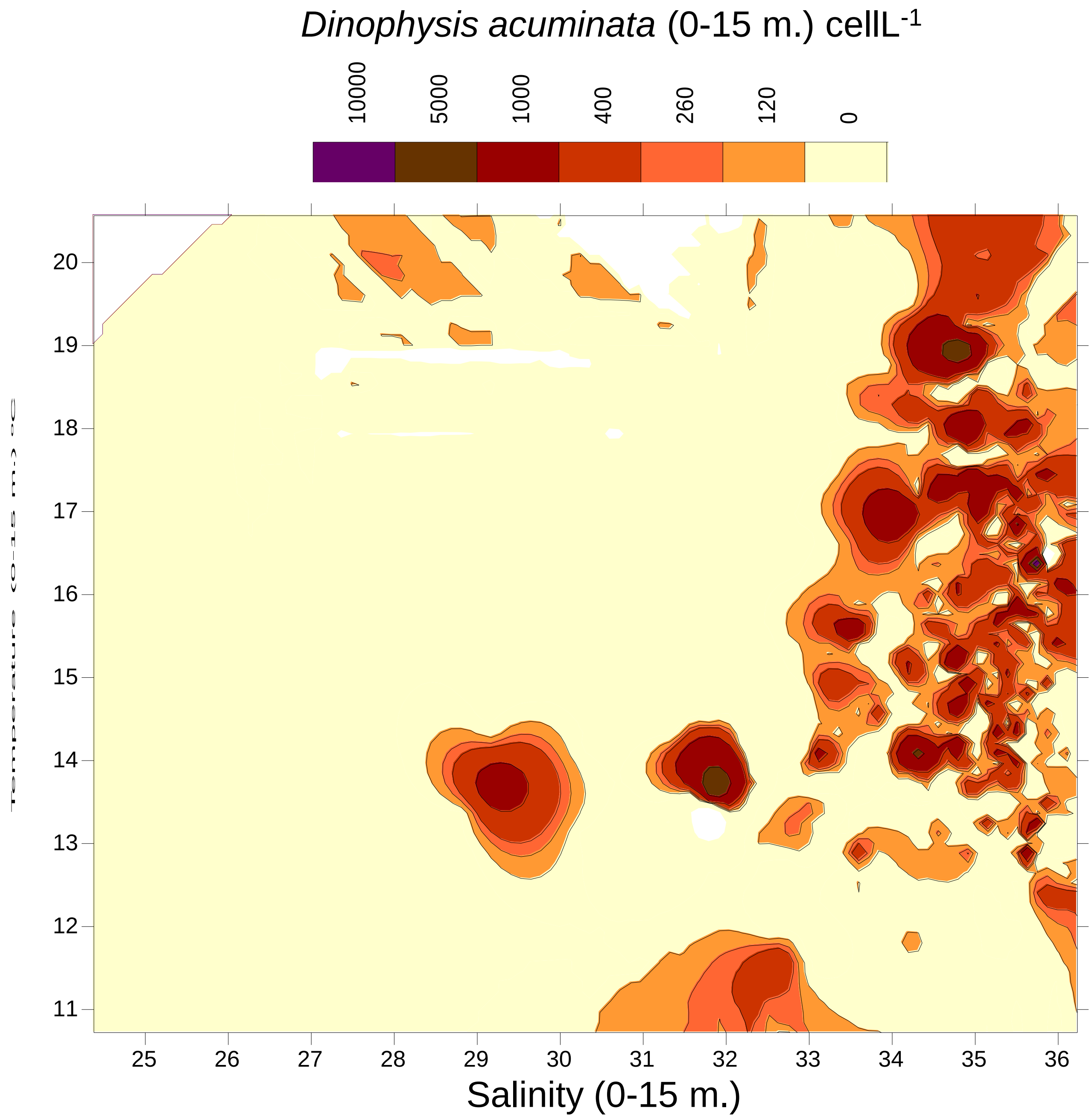
Dinophysis acuta (0-15 m.) cellL-1
10000
5000
1000
400
260
120
0
years
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
months
2
4
6
8
10
12


Upwelling index m³/s/Km coastline
1500
1000
750
500
250
0
-250
-500
-750
-1000
-1500
-3000
-5000
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
years
2
4
6
8
10
12
months

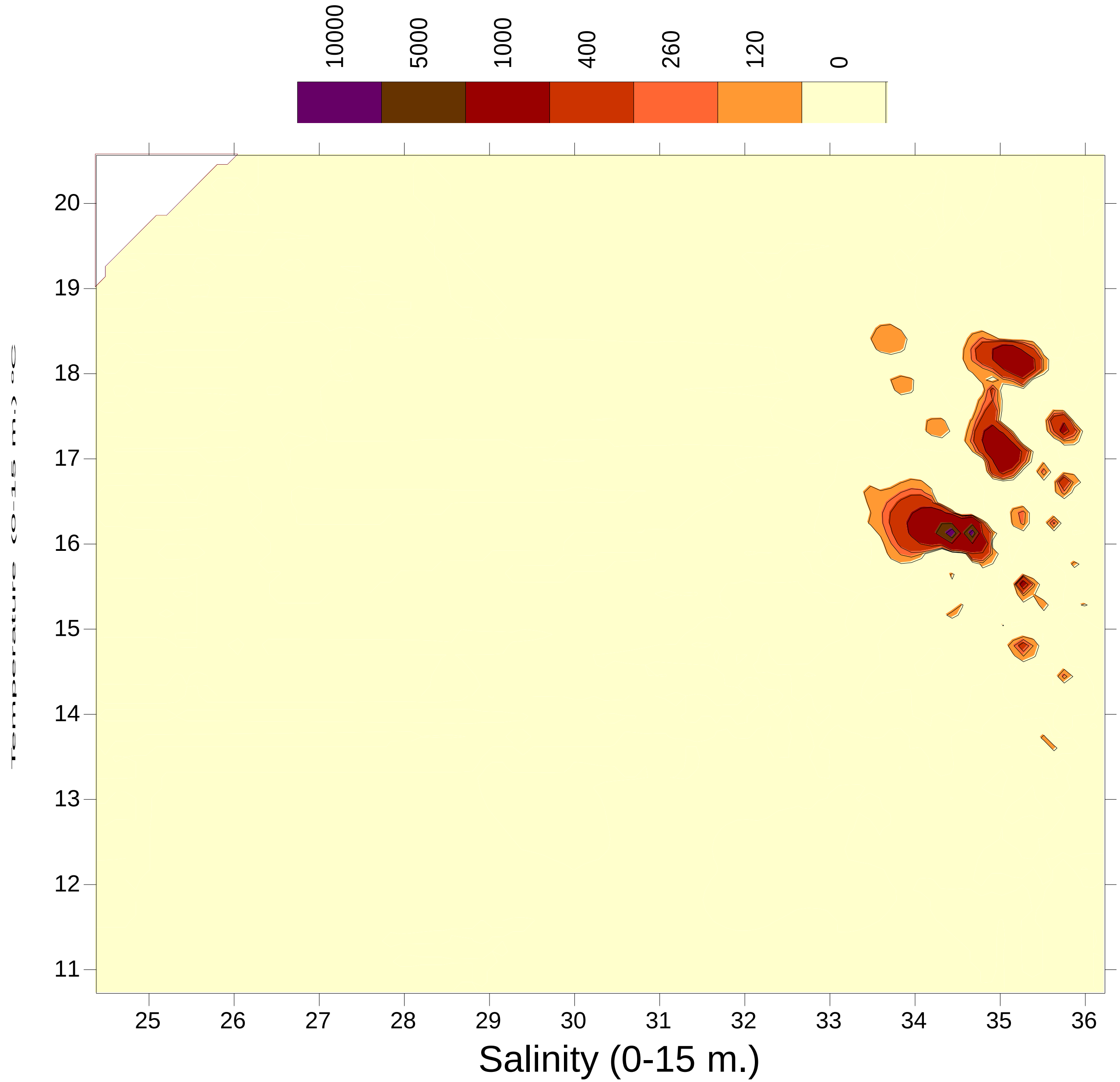

Temperature (0-15 m.) ºC
22 21 20 19 18 17 16 15 14 13 12 11
Salinity (0-15 m.) ºC
35.7 35.5 35 34.5 34 33 32 31 30 25
Dinophysis acuminata
10000 5000 1000 400 260 120 0
Dinophysis acuta
10000 5000 1000 400 260 120 0
1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014
2 4 6 8 10 12

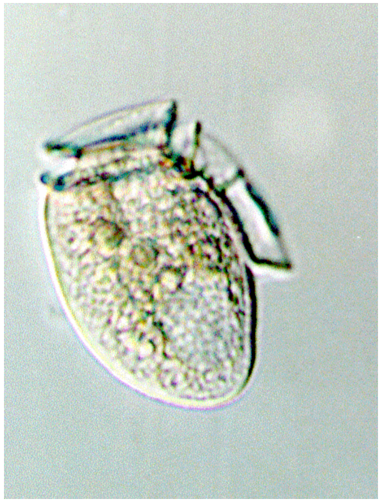
Renewal time (s)



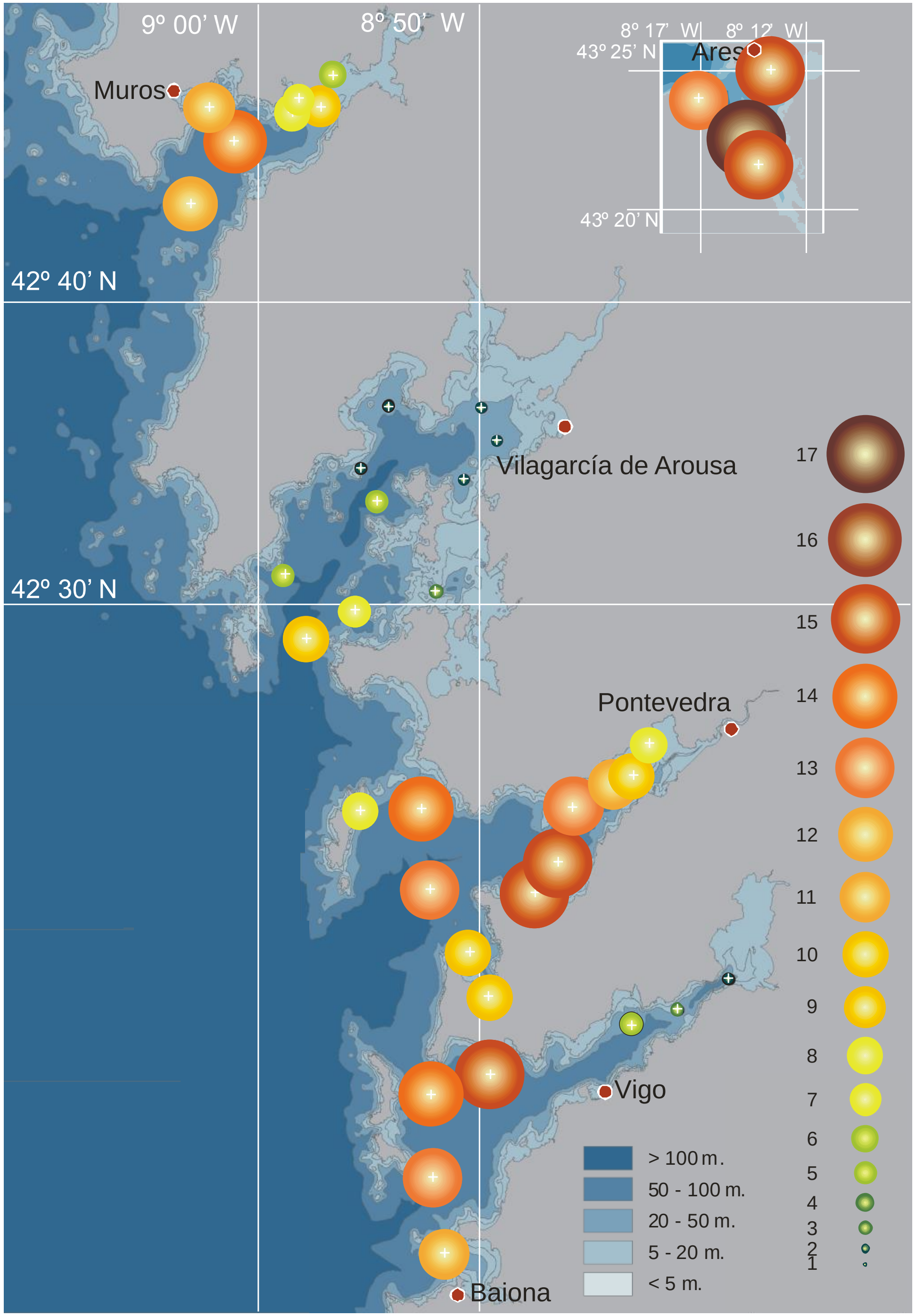

Dinophysis acuminata (0-15 m.) cellL^{-1}
10000
5000
1000
400
260
120
0
20
19
18
17
16
15
14
13
12
11
25
26
27
28
29
30
31
32
33
34
35
36
Salinity (0-15 m.)

Dinophysis acuta (0-15 m.) cellL^{-1}

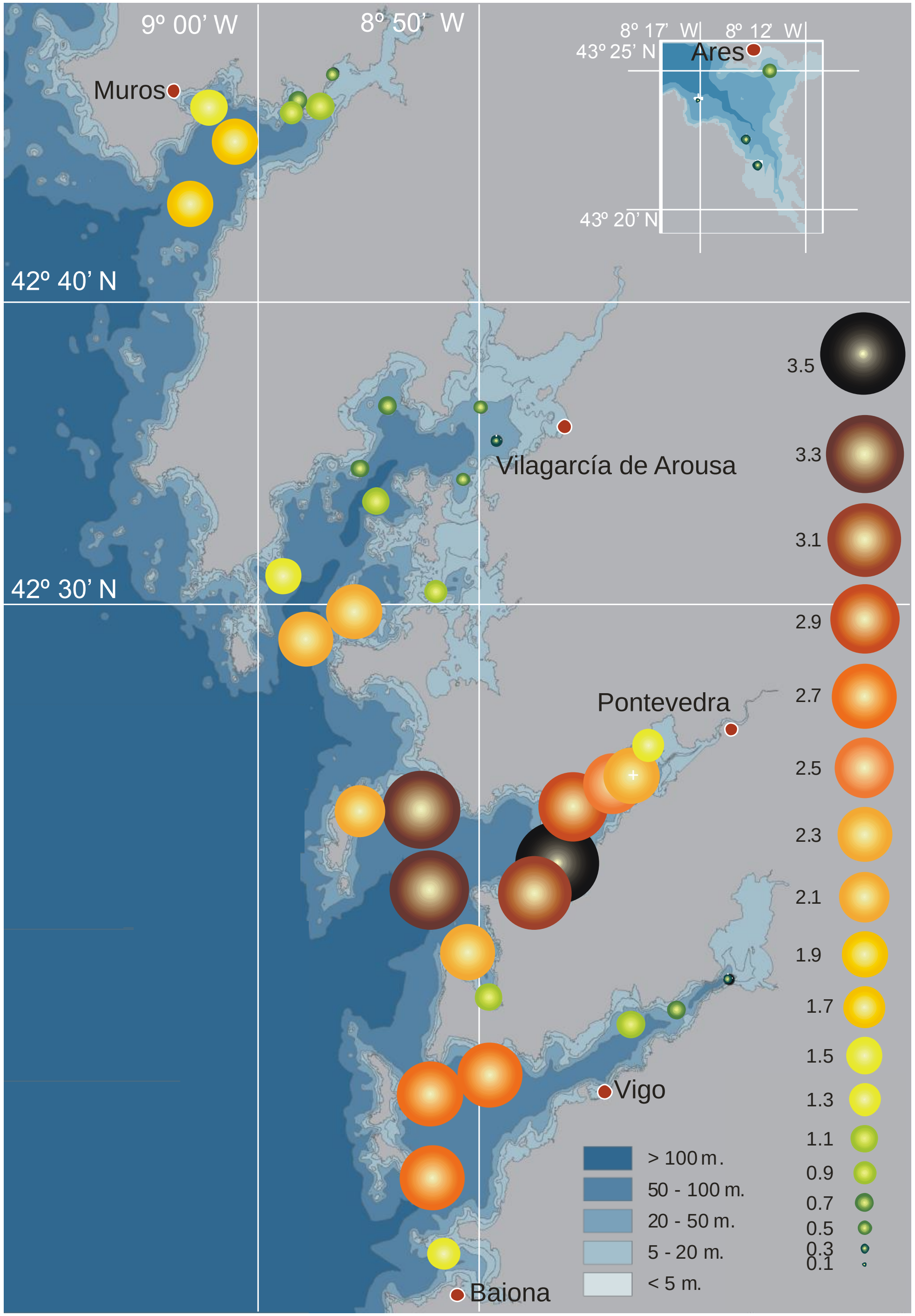




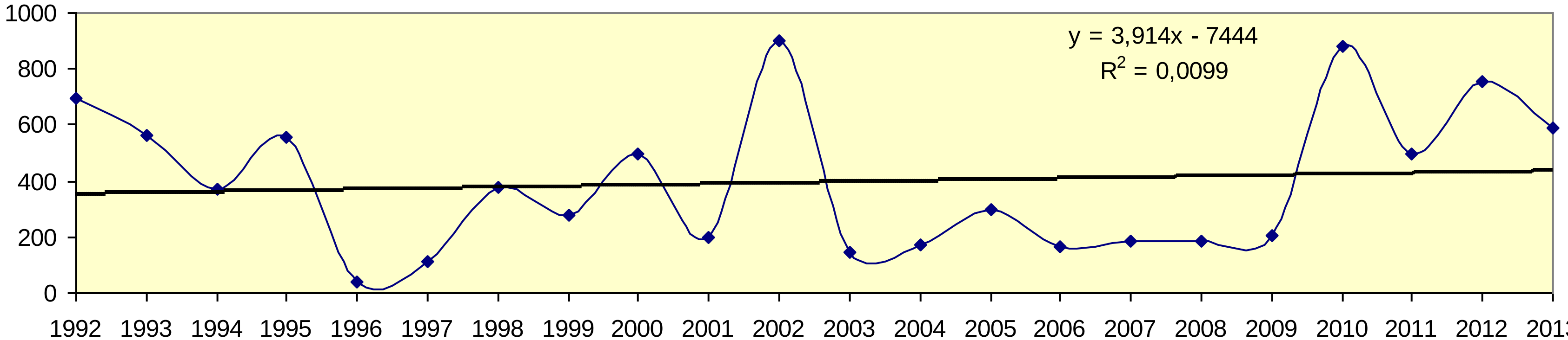
Dinophysis acuminata
Persistence (weeks)
>120 cel L^{-1}
1992-2014



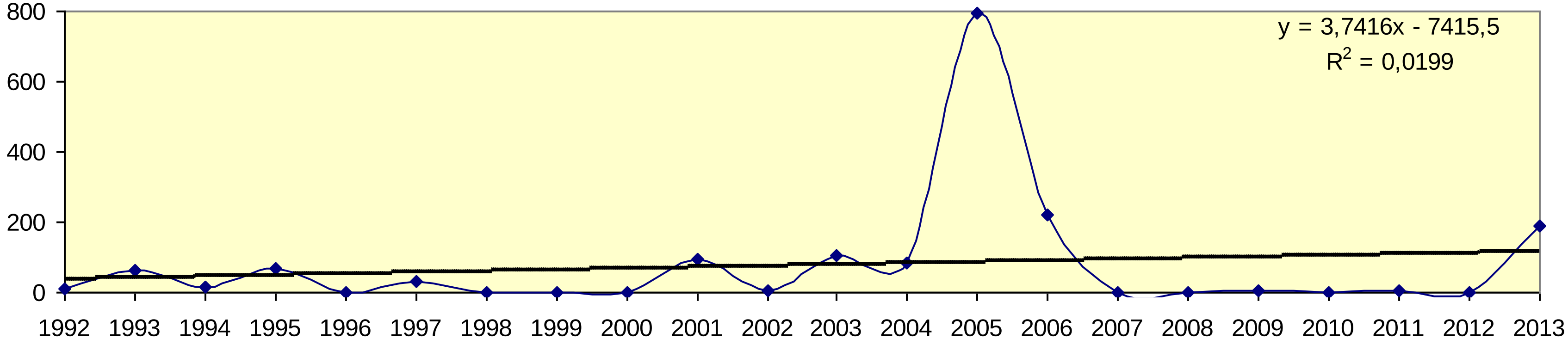
Dinophysis acuta
Persistence (weeks)
>120 cel L^{-1}
1992-2014



Dinophysis acuminata cellL^{-1} (0-15 m) P2 St



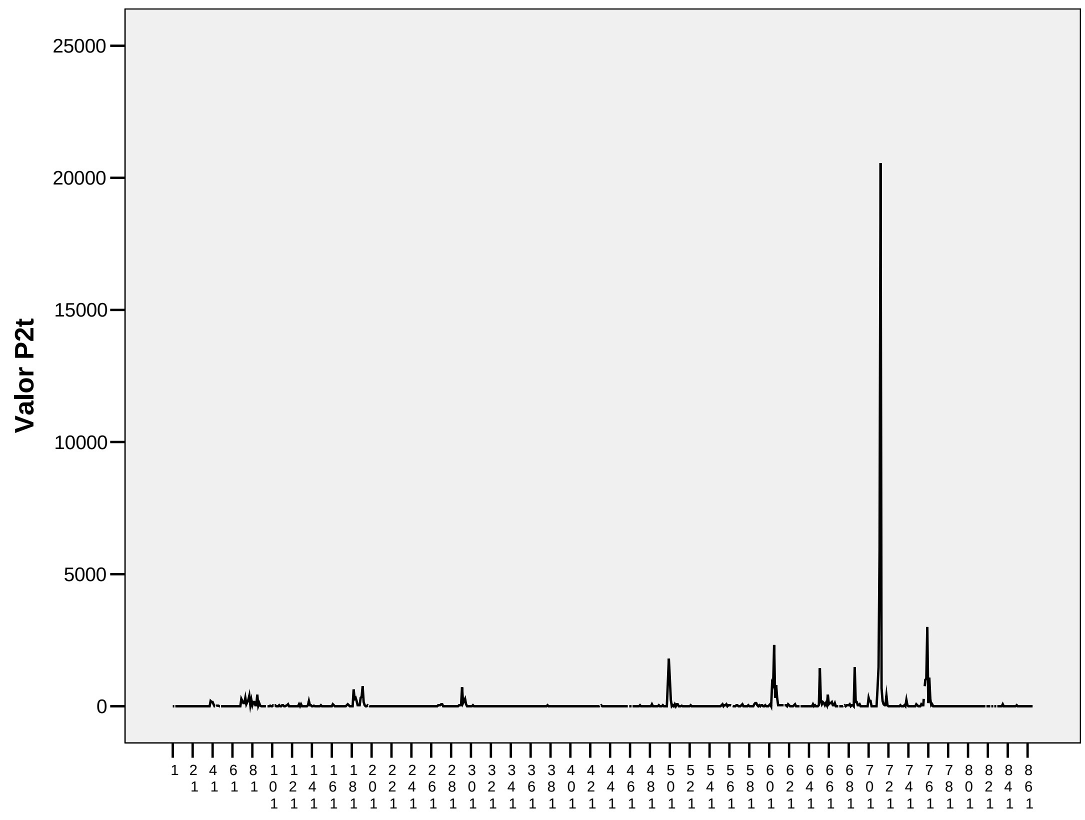
Dinophysis acuta cellL^{-1} (0-15 m) P2 St



Dinophysis acuminata (P2 st)

Model moving average MA (1) because the first two autocorrelations are partial and very high.

A trend is not observed

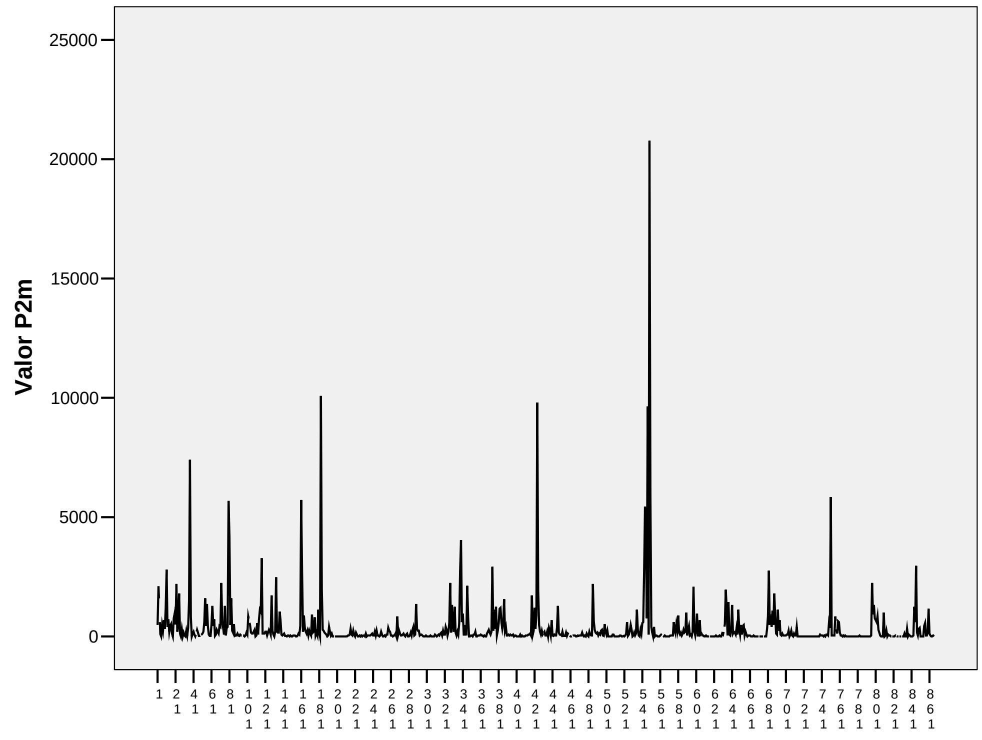


Dinophysis acuta (P2 st)

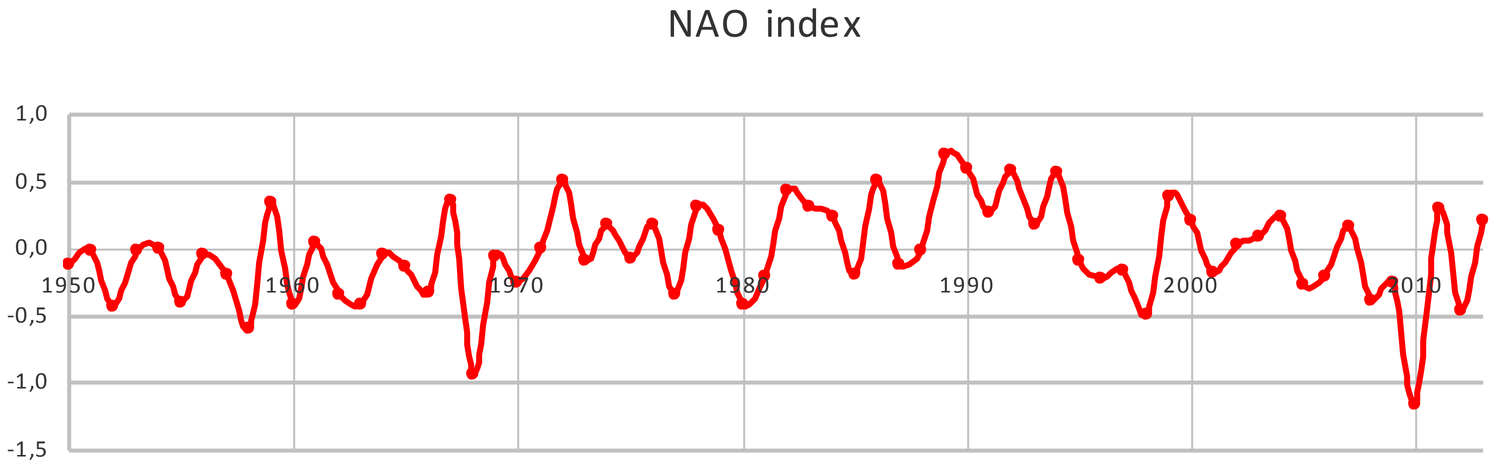
Autoregressive model AR (2). The first autocorrelation is high and the rest falls coup.

This series presents a seasonal cycle

There is not a long-term trend.

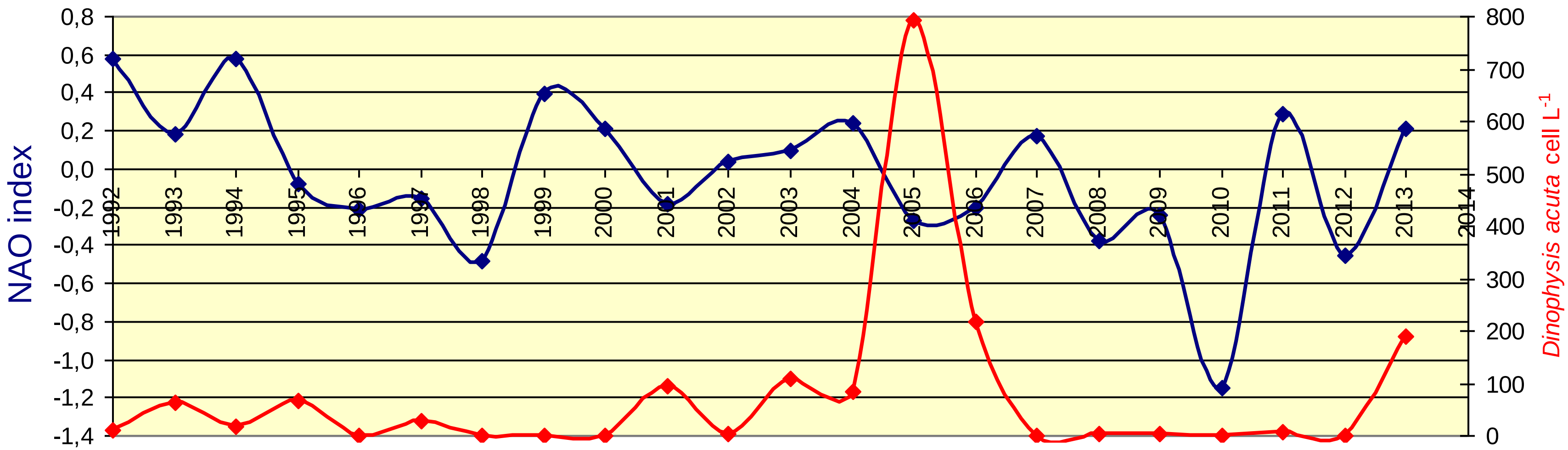


Climate Prediction Center web page
NOAA

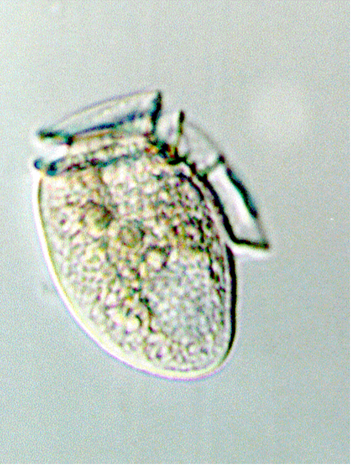


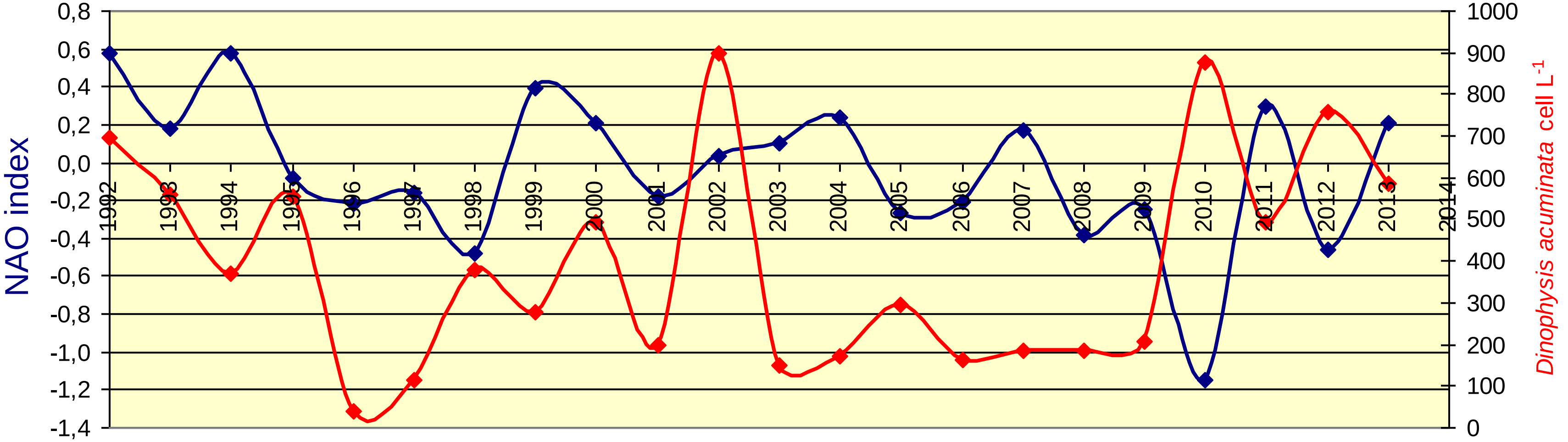
Jones PD, Jonsson T and Wheeler D (1997) Extension to the North Atlantic Oscillation using early instrumental pressure observations from Gibraltar and South-West Iceland. Int. J. Climatol. 17, 1433-1450.

Osborn TJ (2004) Simulating the winter North Atlantic Oscillation: the roles of internal variability and greenhouse gas forcing. Clim. Dyn. 22, 605-623.



NAO index
Dinophysis acuta cell L-1
0,8
0,6
0,4
0,2
0,0
-0,2
-0,4
-0,6
-0,8
-1,0
-1,2
-1,4
800
700
600
500
400
300
200
100
0
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014





NAO index
Dinophysis acuminata cell L-1
0,8
0,6
0,4
0,2
0,0
-0,2
-0,4
-0,6
-0,8
-1,0
-1,2
-1,4
1000
900
800
700
600
500
400
300
200
100
0
1992
1993
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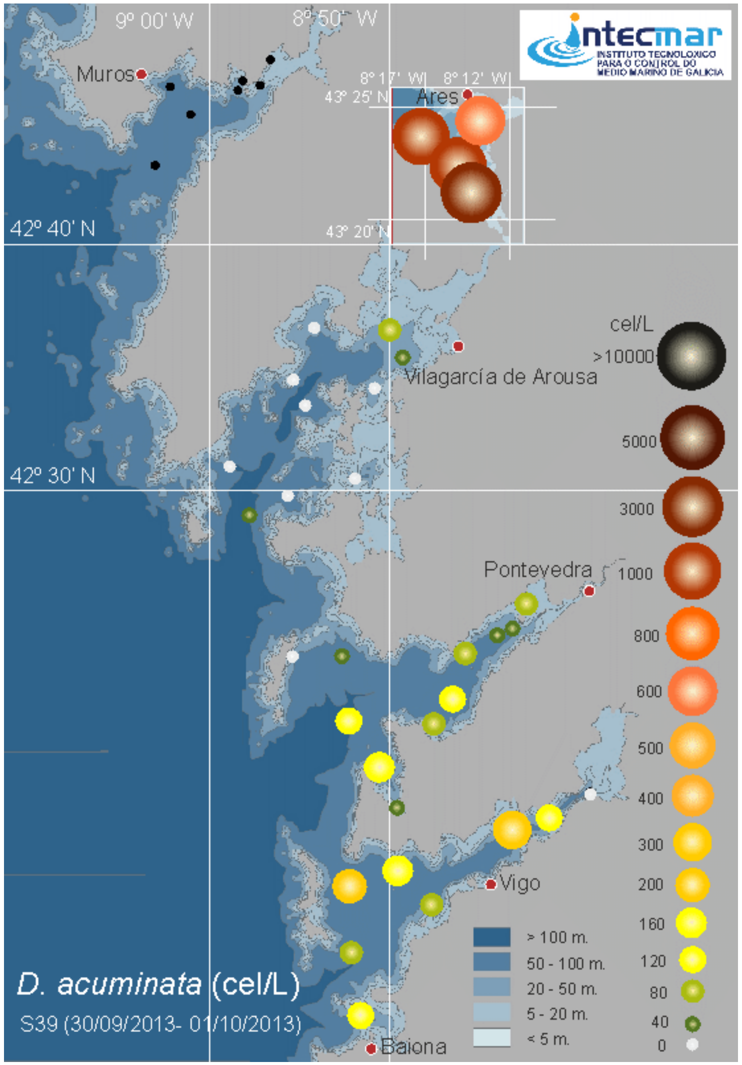
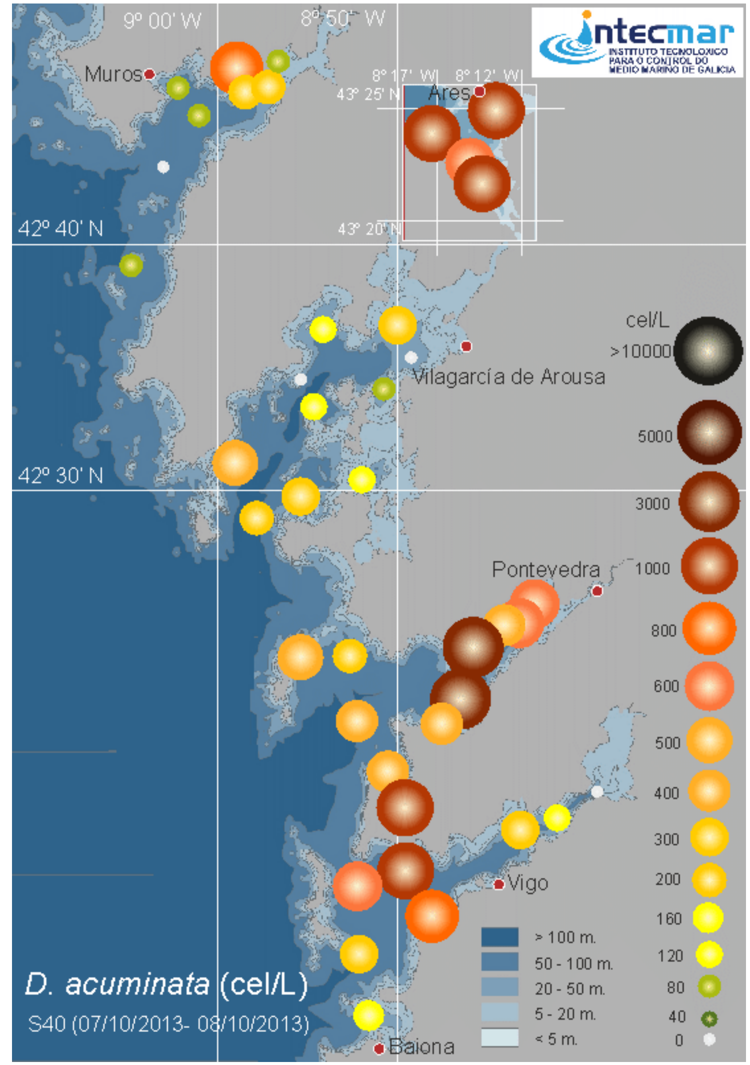
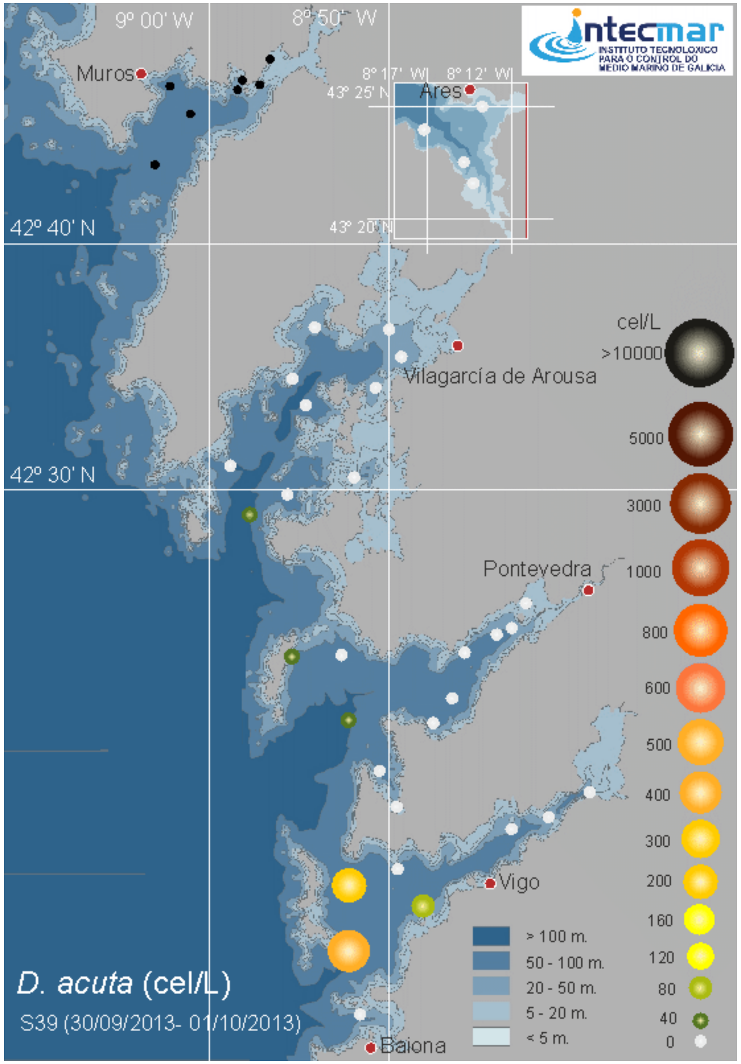
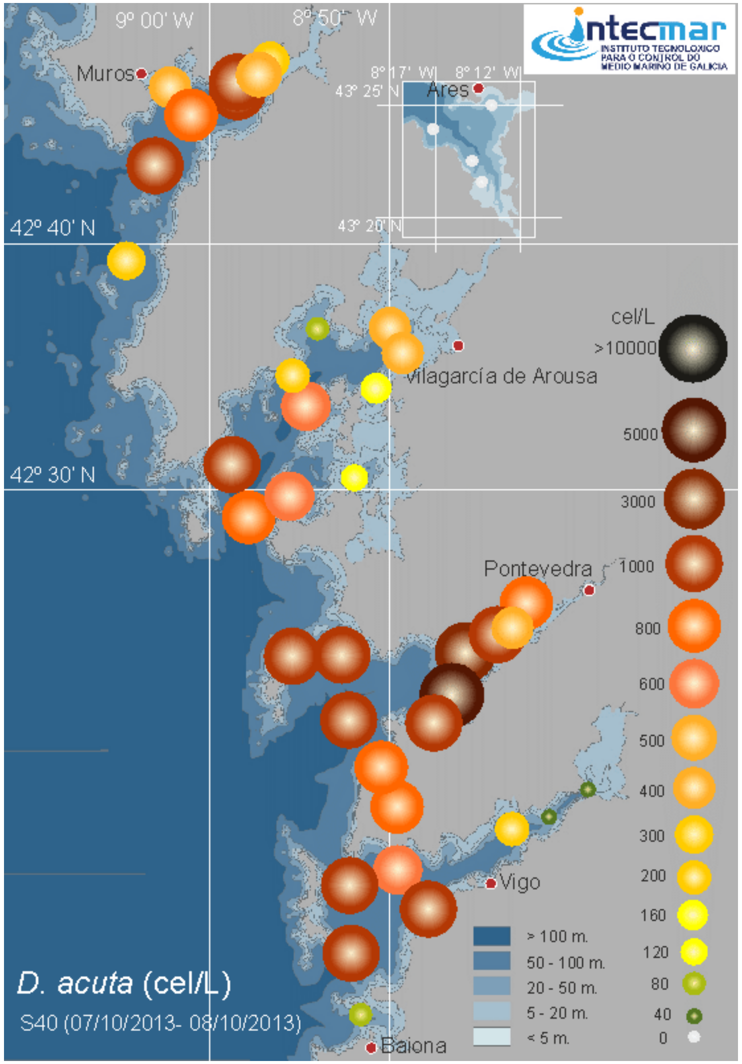
2010
2011
2012
2013
2014


9º 00' W
8º 50' W
Muros
8º 17' W
8º 12' W
43º 25' N
Ares
43º 20' N
42º 40' N
42º 30' N
Vilagarcía de Arousa
Pontevedra
Vigo
Baiona
cel/L
>10000
5000
3000
1000
800
600
500
400
300
200
160
120
80
40
0
> 100 m.
50 - 100 m.
20 - 50 m.
5 - 20 m.
< 5 m.
D. acuminata (cel/L)
S39 (30/09/2013- 01/10/2013)


9º 00' W
8º 50' W
Muros
8º 17' W
8º 12' W
43º 25' N
Ares
43º 20' N
42º 40' N
42º 30' N
Vilagarcía de Arousa
Pontevedra
Vigo
Baiona
cel/L
>10000
5000
3000
1000
800
600
500
400
300
200
160
120
80
40
0
> 100 m.
50 - 100 m.
20 - 50 m.
5 - 20 m.
< 5 m.
D. acuminata (cel/L)
S40 (07/10/2013- 08/10/2013)



9º 00' W
8º 50' W
intecmar
INSTITUTO TECNOLOXICO PARA O CONTROL DO MEDIO MARIÑO DE GALICIA
Muros
8º 17' W
8º 12' W
43º 25' N
Ares
43º 20' N
42º 40' N
cel/L
>10000
Vilagarcía de Arousa
5000
42º 30' N
3000
Pontevedra
1000
800
600
500
400
300
Vigo
200
160
120
80
40
0
> 100 m.
50 - 100 m.
20 - 50 m.
5 - 20 m.
< 5 m.
D. acuta (cel/L)
S39 (30/09/2013- 01/10/2013)
Baiona

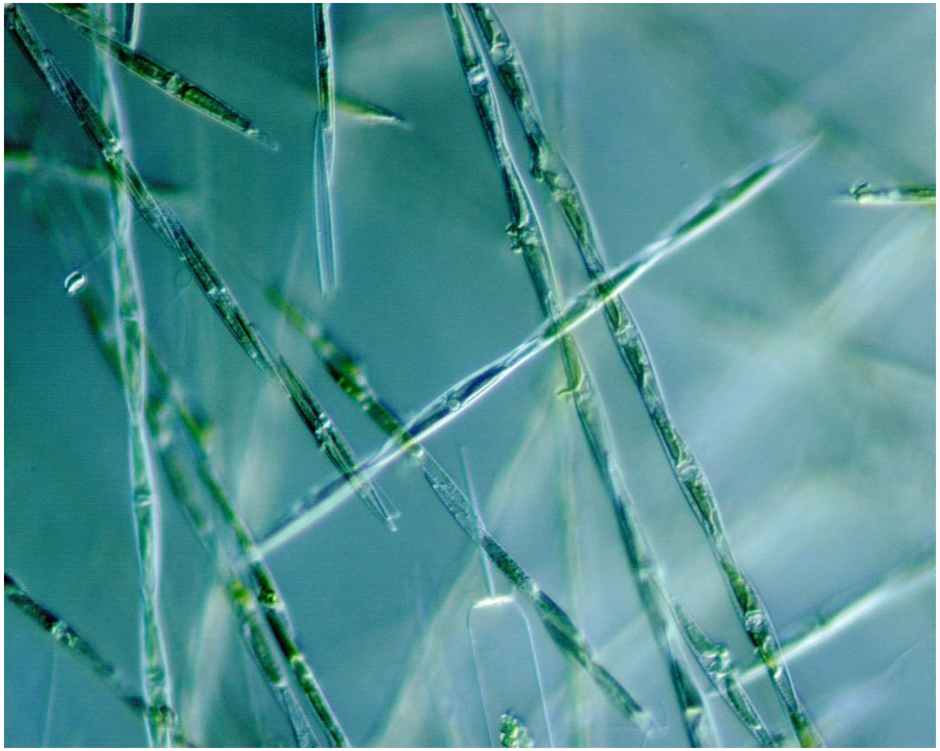


9º 00' W
8º 50' W
intecmar
INSTITUTO TECNOLOXICO PARA O CONTROL DO MEDIO MARIÑO DE GALICIA
Muros
8º 17' W
8º 12' W
43º 25' N
Ares
43º 20' N
42º 40' N
cel/L
>10000
Vilagarcía de Arousa
5000
42º 30' N
3000
Pontevedra
1000
800
600
500
400
300
Vigo
200
160
120
80
40
0
> 100 m.
50 - 100 m.
20 - 50 m.
5 - 20 m.
< 5 m.
D. acuta (cel/L)
S40 (07/10/2013- 08/10/2013)
Baiona

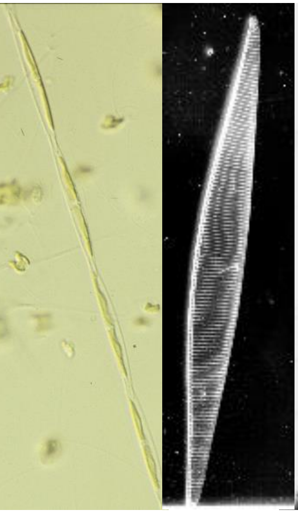
Amnésicas (ASP)

Las especies relaccionadas con la presencia de las toxinas descritas em 1987, toxinas amnésicas pertenecen al género *Pseudo-nitzschia*. La principal causante de las prolongadas prohibiciones de extracción de vieira en Galicia es *P. australis*

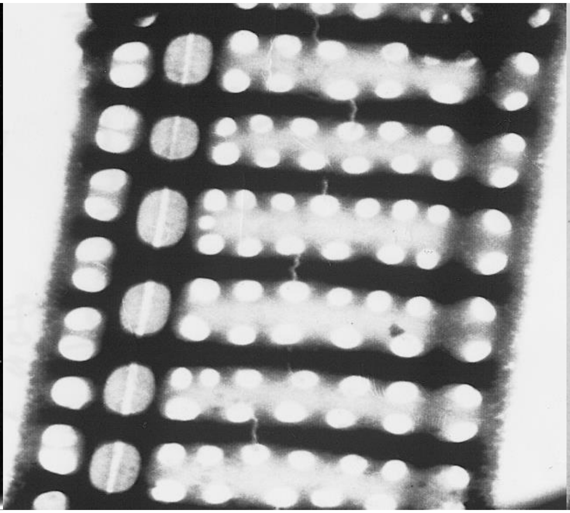
la sopa de nuera



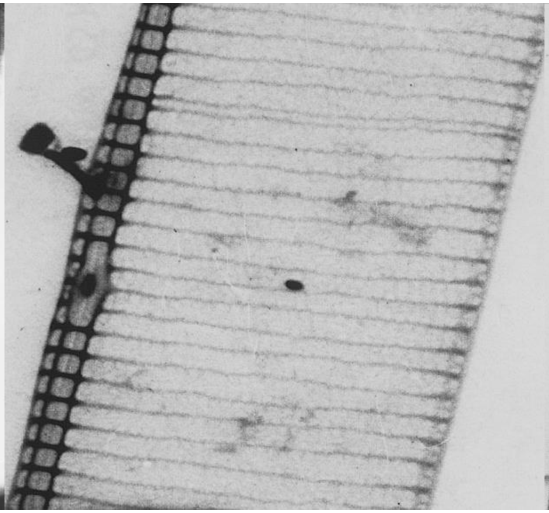
Clase Bacillariophyceae



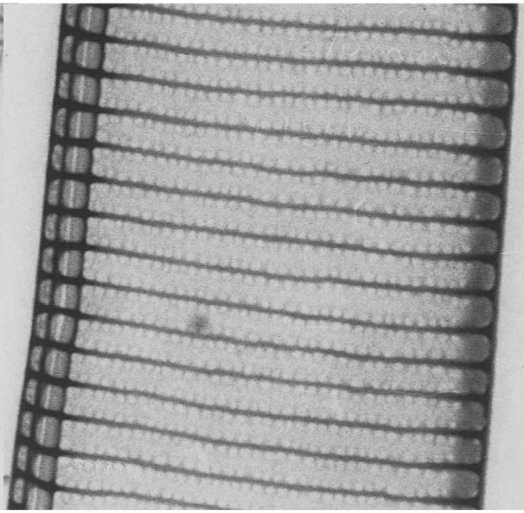
Pseudo-nitzschia sp.



Pseudo-nitzschia pungens (Grunow ex Cleve) Hasle, 1993



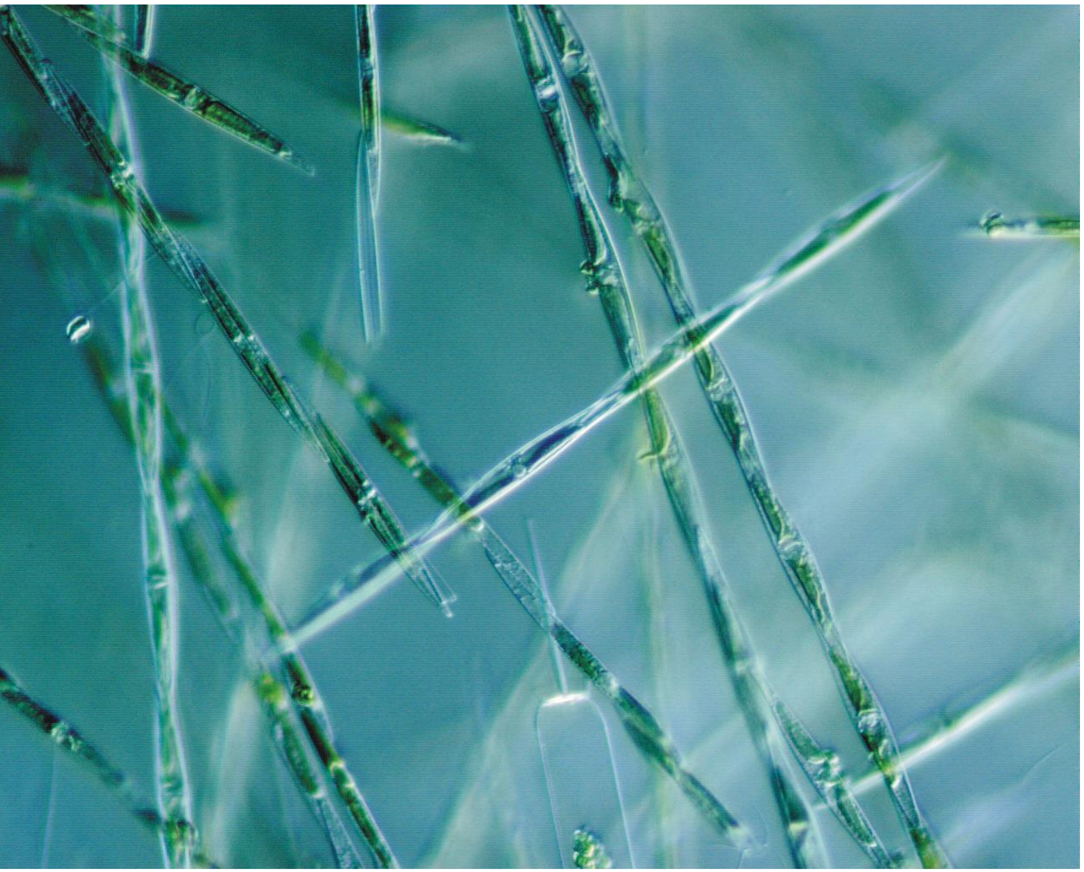
Pseudo-nitzschia fraudulenta (Cleve) Hasle, 1993



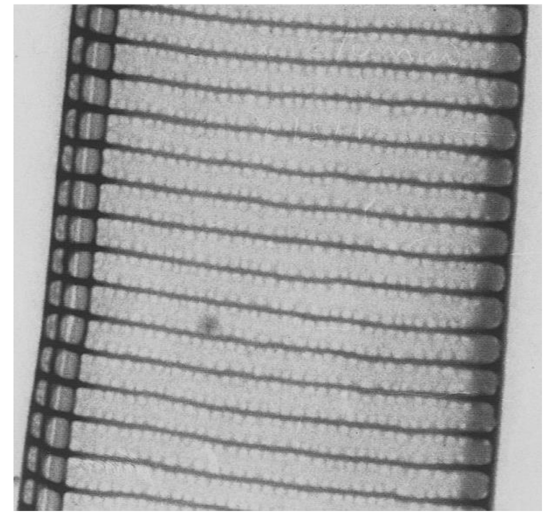
Pseudo-nitzschia australis Frenguelli, 1939

Diatomeas **Amnésicas (ASP)**

AMNESIC SHELLFISH POISONING PRODUCER SPECIES

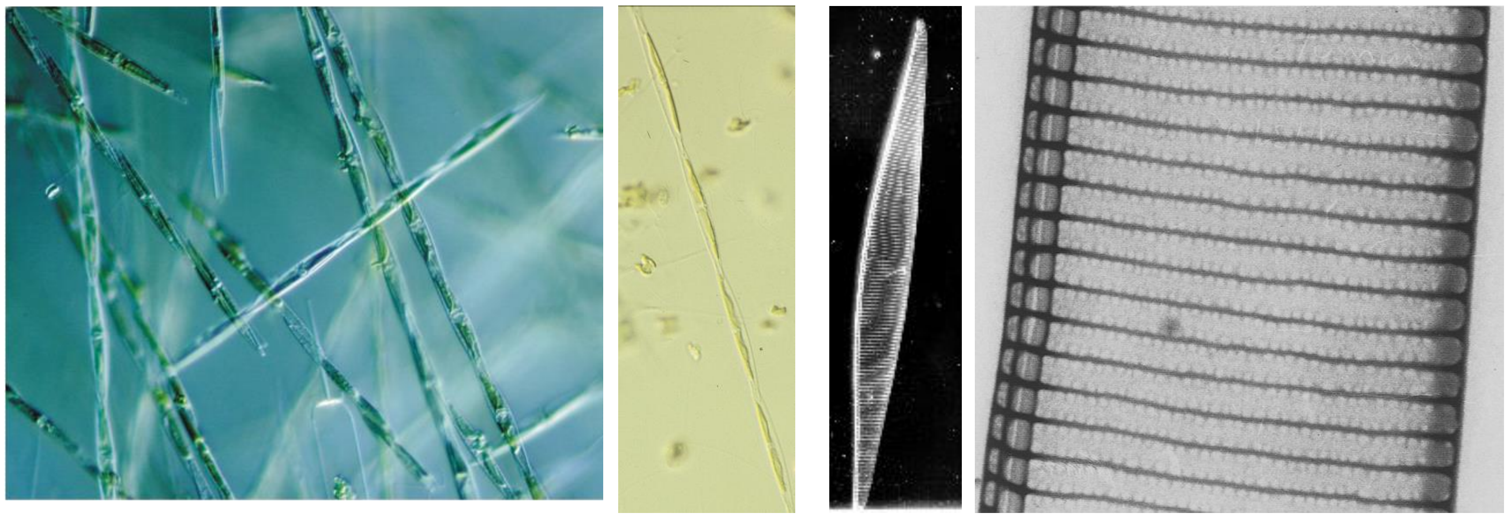


Pseudo-nitzschia sp.
Peragallo in Peragallo & Peragallo, 1900



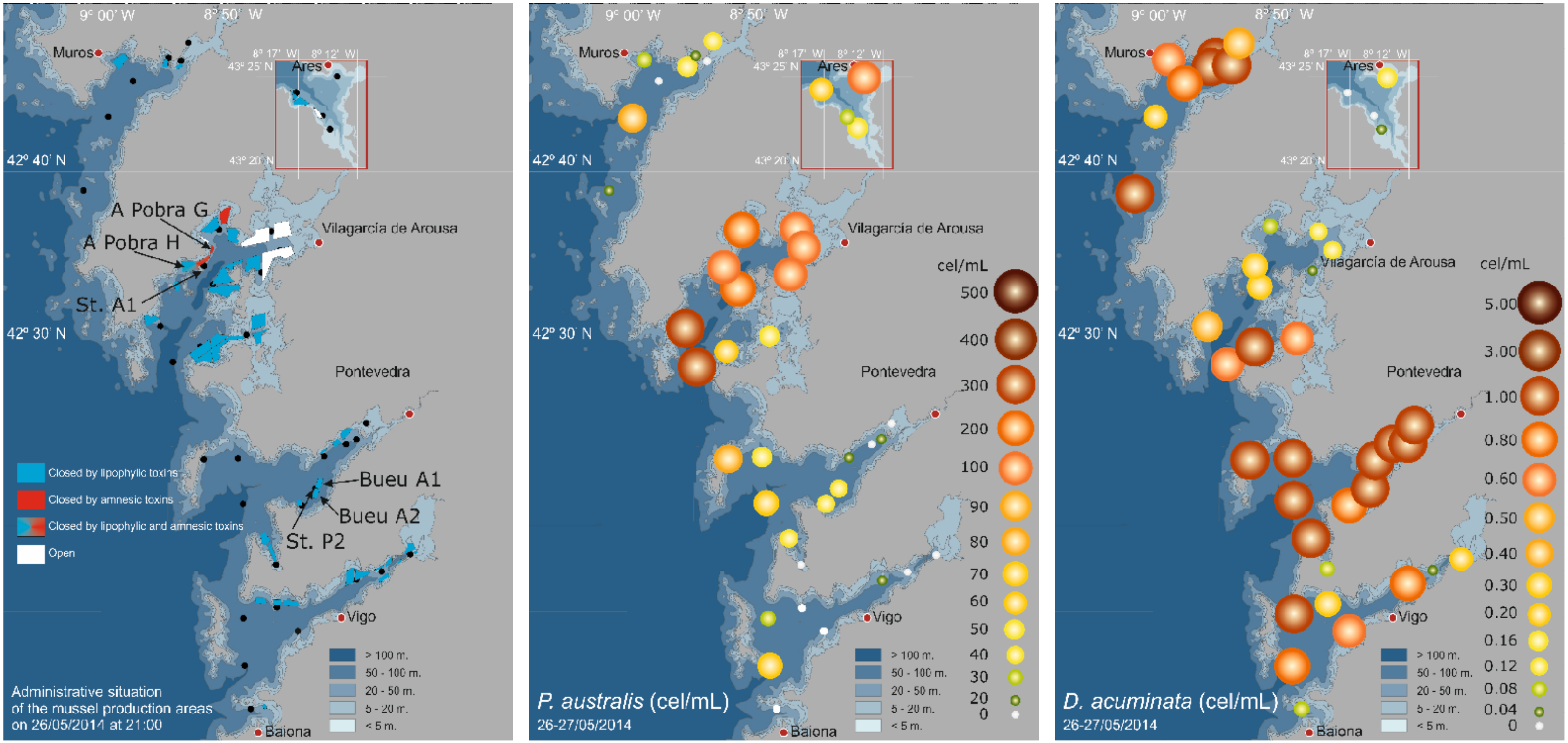
Pseudo-nitzschia australis
Frenguelli, 1939

Pseudo-nitzschia australis Frenguelli,1939



METHODOLOGY

- Biotoxins concentration in the mussels from the production areas (P.A) (0-15 m.)
- Lipophilic toxins quantification by UPLC-MS/MS Sup. EURL-MB v.5
- Domoic acid quantification by HPLC-UV-Diode
- Lipophylic toxins by biological test. T. Yasumoto, 1984
- Phytoplankton counts by Utermohl method
- Vertical profiles of salinity and temperatura by CTD
- *Pseudo-nitzschia australis* identification by TEM



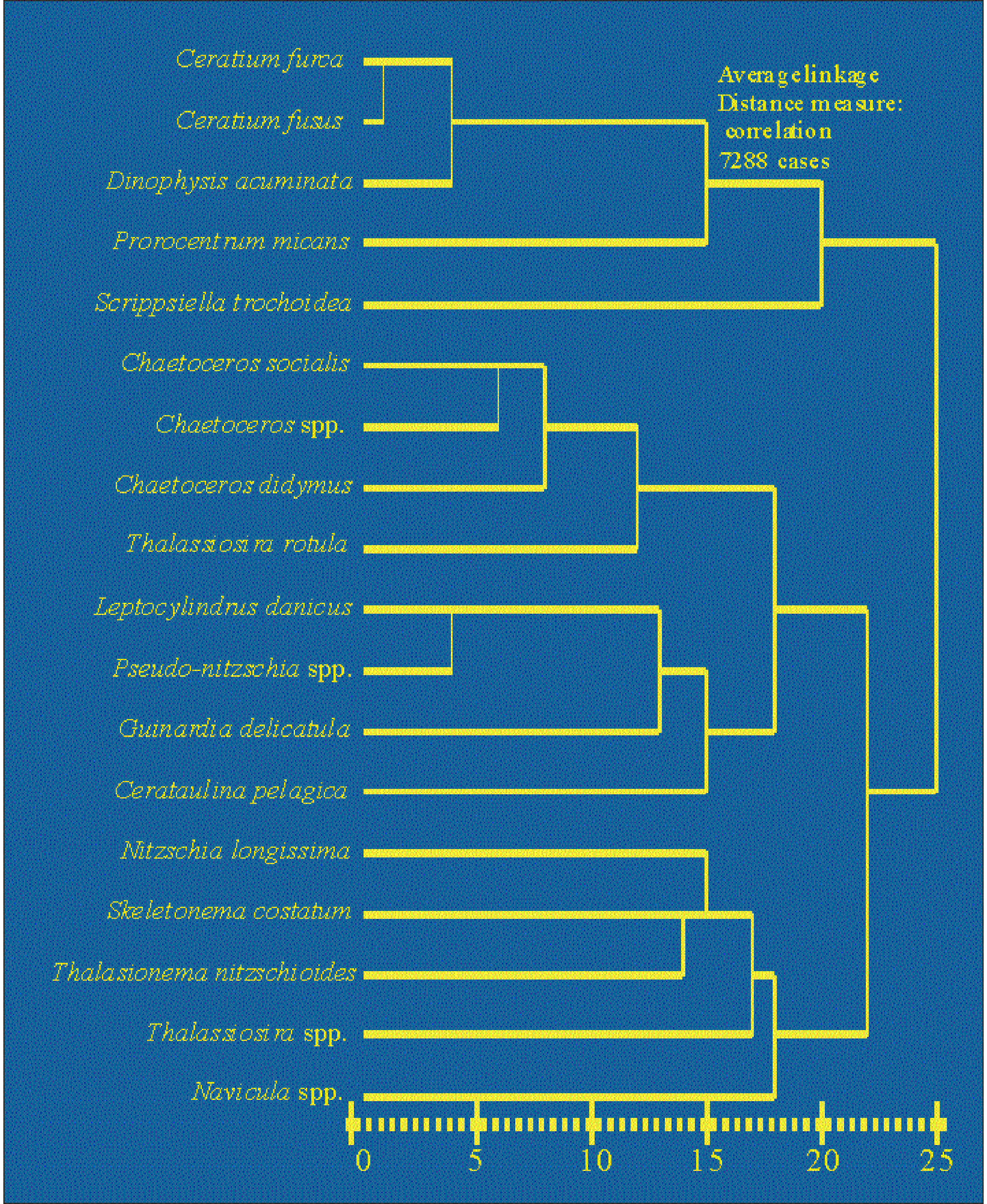
According to the Epidemiological Bulletin of the Xunta de Galicia, and despite the ban of harvesting of mussels, two people were poisoned by ASP with symptoms of confusion and memory loss after consuming cooked paella prepared with frozen mussels acquired out of the legal channels of commercialization.

Pazos et al., 2016 Florianapolis ICHA conference

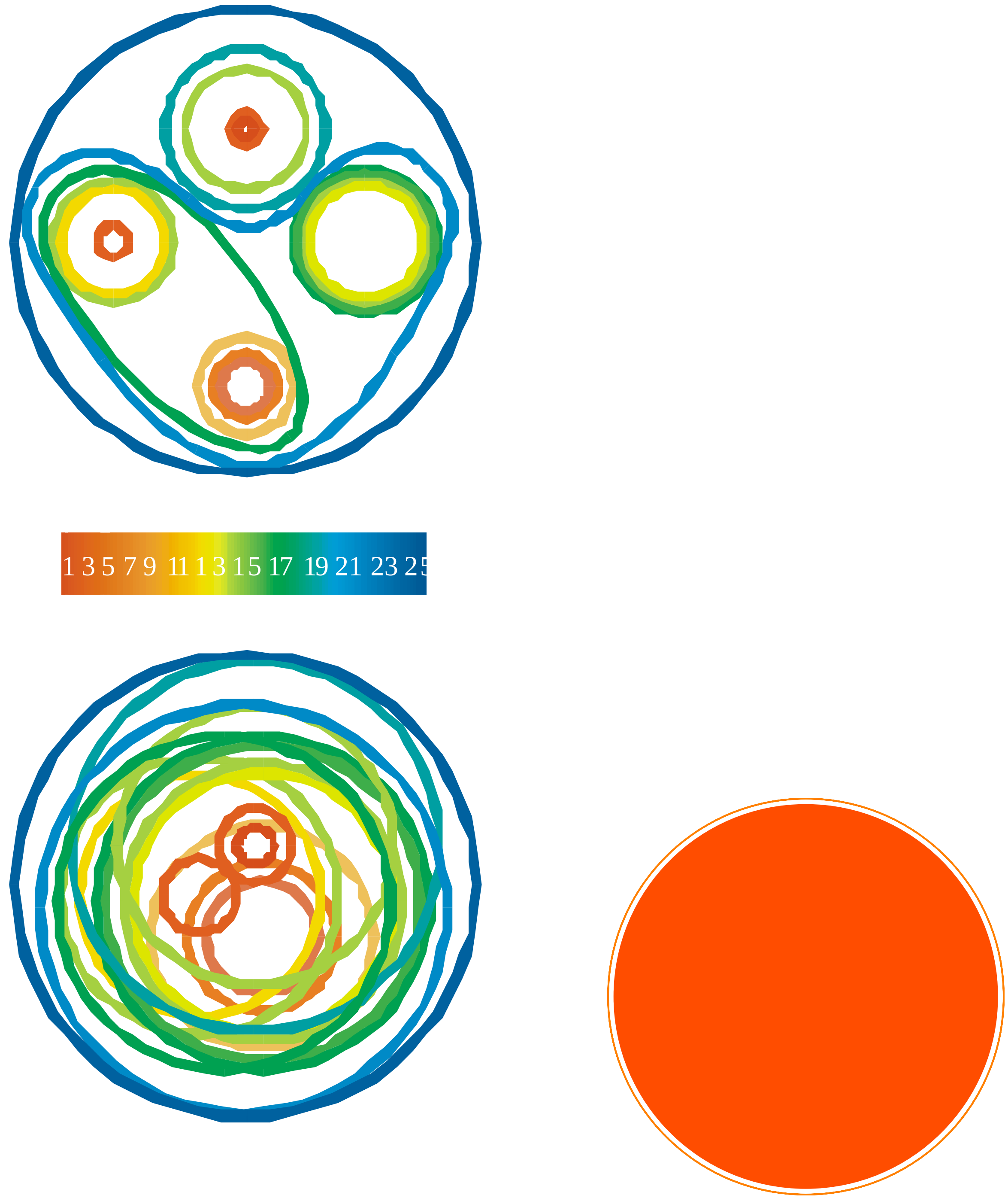
Phytoplankton assemblages by their cellular shape and its ecological significance

Yolanda Pazos[1], Juan Maneiro[1], Ángeles Moroño[1], Juan Blanco[2]

[1]INTECMAR. Vilagarcía de Arousa. Pontevedra. Spain. ypazos@cccmm.cesga.es [2]CIMA. Vilanova de Arousa. Pontevedra. Spain. Xunta de Galicia



The cluster analyses, using abundance of the most frequently detected (50 % of presence) phytoplankton species, was carried out including 7288 samples weekly collected, from 1992 to 1995, in 33 stations located in the Rías Baixas (NW, Spain). Cluster was made by average linkage using correlation measure in SPSS 11.5 statistical package.


1 3 5 7 9 11 13 15 17 19 21 23 25

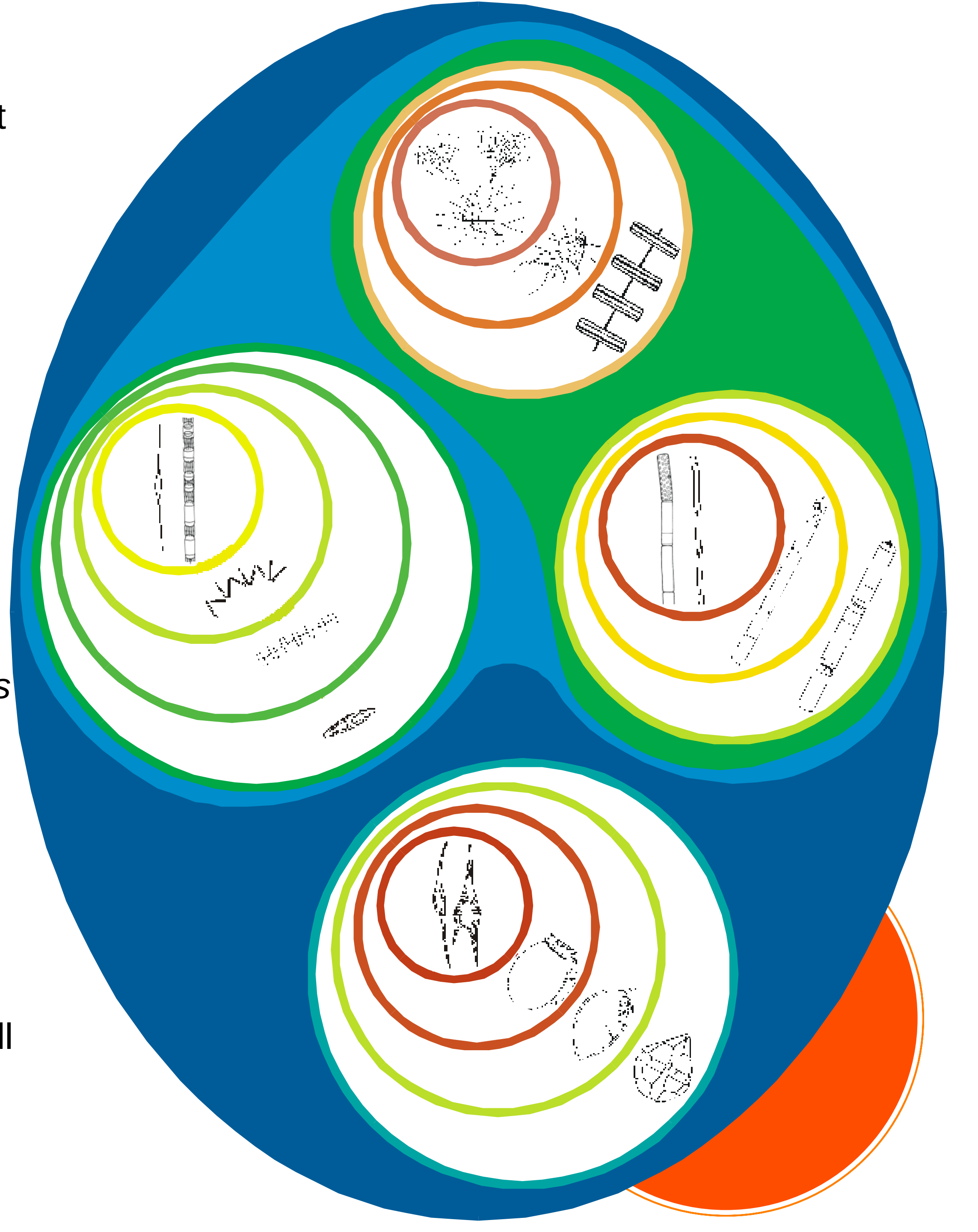
The first cluster included the dinoflagellate species that usually do not form chains, with low eccentricity and low surface/volume ratio: *Ceratium fusus, Ceratium furca, Dinophysis acuminata* and *Prorocentrum micans*.

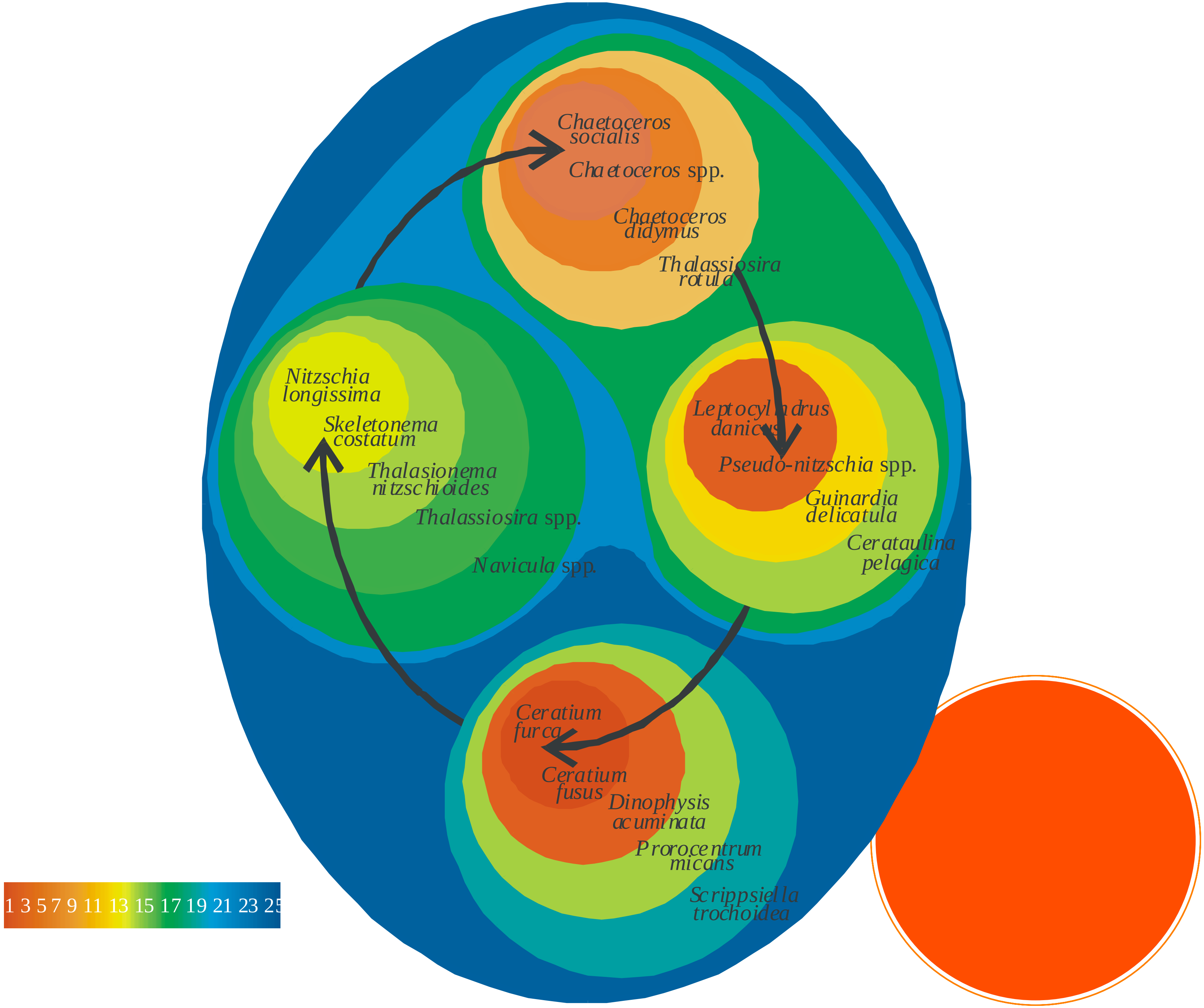
A second cluster associated all the remainder species, that it is all the diatoms. Inside of this second cluster there are three clusters.

One of those clusters comprised diatom species, with setae and chain, or colony formers: *Chaetoceros sociale, Chaetoceros* spp., *Chaetoceros didymus* and *Thalassiosira rotula.*

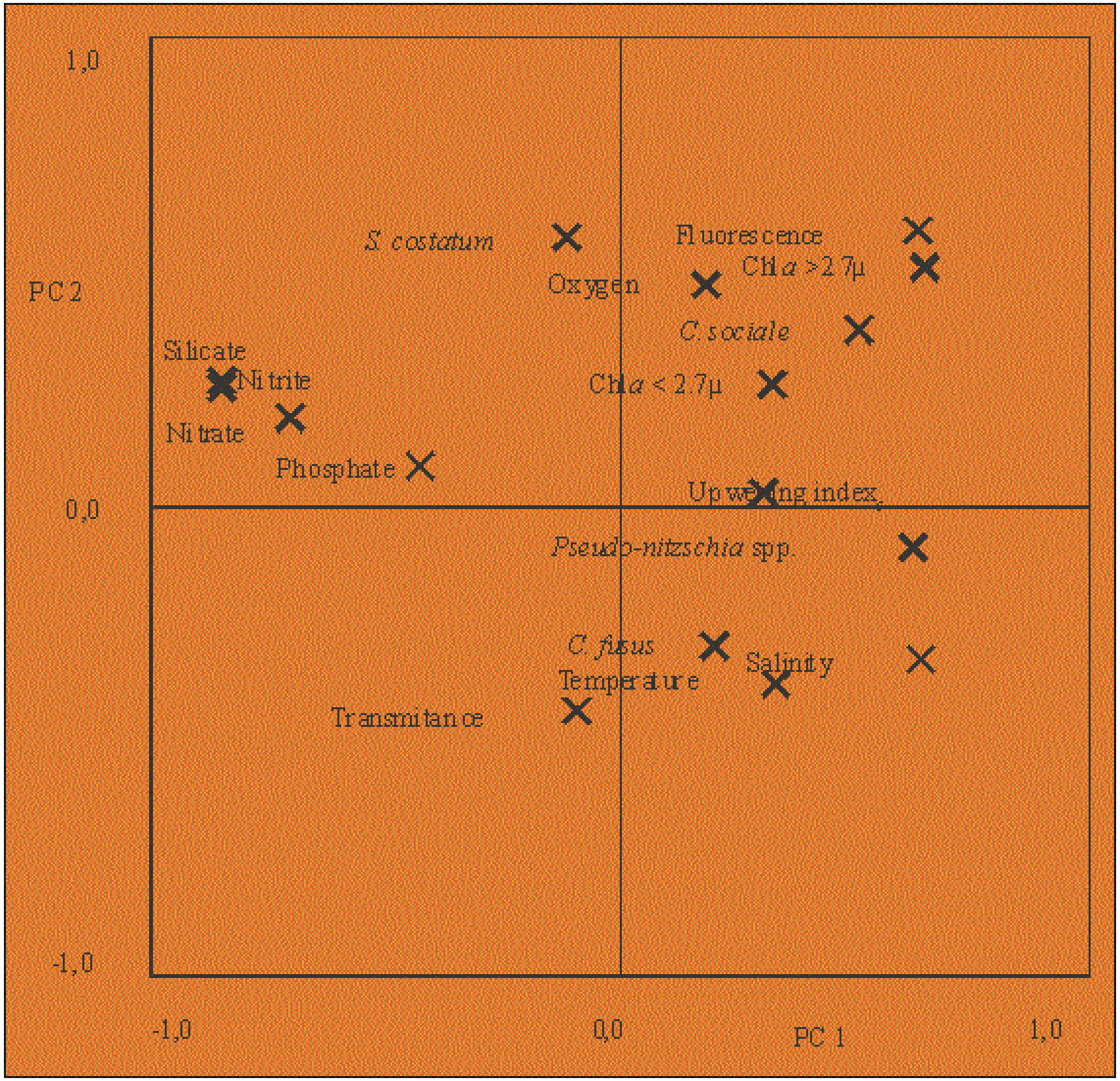
The diatom species that form long chains as *Pseudo-nitzschia* spp., *Leptocylindrus danicus, Guinardia delicatula* and *Cerataulina pelagica* are included in another cluster.

To the last cluster, were associated small diatom species: *Nitzschia longissima, Skeletonema costatum, Thalassionema nitzschioides*, small *Thalassiosira* spp. and small *Navicula* sp.



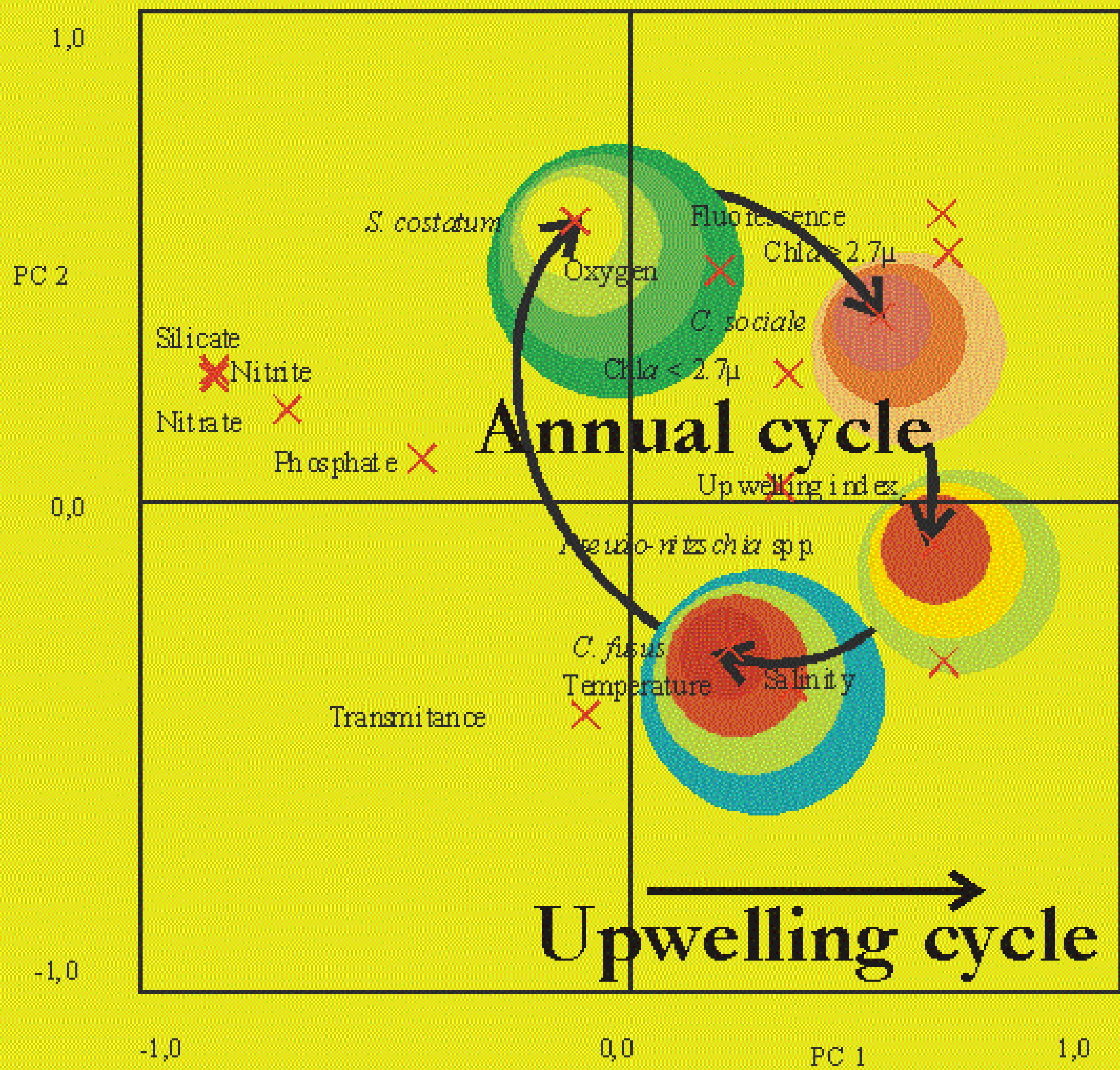


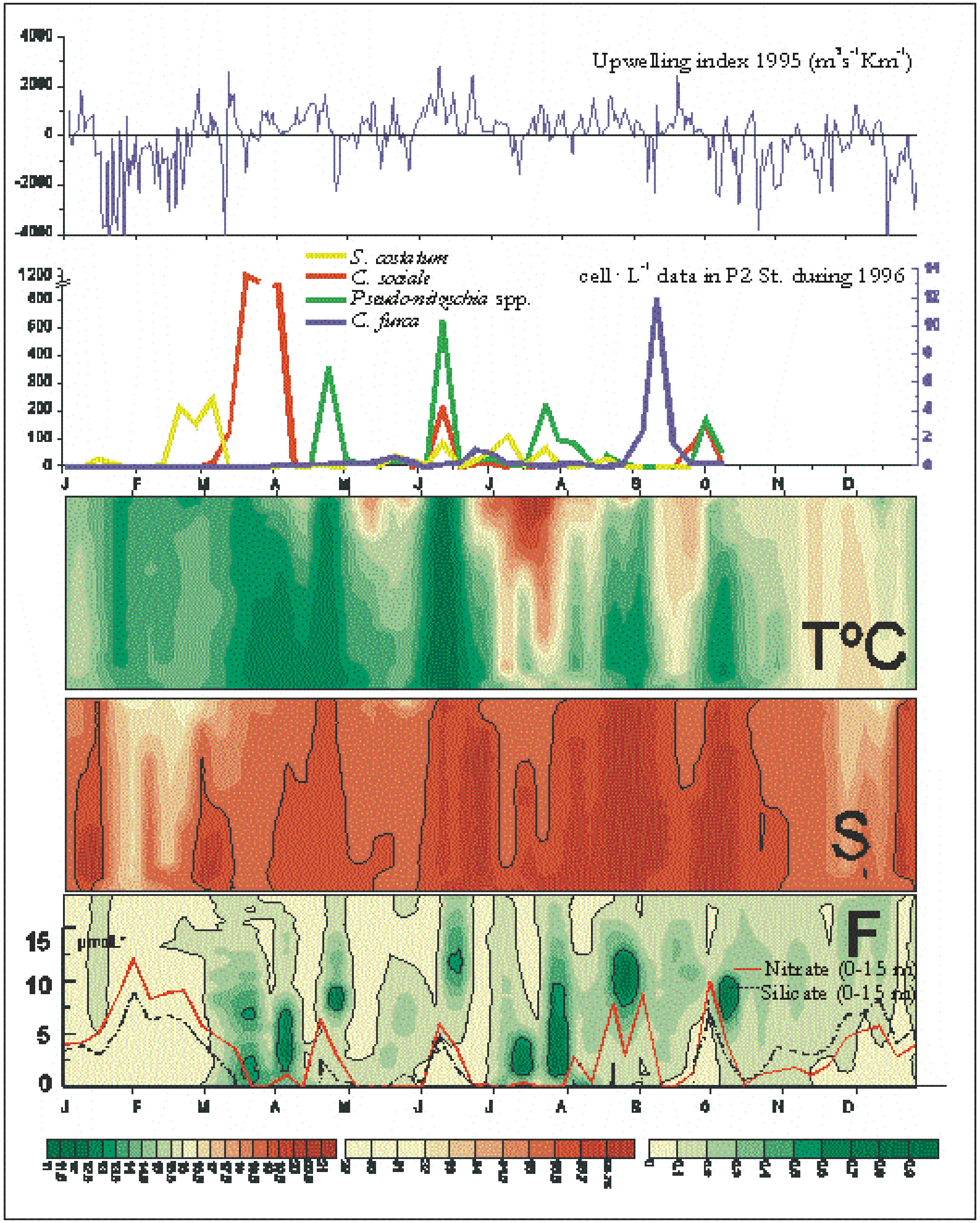
Chaetoceros socialis
Chaetoceros spp.
Chaetoceros didymus
Thalassiosira rotula
Nitzschia longissima
Skeletonema costatum
Thalasionema nitzschioides
Thalassiosira spp.
Navicula spp.
Leptocylindrus danicus
Pseudo-nitzschia spp.
Guinardia delicatula
Cerataulina pelagica
Ceratium furca
Ceratium fusus
Dinophysis acuminata
Prorocentrum micans
Scrippsiella trochoidea
1 3 5 7 9 11 13 15 17 19 21 23 25



A principal component analysis (PCA) was carried out, including: upwelling index calculated from geostrophic winds (average of previous five days to sampling date); temperature, salinity, transmitance, fluorescence, oxygen from CTD measurements; nutrient salts (silicates, nitrates, nitrites, phosphates, ammonium) obtained by colorimetry; chlorophyll a by spectrofluorimetry (fractions higher and lower of 2.7 µm) and cellular concentration of phytoplankton species extracted of the previous cluster analyses. This PCA led to the extraction of two components with eclological significance: a first component that explained a 29 % of variance and a second component that explained a 14 % of the total variance. .

The first component of PCA is related to upwelling, primary production and decrease of nutrients. The second component showed a gradation in loadings from winter to autumn, and then associated to the annual cycle. Both components led to identify an annual cycle of species succession in winter, spring, summer and autumn to which are superimposed the following cycles: upwelling, upwelling relaxation and winter mixing.





It is possible to see an example of this theory in the data obtained in P2 station throughout 1995.

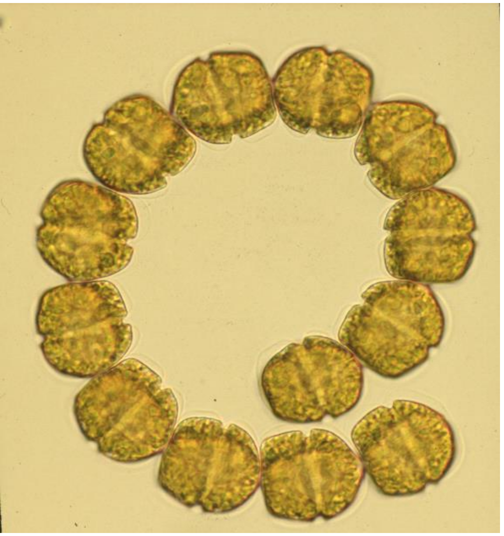
The cellular shape of species of each cluster are related to with the oceanographic conditions inside the succession cycle.

The dinoflagellates of rounded forms (including the diarrhetic species *Dinophysis acuminata*) appear in summer and relaxation of upwelling, small diatoms are present in winter mixing situation adapted to turbulence, the setae of the spring diatoms are related to higher surface volume ratio to prevent sinking and finally the elongated chain-forming diatoms (including potentially amnesic species of the genus *Pseudo-nitzschia*) are related to strong upwelling in summer.

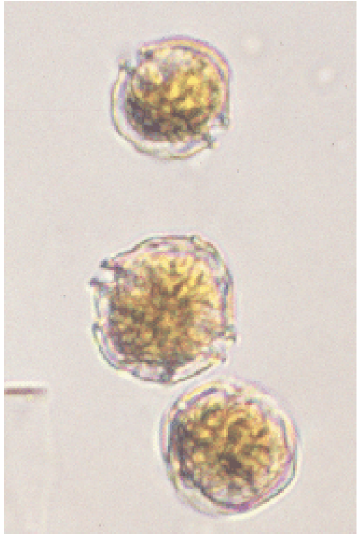
Paralizantes (PSP)

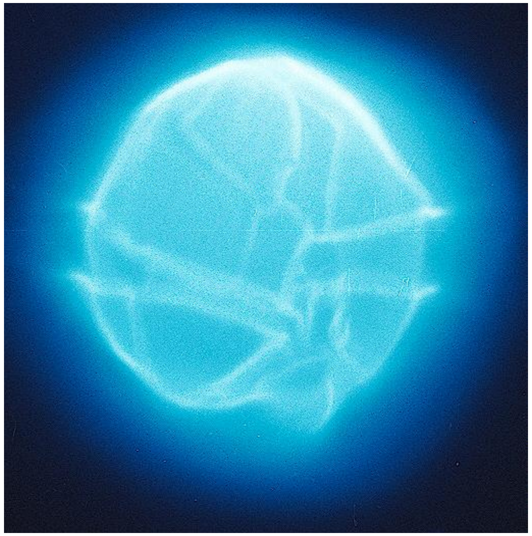
La acumulación de toxinas paralizantes en los moluscos de las Rías Galegas es debida sobre todo a dos especies: *Gymnodinium catenatum* y *Alexandrium minutum.* A pesar de su gravedad en los últimos años estos episodios fueron muy escasos en Galicia.

Clase Dinophyceae



Gymnodinium catenatum Graham, 1943



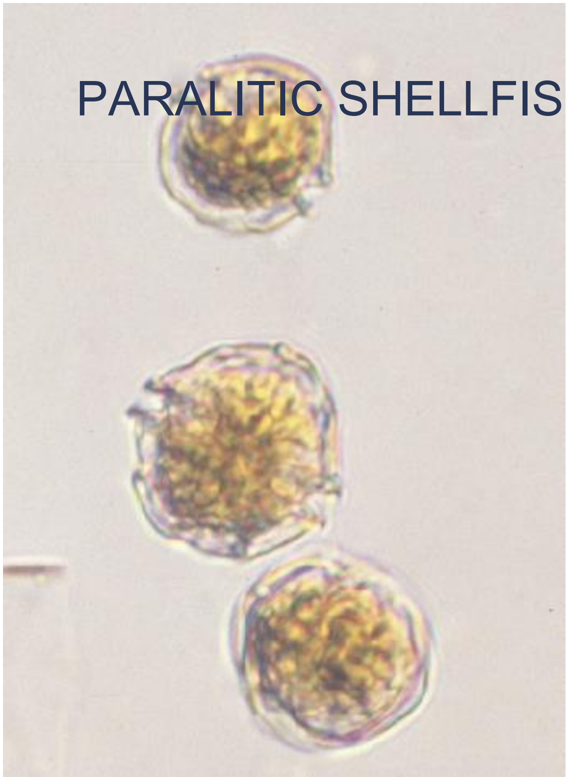


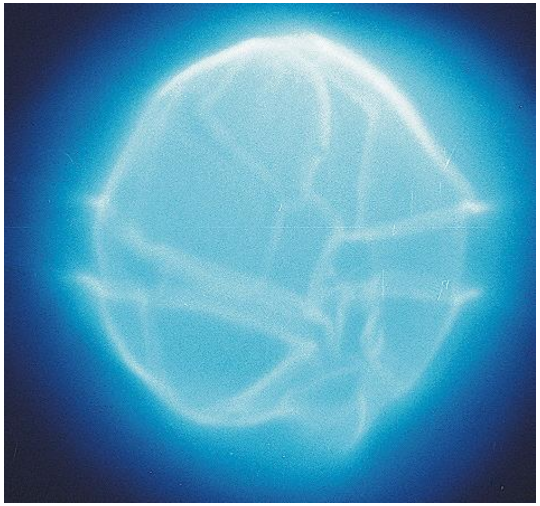
Alexandrium minutum Halim, 1960

Dinoflagelados

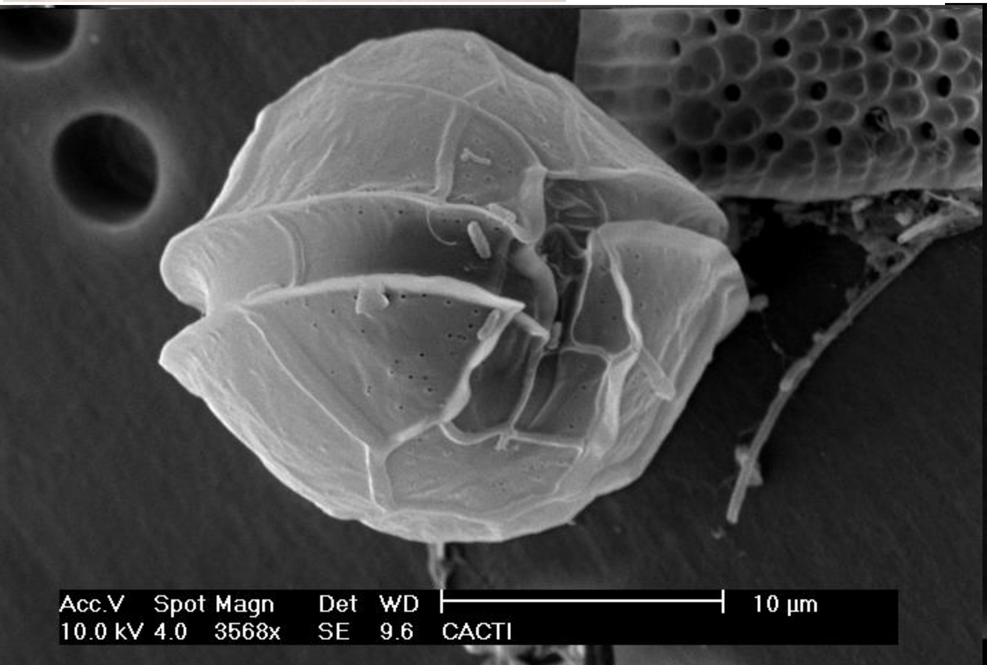
Paralizantes (PSP)

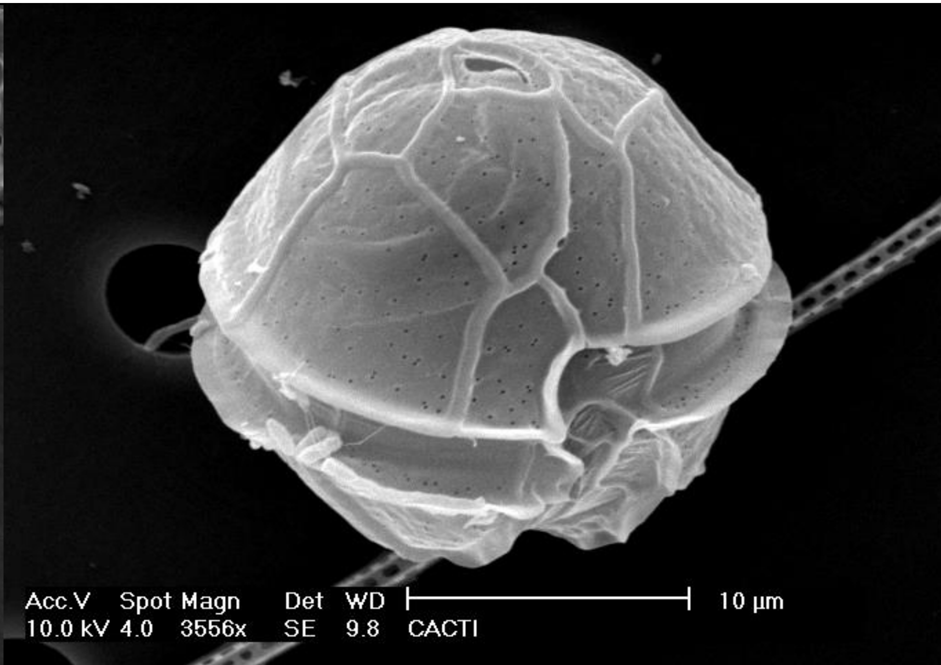
PARALITIC SHELLFISH POISONING PRODUCER SPECIES





Alexandrium minutum Halim, 1960

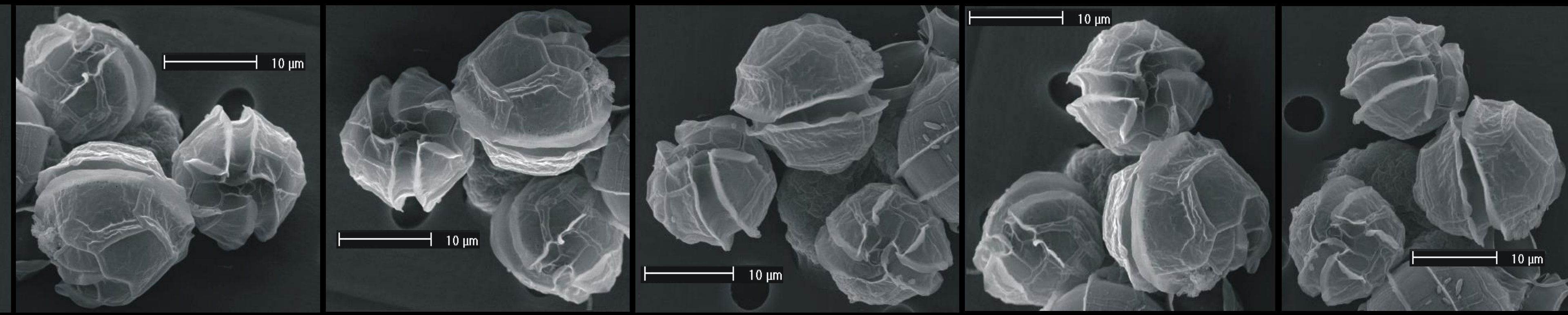


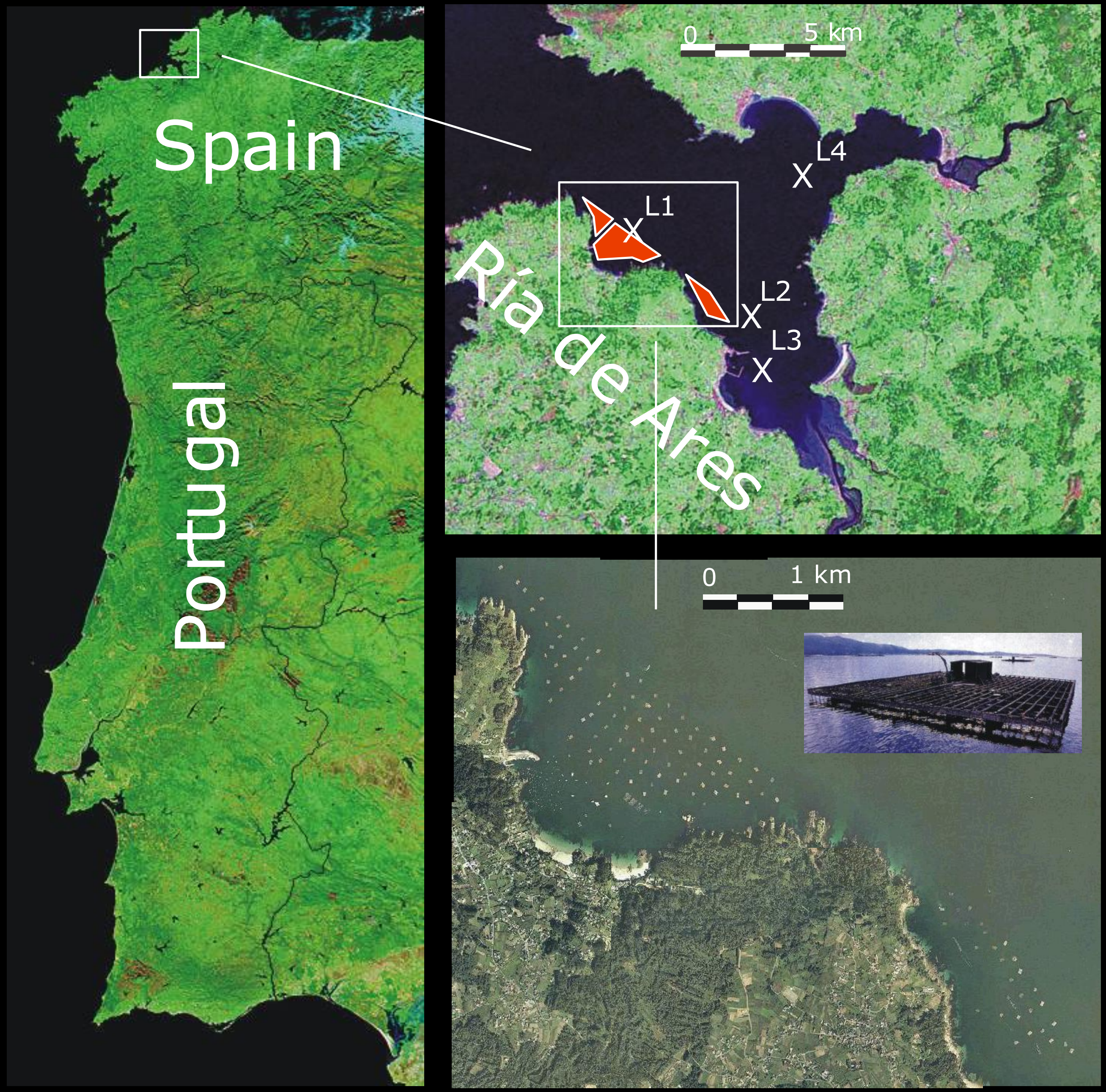


TIME SERIES ANALYSIS (1992-2003) OF *Alexandrium minutum* HALIM AND ITS OCEANOGRAPHIC CONDITIONS IN GALICIA (NW SPAIN)

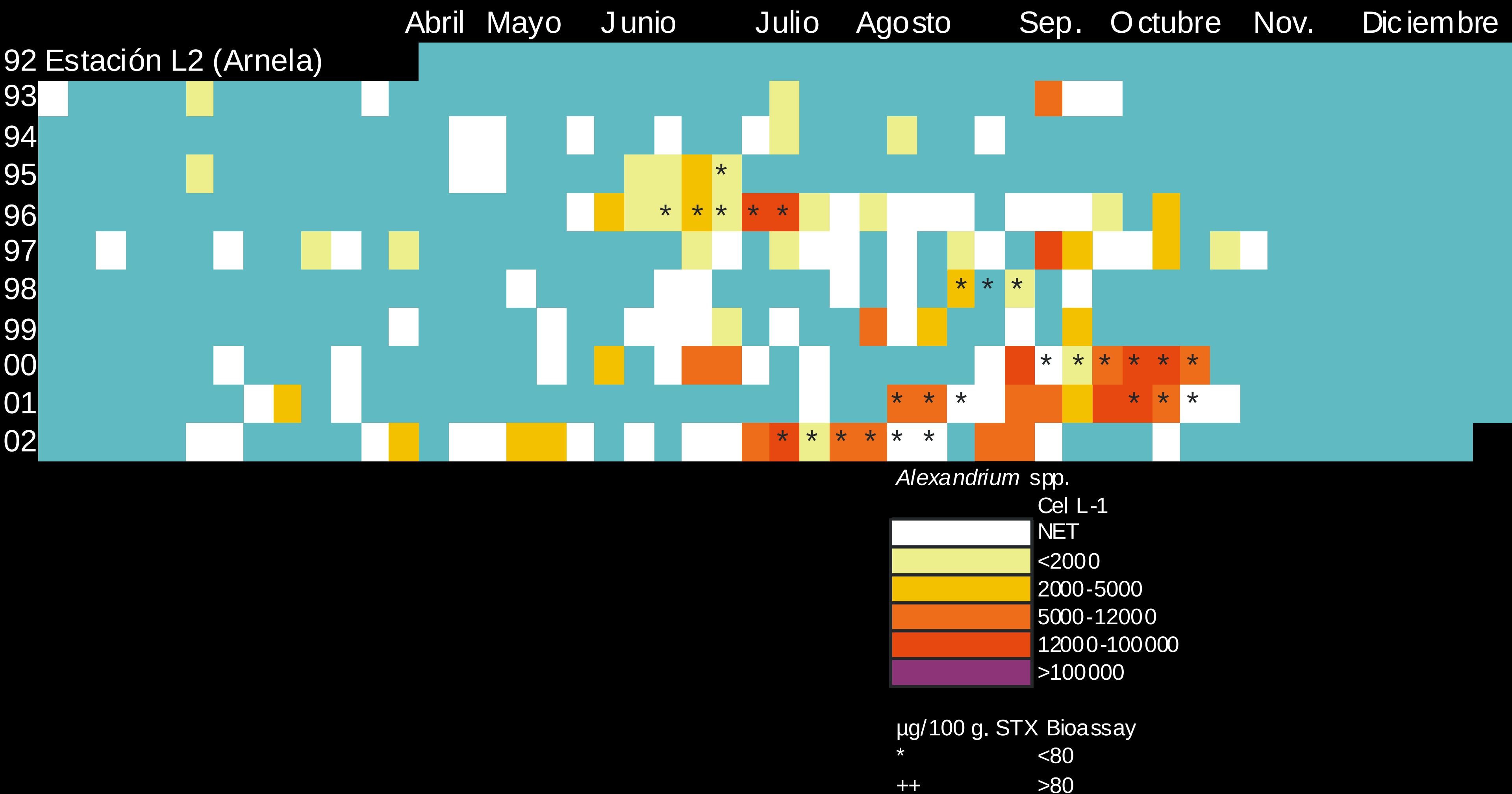
Y Pazos[1], J Maneiro[1], Á Moroño[1], M Doval[1] & J Blanco[2]

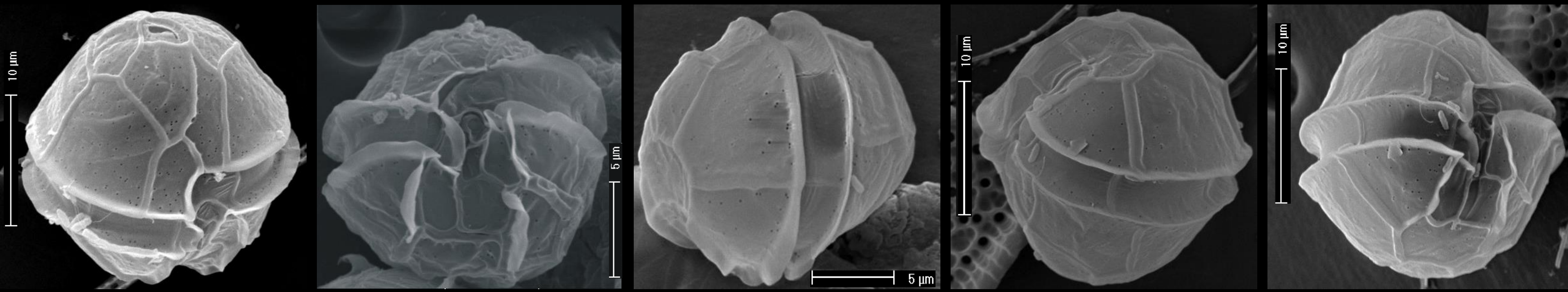
[1]INTECMAR. [2]Centro de Investigacións Mariñas. Consellería de Pesca e Asuntos. Xunta de Galicia

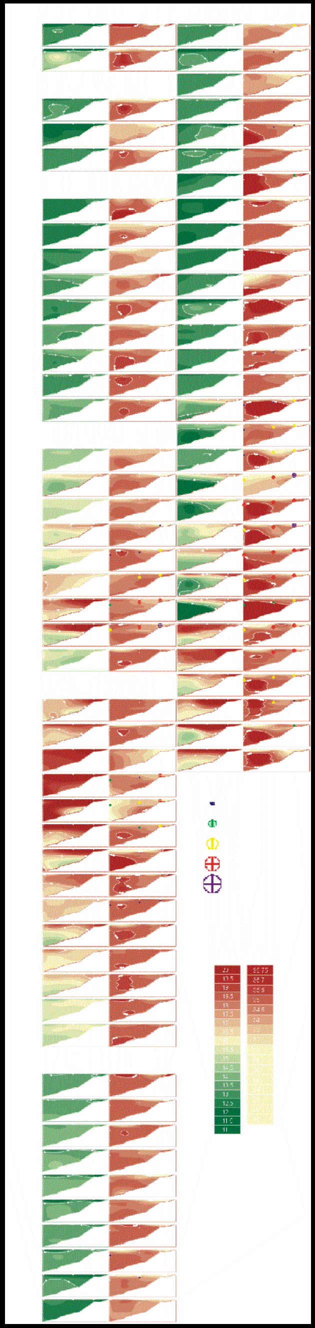


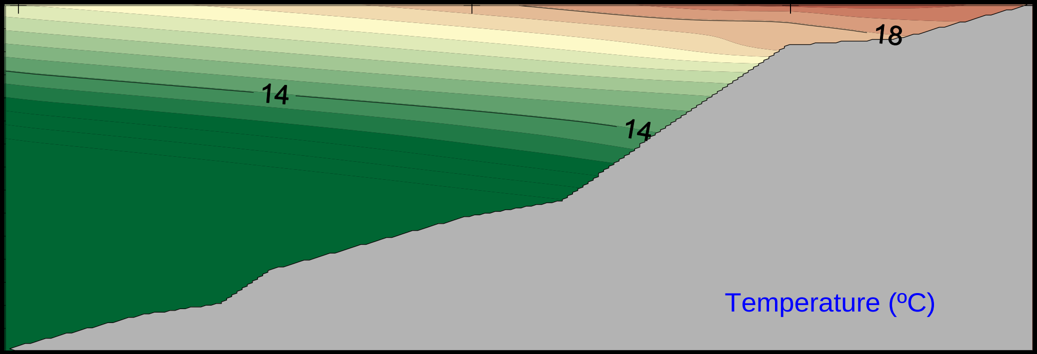


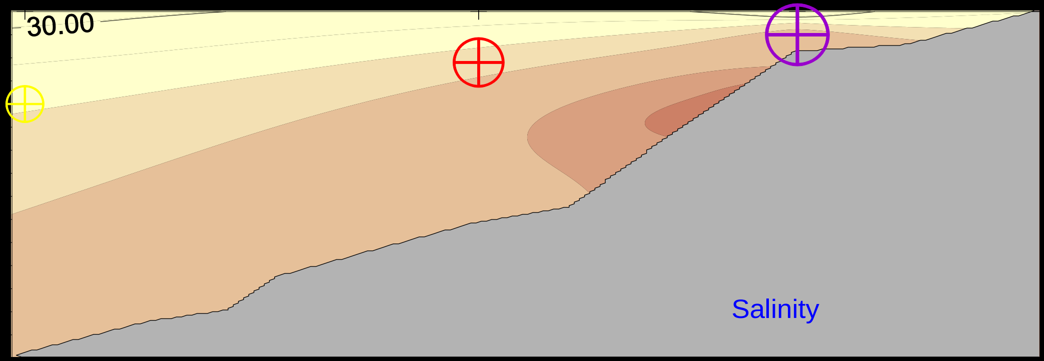
Distribution of mussel rafts production areas and position of oceanographic stations in the Ría de Ares


Abril
Mayo
Junio
Julio
Agosto
Sep.
Octubre
Nov.
Diciembre
92 Estación L2 (Arnela)
93
94
95
96
97
98
99
00
01
02
Alexandrium spp.
Cel L-1
NET
<2000
2000-5000
5000-12000
12000-100000
>100000
µg/100 g. STX Bioassay
* <80
++ >80

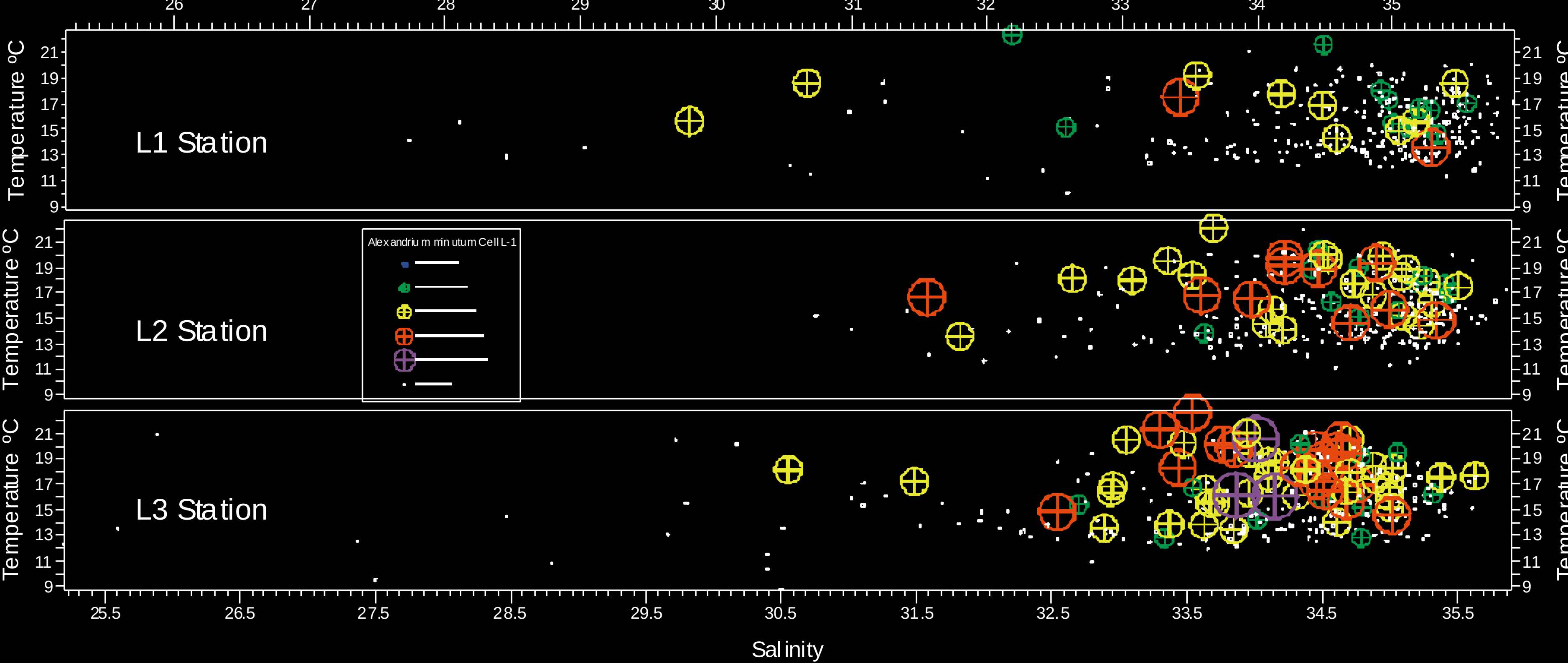

10 µm
5 µm
5 µm
10 µm
10 µm







The intensive analysis from three sampling points, located along the river-ocean axis, allow to conclude that the *A. minutum* populations develop by *in situ* grow in the inner part of the Ría with a dilution effect oceanwards.

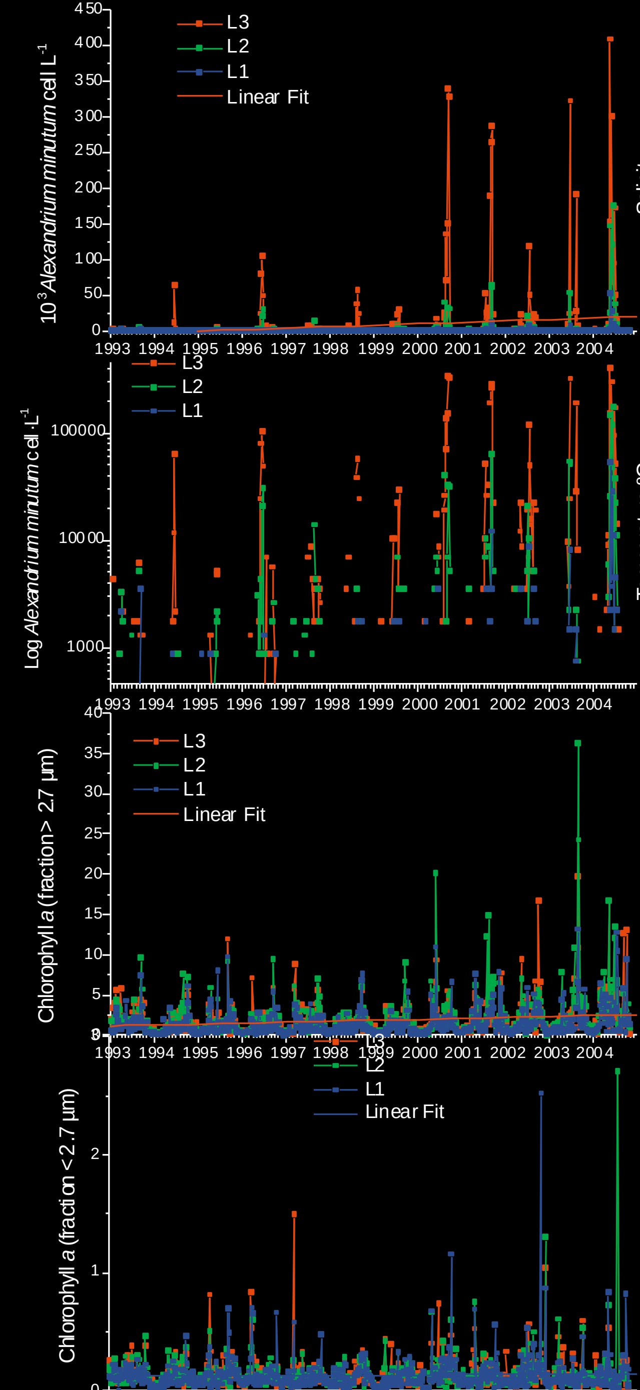


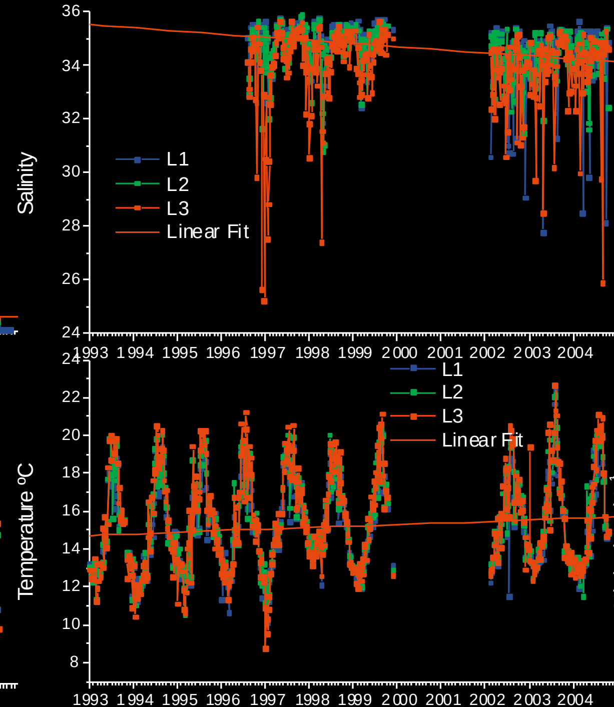
T/S diagrams allow to conclude that it's a brackish water organism.

A. minutum displays the higher cellular concentrations in a range of salinity of 33,5 and 35,0 and practically it doesn't appear with values higher than 35,5 and lower than 29.

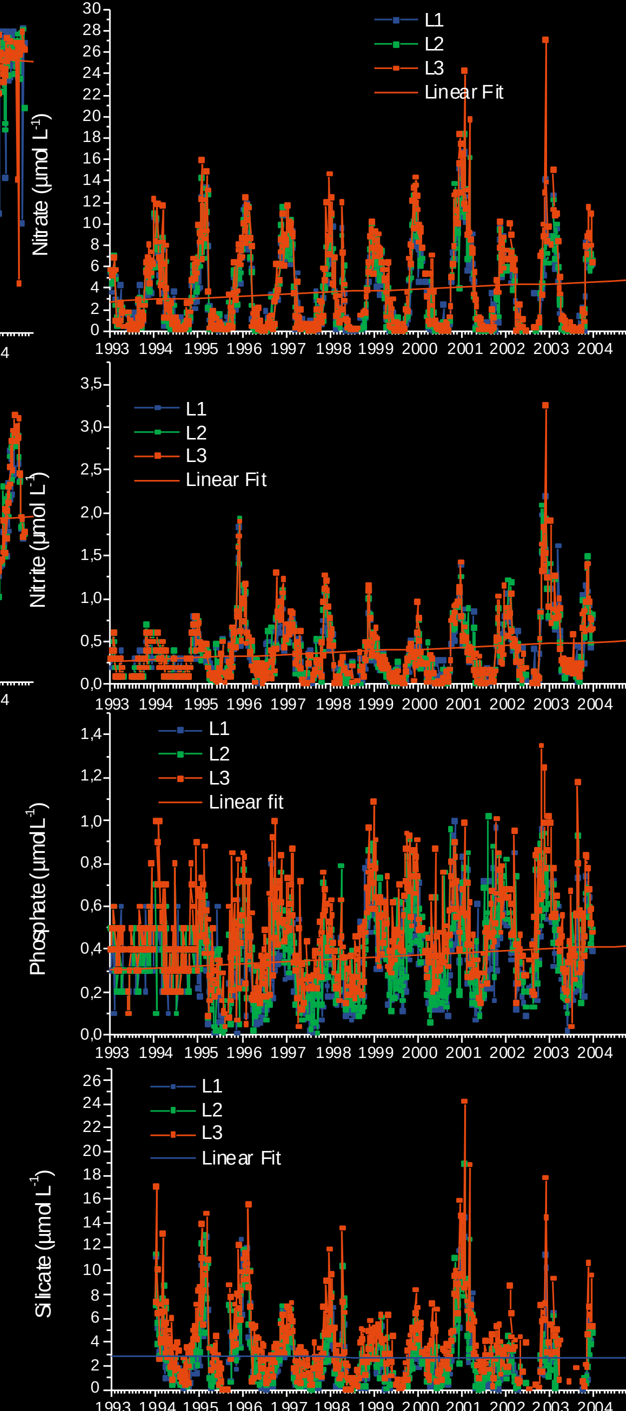
Regarding temperature, the favourable range is wide, between 13,5 and 20ºC. *A. minutum* doesn't appear related to upwelled waters.

It is also possible to observe that the inner station is the most affected by populations of *A. minutum* in agreement with its most brackish character.





A. minutum increase cell concentrations throughout this studied decade. The linear tendency was significant (P<0.001) for all the variables except: chlorophyll *a* concentration for phytoplankton <2,7 µm and silicate concentrations.



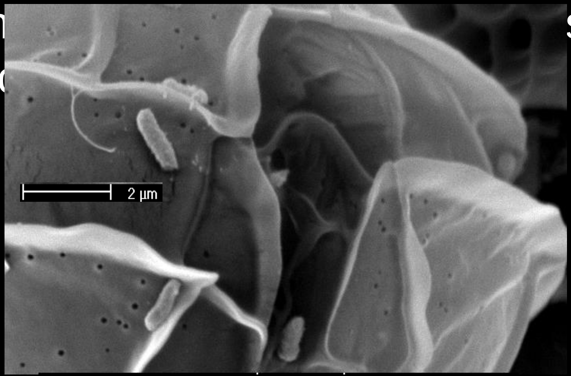
An apparent increase in toxic harmful algal blooms is detected by a weekly oceanographic conditions and phytoplankton monitoring, carried out since 1992, in Ría de Ares (NW Spain).

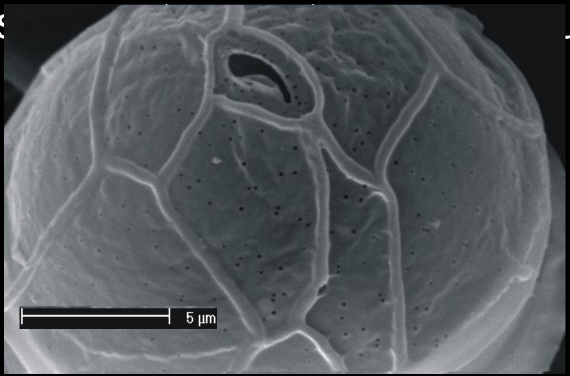
The small thecate dinoflagellate *Alexandrium minutum* Halim is the causative species of PSP toxins accumulation by rafts mussels and other molluscs cultivated in the area. PST detection was always predicted by previous detection of *A. minutum* cells in seawater.

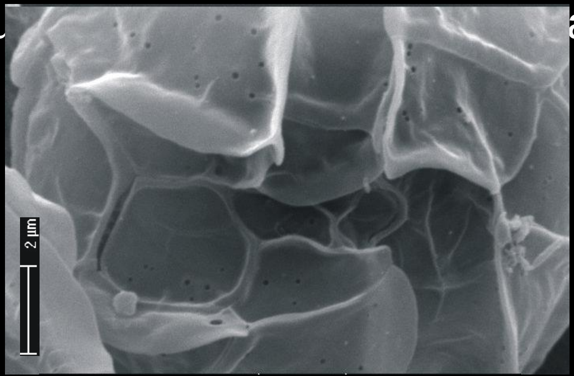
The intensive analysis from three sampling points, located along the river-ocean axis, allow to conclude that the *A. minutum* populations develop by *in situ* grow in the inner part of the Ría with a dilution effect oceanwards.

Annual distribution shows a seasonal component with maximum cell around 1. 10^5 cell L^{-1} in June. Blooms of this species are detected in September (max. 3. 10^5 cell L^{-1}) in the inner part of the Ría associated to an oceanographic front, in downwelling situations with blocking of estuarine circulation.

A temporal trend to increase was observed for *A. minutum*, nitrates, nitrites and ph a
fa







Early detection and intensive monitoring during an unusual toxic bloom of *Gymnodinium catenatum* advected into the Galician Rías (NW, Spain)

Yolanda Pazos[1], Ángeles Moroño[1], Joaquín Triñanes[2], Mariló Doval[1], Pedro Montero[1], M. Graça Vilarinho[3] and M.Teresa Moita[3]

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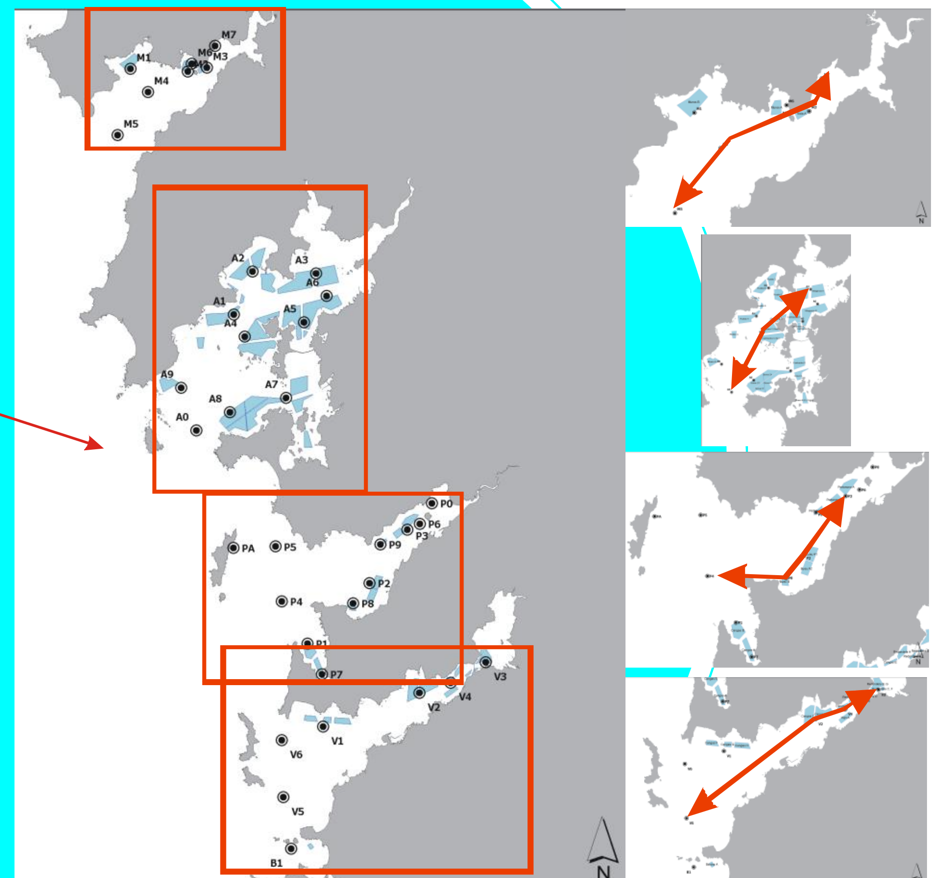
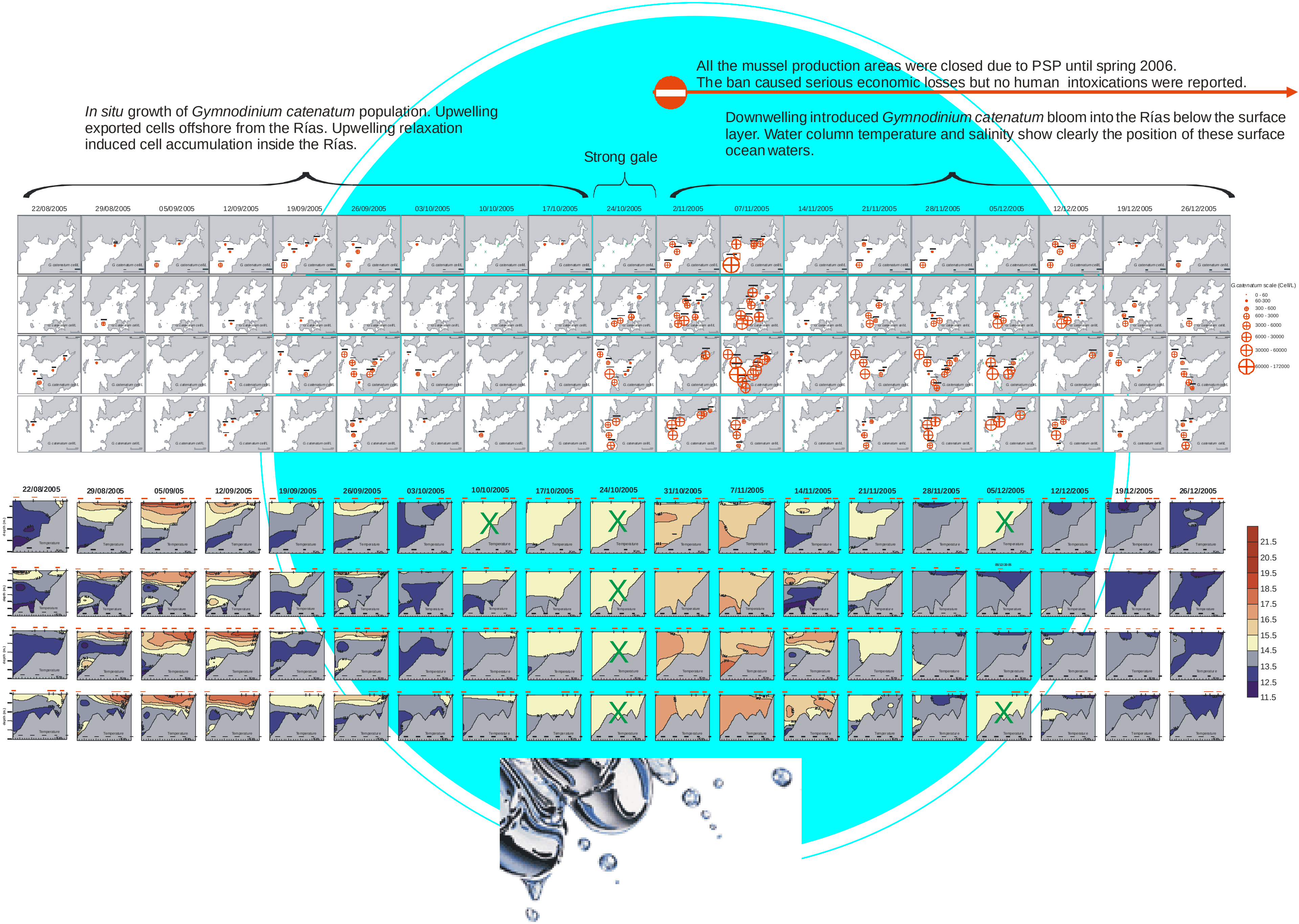
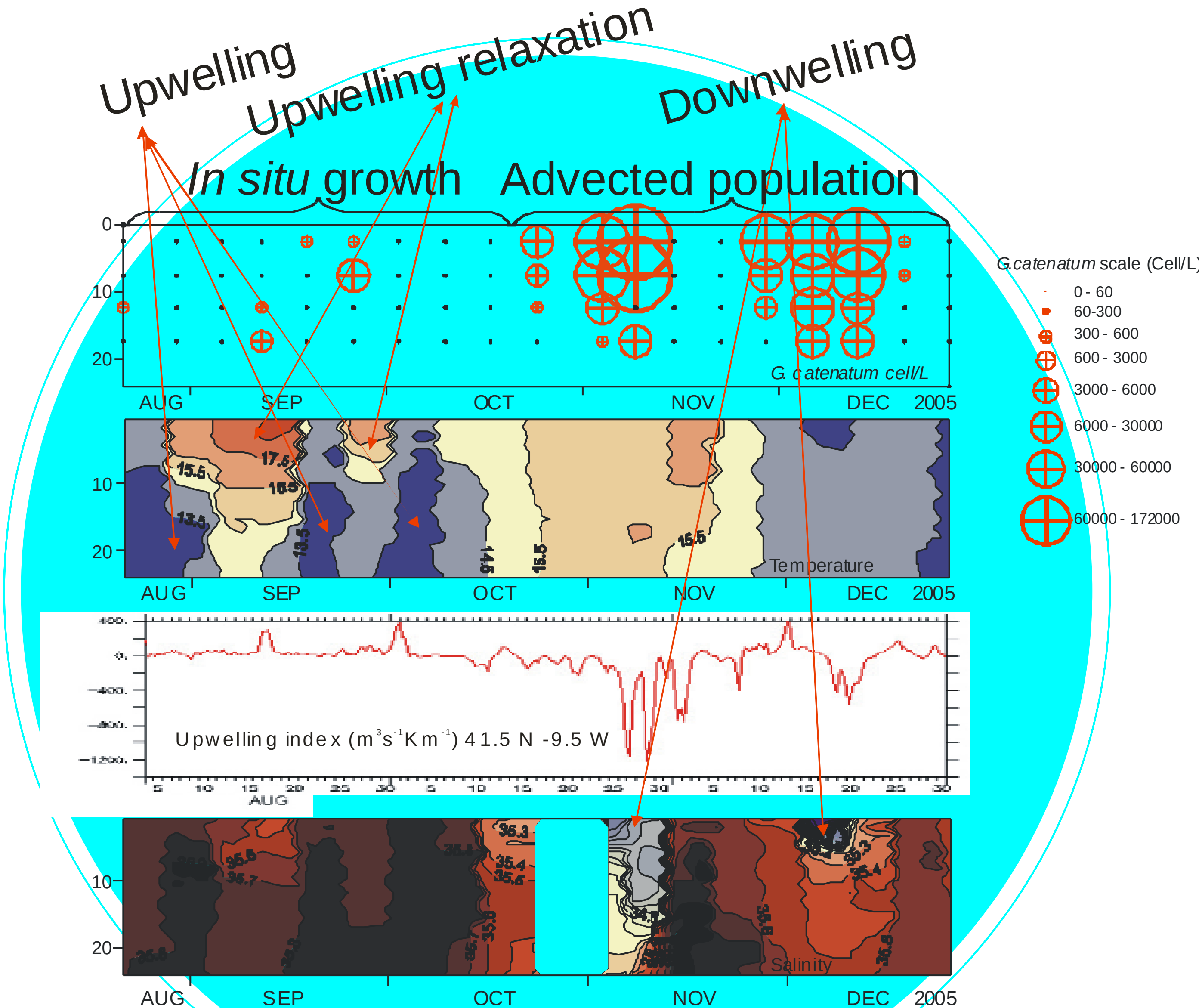


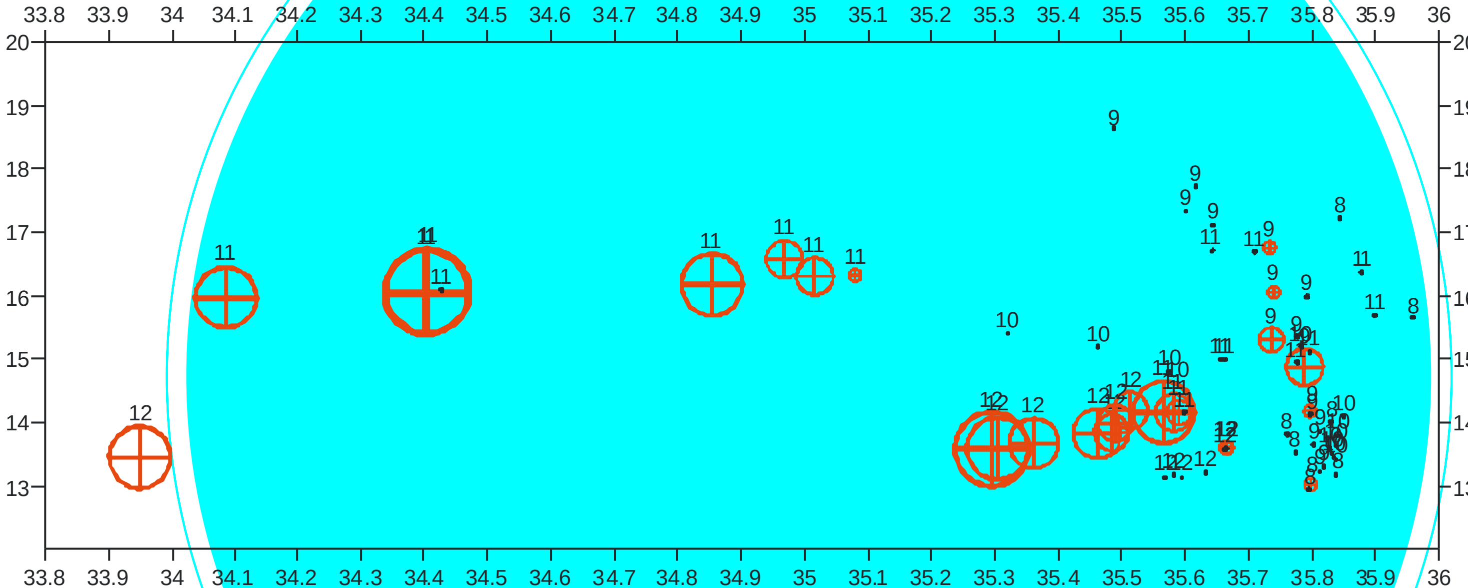
Location of oceanographic stations, weekly monitorized by INTECMAR in the Galician Rías, since 1992. Blue polygons represents the position of the raft mussel culture areas.



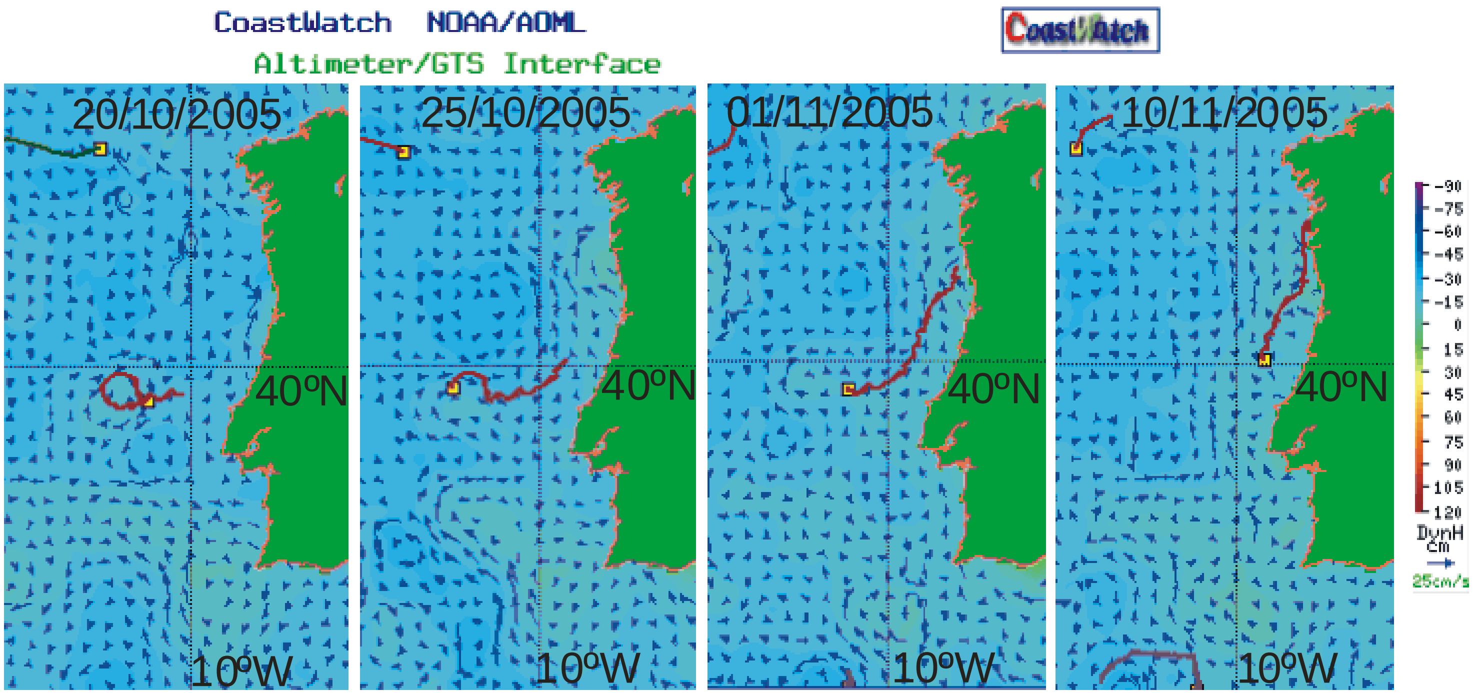
All the mussel production areas were closed due to PSP until spring 2006.
The ban caused serious economic losses but no human intoxications were reported.
In situ growth of Gymnodinium catenatum population. Upwelling exported cells offshore from the Rías. Upwelling relaxation induced cell accumulation inside the Rías.
Downwelling introduced Gymnodinium catenatum bloom into the Rías below the surface layer. Water column temperature and salinity show clearly the position of these surface ocean waters.
Strong gale
22/08/2005
29/08/2005
05/09/2005
12/09/2005
19/09/2005
26/09/2005
03/10/2005
10/10/2005
17/10/2005
24/10/2005
2/11/2005
07/11/2005
14/11/2005
21/11/2005
28/11/2005
05/12/2005
12/12/2005
19/12/2005
26/12/2005
G.catenatum scale (Cell/L)
0 - 60
60-300
300 - 600
600 - 3000
3000 - 6000
6000 - 30000
30000 - 60000
60000 - 172000
22/08/2005
29/08/2005
05/09/05
12/09/2005
19/09/2005
26/09/2005
03/10/2005
10/10/2005
17/10/2005
24/10/2005
31/10/2005
7/11/2005
14/11/2005
21/11/2005
28/11/2005
05/12/2005
12/12/2005
19/12/2005
26/12/2005
Temperature
21.5
20.5
19.5
18.5
17.5
16.5
15.5
14.5
13.5
12.5
11.5

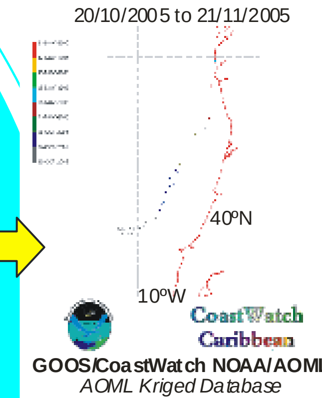


Vertical distribution of *G. catenatum*, temperature, upwelling index, and salinity in P2 station.

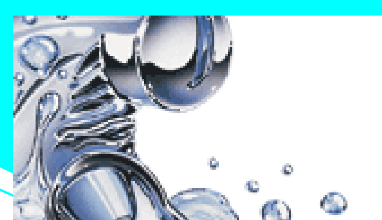


T-S diagram and *G. catenatum* cell concentration in P2 station. Numbers indicate the month.





Data from a lagrangian drifter (NOAA/CoastWatch) confirmed the presence of a northward coastal current (Vel ~0.2-0.6 $m \cdot s^{-1}$) that appears to have advected the bloom northwards.

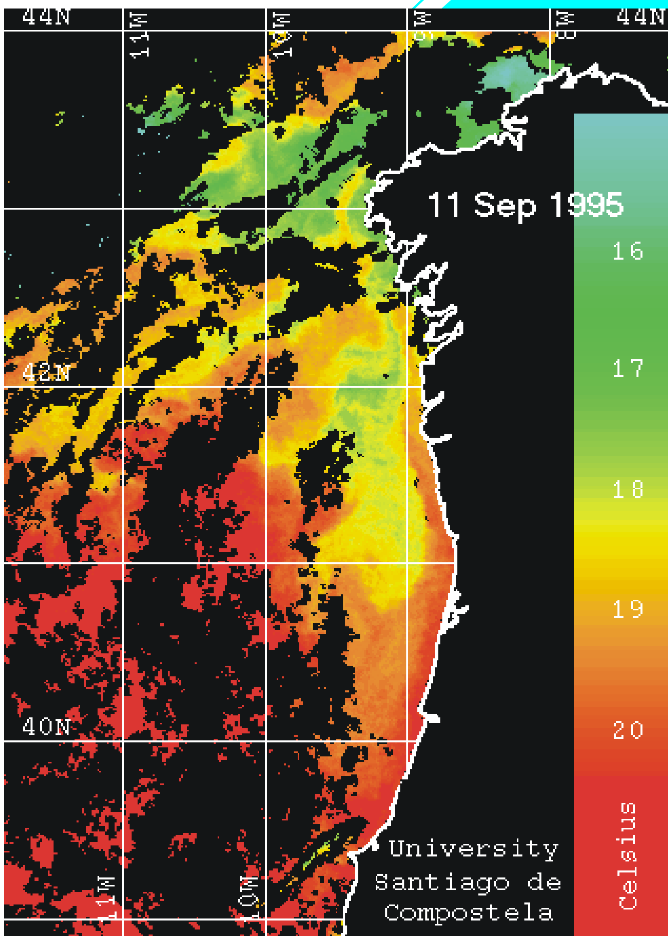


Cooperation between Galician and Portuguese monitoring programs allowed an early alert of a *Gymnodinium catenatum* bloom in the Galician Rías a month before the PSP toxins accumulation in mussels.

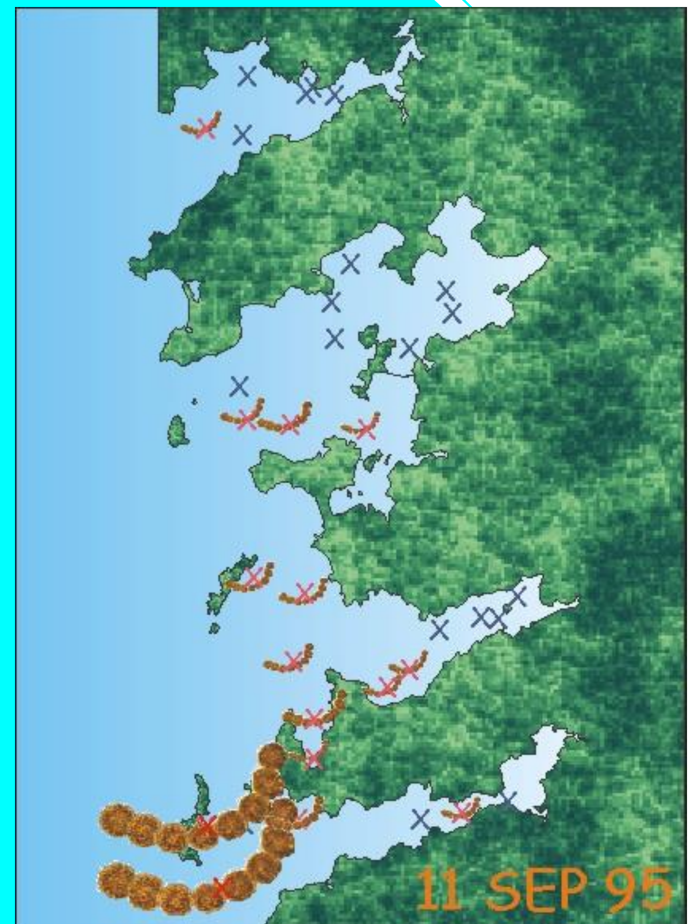
This intense and persistent episode caused bans on mussel culture areas (average production>$2 \cdot 10^5$ Tons·y^{-1}) until mid February, having an important social and economic impact.

From the near real-time sea surface temperature fields, it was inferred that a northward coastal current was present during this period.

Data from a lagrangian drifter (NOAA/CoastWatch) confirmed the presence of a northward coastal current (Vel ~0.2-0.6 $m \cdot s^{-1}$) on these dates.



44N
11W
10W
9W
8W
44N
11 Sep 1995
16
17
18
19
20
Celsius
42N
40N
11W
10W
University
Santiago de
Compostela



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