Diversità delle fioriture algali tossiche

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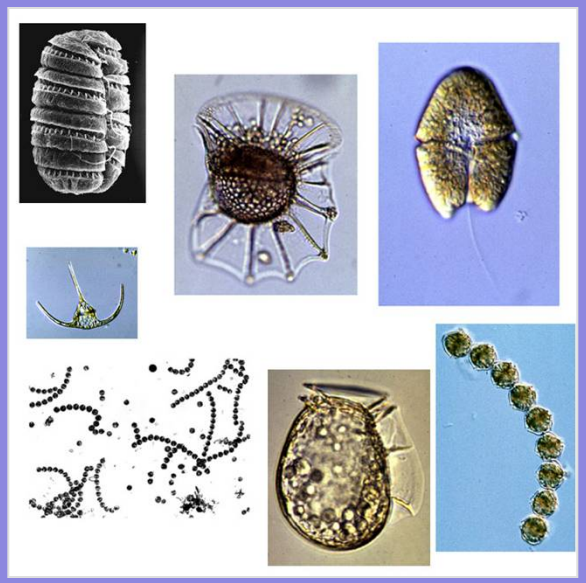
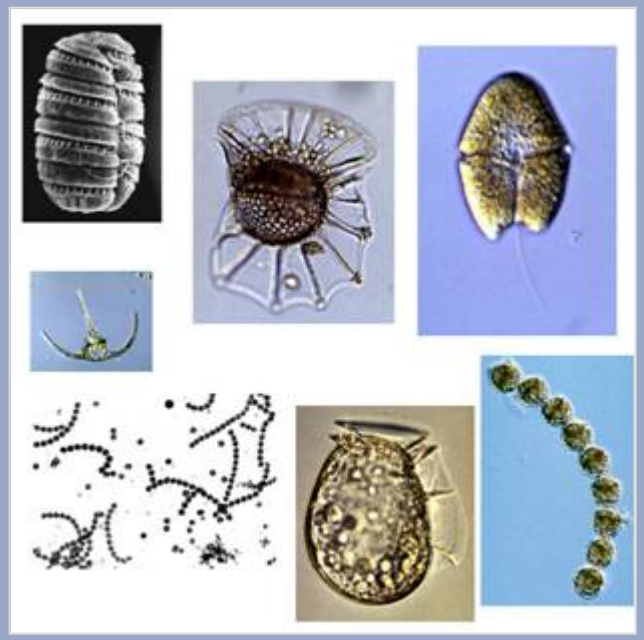


Che cosa si intende per fioritura, o bloom?

- **Bloom primaverile**
- **Bloom di una specie**

Si definisce ‘bloom’ o ‘fioritura’ un aumento della biomassa di una singola specie o di tutto il comparto autotrofo rispetto ai rispettivi valori di base

Che cosa si intende per FIORITURE ALGALI NOCIVE, o HARMFUL ALGAL BLOOMS (HAB)?



HAB = Fioriture algali nocive
- sono causati da microalghe
- producono effetti dannosi per la salute e le attività umane o per l'ambiente

In che modo gli HAB producono danni?

Salute umana

Paralytic shellfish poisoning (PSP)	**Dinoflagellati**	*Alexandrium* spp.,*P. bahamense* var. *compressum* , *G. catenatum*
	Cianobatteri	*Anabaena circinalis*
Diarrhetic shellfish poisoning (DSP)	**Dinoflagellati**	*Dinophysis* spp.,*Prorocentrum* spp.
Neurotoxic shellfish poisoning (NSP)	**Dinoflagellati**	*Karenia brevis (=Gymnodinium brev*
Amnesic shellfish poisoning (ASP)	**Diatomee**	*Pseudo-nitzschia* spp.,*Nitzschia* sp.
Ciguatera fish poisoning (CFP)	**Dinoflagellati**	*Gambierdiscus toxicus*
Azaspiracid shellfish poisoning (AZP)	**Dinoflagellati**	***Azadinium spinulosum, A. Spp.***
Allergie, problemi respiratori e irritazioni della pelle	**Dinoflagellati**	*Karenia brevis, Pfiesteria piscicida*
	Cianobatteri	*Nodularia spumigena*
Epatotossicità	**Cianobatteri**	*Microcystis aeruginosa, Nodularia spumigena*

In che modo gli HAB producono danni?

Risorse marine naturali e di allevamento

anossia/H_2S , St Helena Bay, South Africa

Effetti ematolitici, epatotossici, osmoregolatori e tossicità aspecifica di origine ignota

Dinoflagellati	*Gymnodinium* spp., *Margalefidinium polykrikoides (=Cochlodinium polyk.),*
	Pfiesteria piscicida, Gonyaulax spp.
Rafidoficee	*Heterosigma akashiwo, Fibrocapsa japonica*
Primnesioficee	*Chrysochromulina* spp., *Prymnesium* spp., *Phaeocystis* spp.
Cianobatteri	*Microcystis aeruginosa*
Dinoflagellati	*Prorocentrum micans, Tripos furca (=Ceratium furca)*
Pelagoficee	*Aureococcus anophagefferens*
Diatomee	*Chaetoceros* spp.
Prymnesiophytes	*Phaeocystis* spp.

Ipossia, anossia, H_2S

Effetti negativi sull'alimentazione

Danni meccanici

Intasamento delle branchie e necrosi

In che modo gli HAB producono danni?

Turismo e attività ricreative

Fioritura di cianobatteri, Great Barrier Reef, Australia. Foto P. Glibert

Produzione di schiume, mucillagini, colori anomali, odori repellenti

Dinoflagellati	*Noctiluca scintillans, Prorocentrum* spp.
Primnesioficee	*Phaeocystis spp.,*
Diatomee	*Cylindrotheca closterium*
Cianobatteri	*Nodularia spumigena, Aphanizomenon flos-aquae, Microcystis aeruginosa, Lyngbya* spp.

Moestrup et al. 2017 http://www.marinespecies.org/hab/

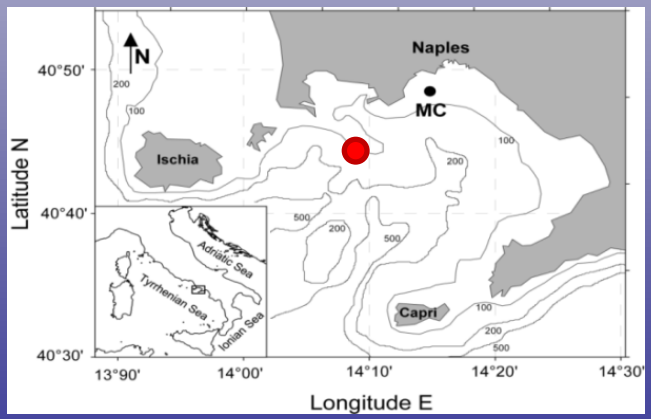
ca 140 Harmful Microalgae (HMa)

Elevata diversità
fisiologica, filogenetica e morfologica

LTER MC Marechiara

LTER-MareChiara
Golfo di Napoli

1251 campionamenti dal 1984

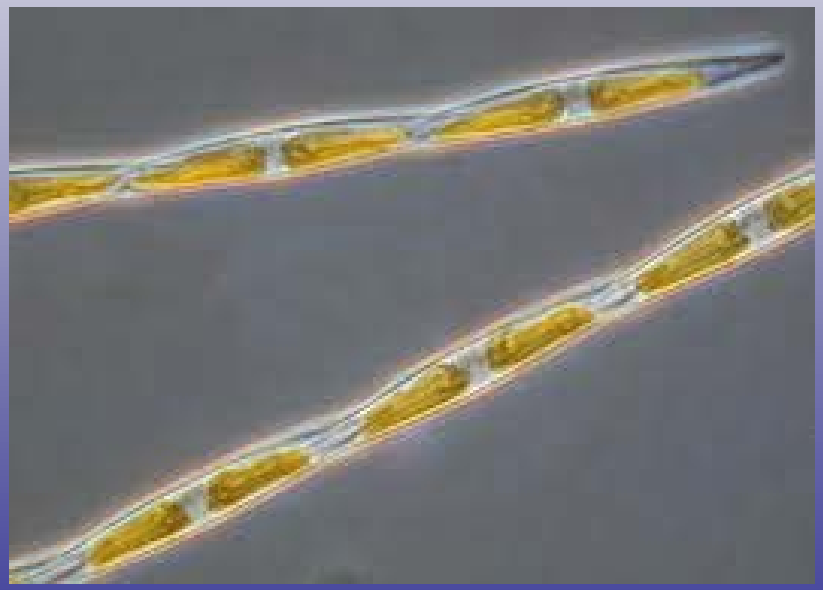


In Campania: circa 50 specie potenzialmente dannose

(Zingone, et. al. 2006 *Harmful Algae*)

Il genere *Pseudo-nitzschia* H. Peragallo

- > 45 specie (ca 15 nel 1990)
- Genere cosmopolita
- Fanno fioriture
- 24 specie potenzialmente tossiche (acido domoico, ASP)

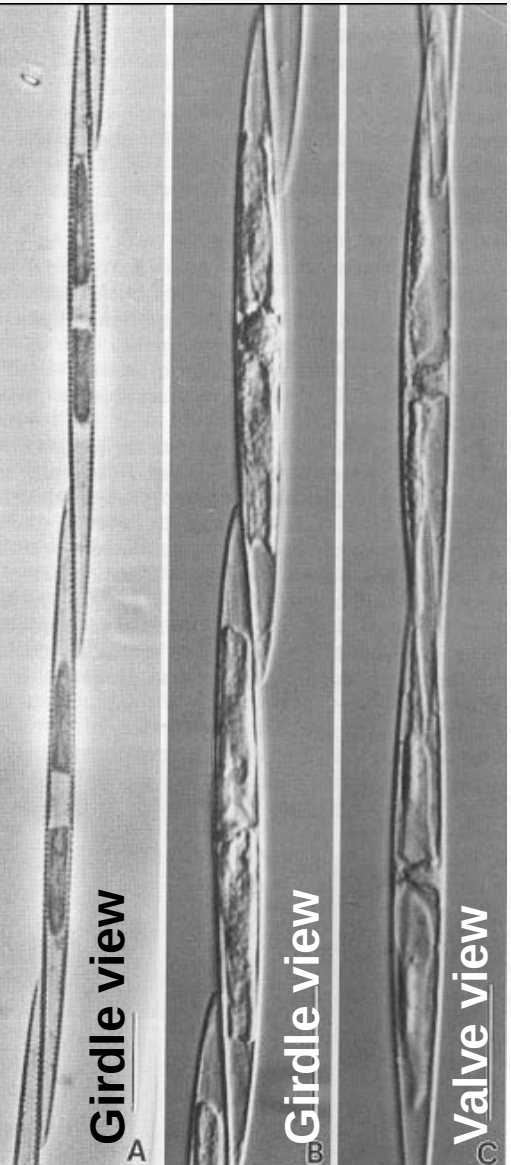


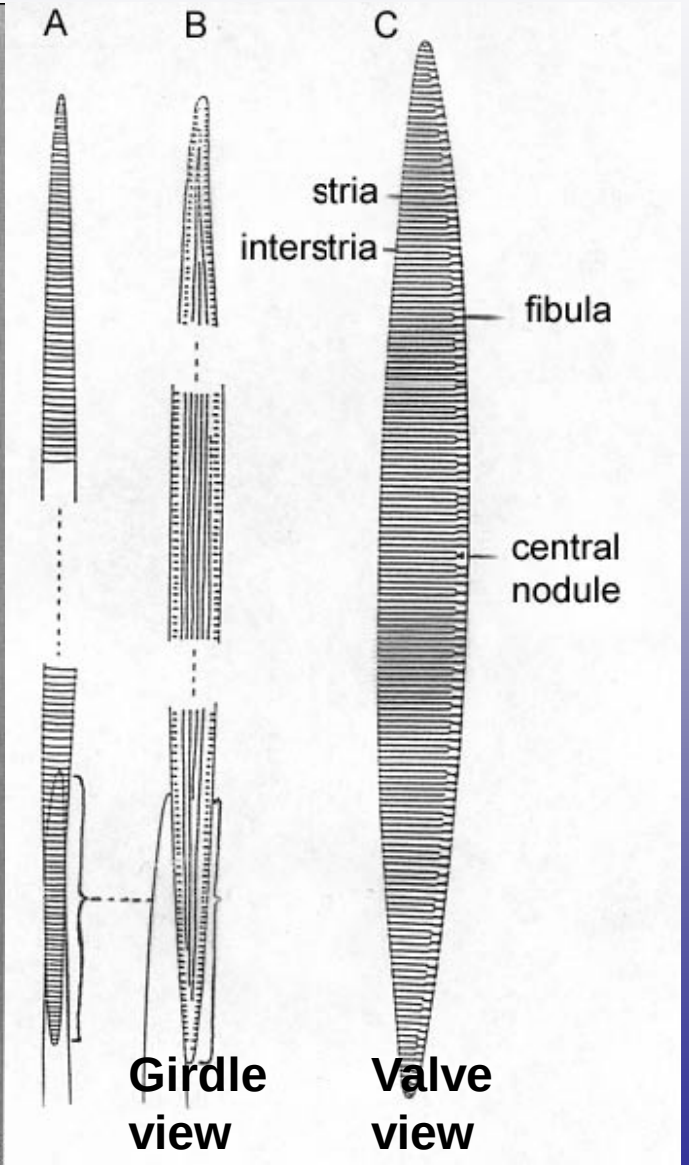
Specie più o meno tossiche

Produzione di tossine (pg/cell)

• ***P. australis***	**2.0-37.0**
• *P. calliantha*	0.007-0.22
• *P. cuspidata*	0.02
• *P. delicatissima*	0.005
• *P. fraudulenta*	0.03-0.12
• *P. galaxiae*	$3.6*10^{-4}$-$7.8*10^{-7}$
• ***P. multiseries***	**0.3-21.0**
• *P. multistriata*	0.003-0.645
• *P. pseudodelicatissima*	0.005
• ***P. seriata***	**1.0-33.6**
• *P. pungens*	0.47
• *P.* cf. *turgidula*	0.03

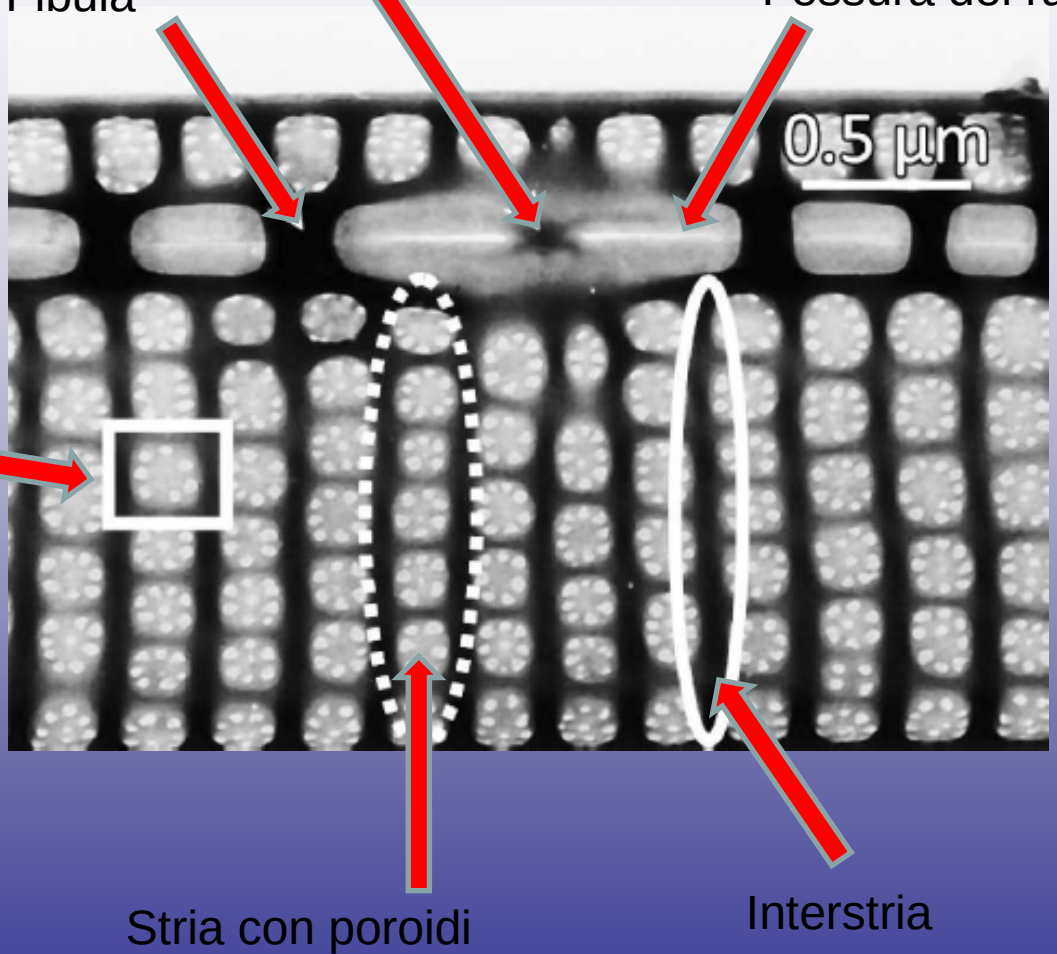
Pseudo-nitzschia



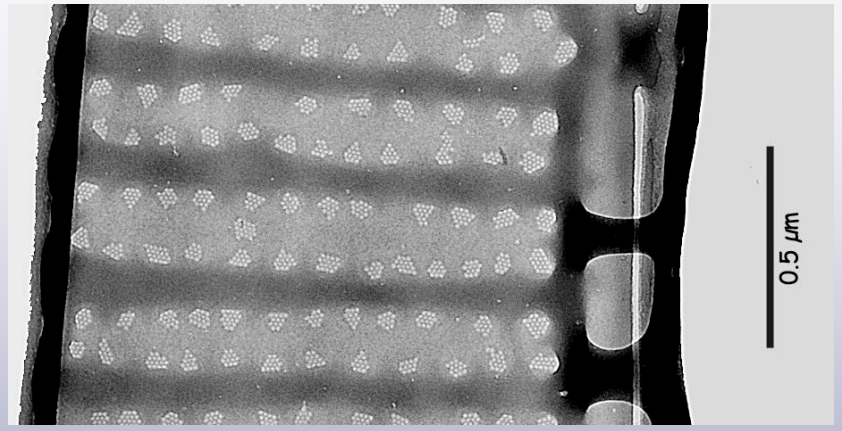


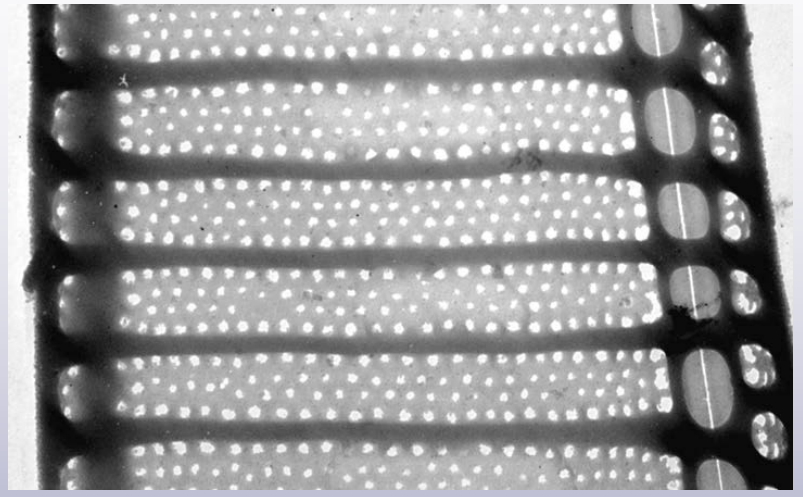
- Cellule allungate, fusiformi
- Colonie lineari a scalino (in vista connettivale)
- 2 cloroplasti

Pseudo-nitzschia - Ultrastruttura del frustulo siliceo

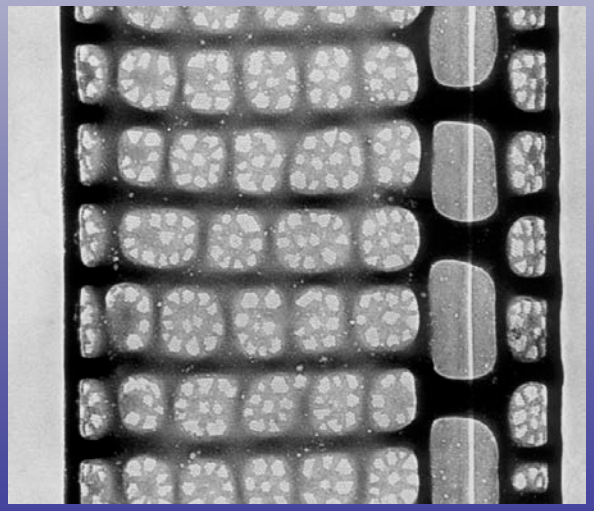


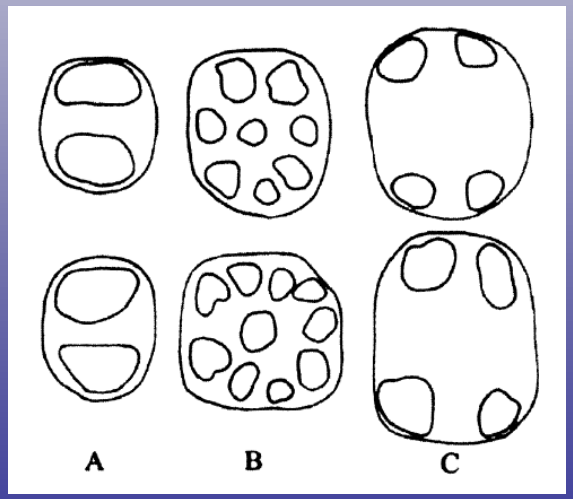
Pseudo-nitzschia - Ultrastruttura del frustulo siliceo





Strie: n° di file di poroidi e struttura dei poroidi





Il genere *Pseudo-nitzschia*

Caratteri tassonomici per l'identificazione delle specie

- Larghezza della valva (asse transapicale):

  ***Pseudo-nitzschia seriata* group t.a. > 3 µm**

  ***Pseudo-nitzschia delicatissima* group t.a. < 3 µm**

- forma della valva
- forma delle estremità in vista valvare e laterale (girdle view)
- densità di fibule e interstriae
- presenza/assenza del «larger central interspace»
- struttura delle strie:
  - n° di file di poroidi
  - densità dei poroidi
  - struttura dei poroidi
- struttura delle bande del cingolo

Pseudo-nitzschia

E’ possibile identificare le specie in LM?

- Specie pseudocriptiche: piccole differenze ultrastrutturali
- Specie criptiche: morfologicamente identiche

L’identificazione molto spesso richiede EM o analisi moleculari

Distinzione in 2 grandi gruppi:

***Pseudo-nitzschia seriata* group t.a. > 3 µm**

***Pseudo-nitzschia delicatissima* group t.a. < 3 µm**

P. delicatissima-group (< 3 µm) include:

1) *P.pseudodelicatissima* complex

- *P. pseudodelicatissima*
- *P. arctica*
- *P. abrensis*
- *P. batesiana*
- *P. caciantha*
- *P. calliantha*
- *P. circumpora*
- *P. cuspidata*
- *P. fryxelliana*
- *P. fukuyoi*
- *P. hasleana*
- *P. inflatula*
- *P. lineola*
- *P. kodamae*
- *P. lundholmiae*
- *P. mannii*
- *P. plurisecta*

✓ **17 specie**

✓ **Identificazione difficile/impossibile in LM!**

2) *P.delicatissima* complex

- *P. delicatissima*
- *P. arenysensis*
- *P. decipiens*
- *P. dolorosa*
- *P. sabit*

3) *P. americana* complex

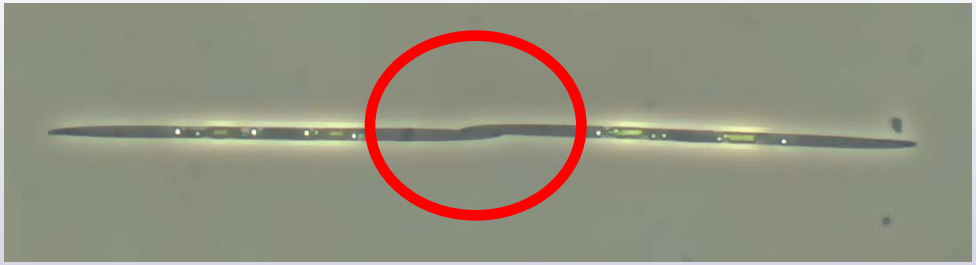
- *Pseudo-nitzschia americana*
- *Pseudo-nitzschia brasiliana*
- *Pseudo-nitzschia linea*

4) Altre specie

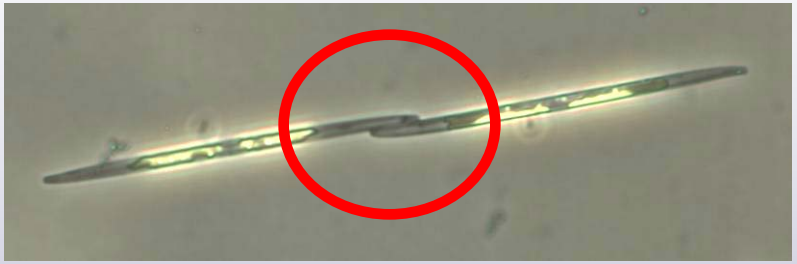
- *Pseudo-nitzschia galaxiae*
- *Pseudo-nitzschia multistriata*

Specie tossiche *P. delicatissima*-group (< 3 µm)

Pseudo-nitzschia **c***alliantha, P. pseudodelicatissima, P. cuspidata*



Pseudo-nitzschia delicatissima



Pseudo-nitzschia galaxiae

Acido domoico: max 3.6 x 10^{-4} pg·cell^{-1}

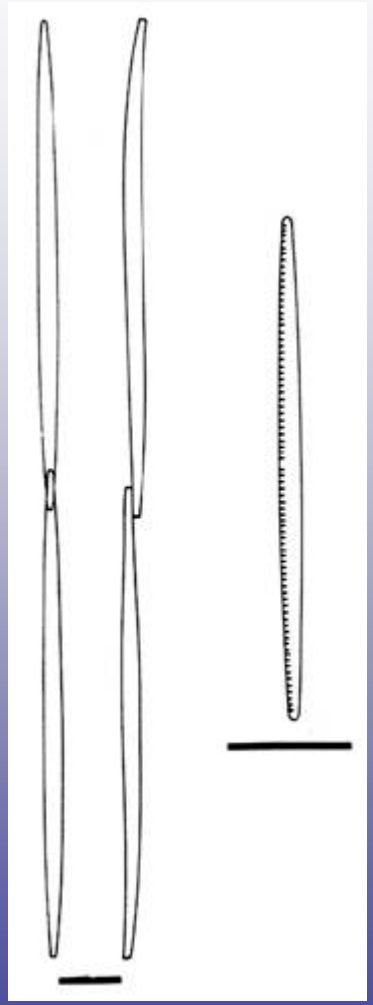
(Cerino et al., 2005)

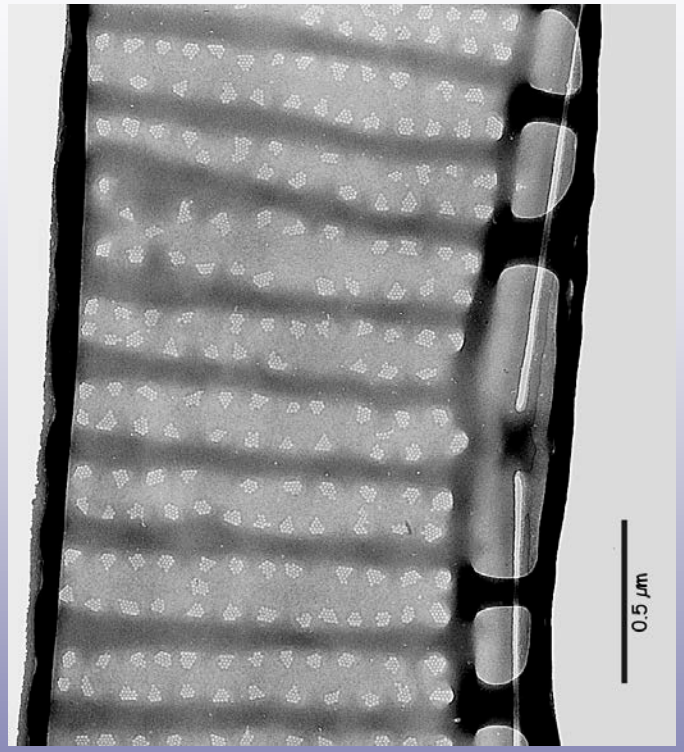
Pseudo-nitzschia multistriata

Acido domoico: max 6.9 x 10^{-1} pg·cell^{-1}

(Orsini et al., 2002)

Pseudo-nitzschia delicatissima **complex**

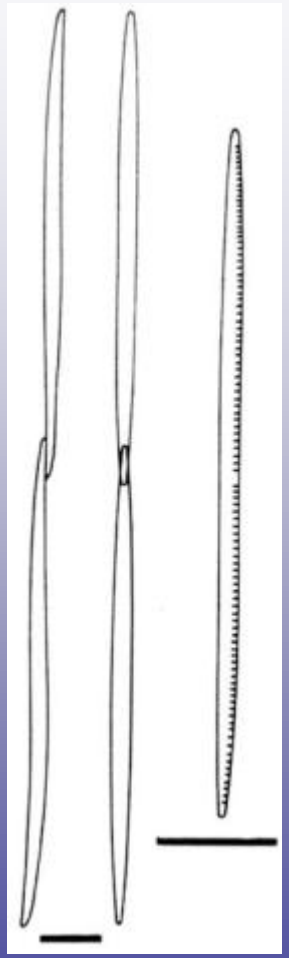


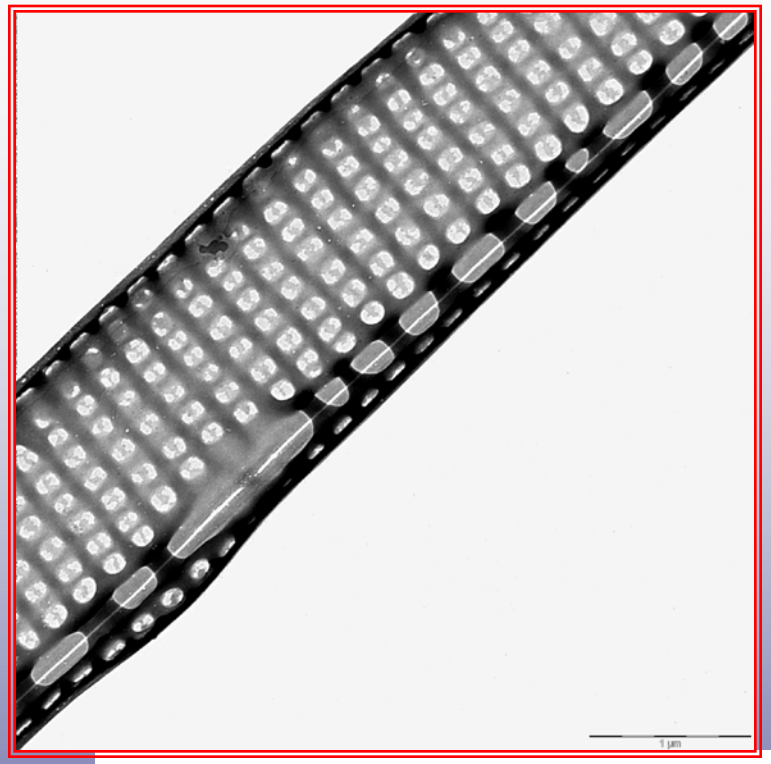


- T.a. 2-2.5 µm
- central larger interspace
- strie con 2 file di poroidi

Girdle view: estremità cellulari non appuntite, arrotondate o a scalino

Pseudo-nitzschia pseudodelicatissima **complex**





- T.a. ca. 1.5-2.5 µm
- central larger interspace
- strie con 1 fila di poroidi

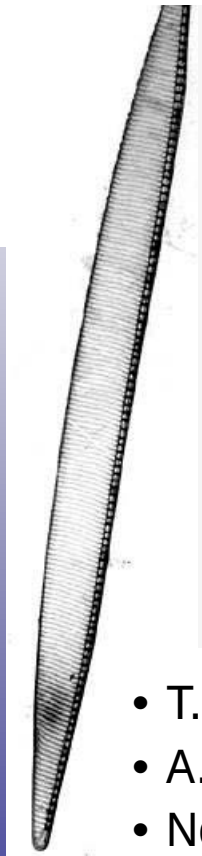
Girdle view: estremità cellulari appuntite

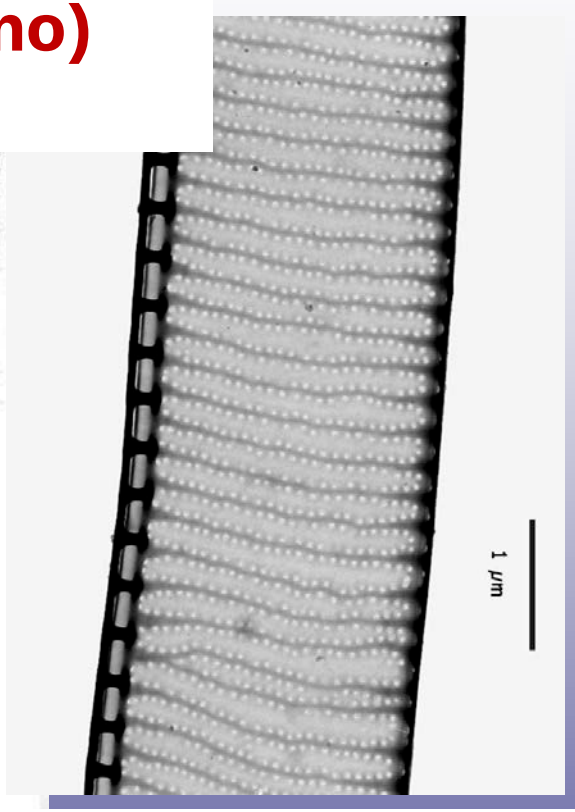
Non-Indigenous Species

Pseudo-nitzschia multistriata (Takano) Takano

Tipica forma sigmoide

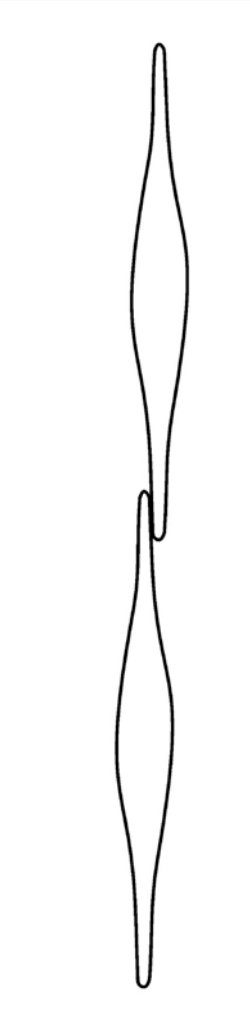
<u>in vista connettivale</u>

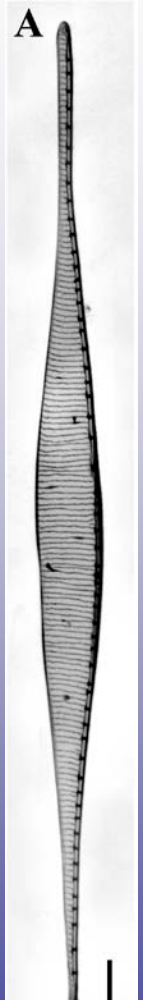


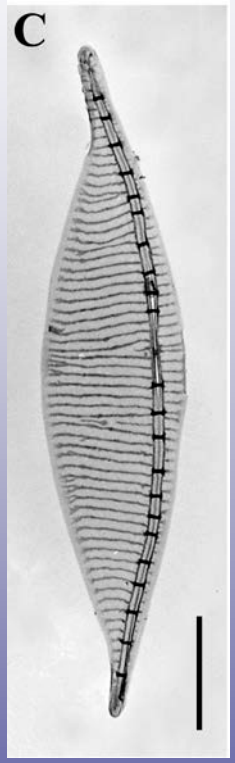


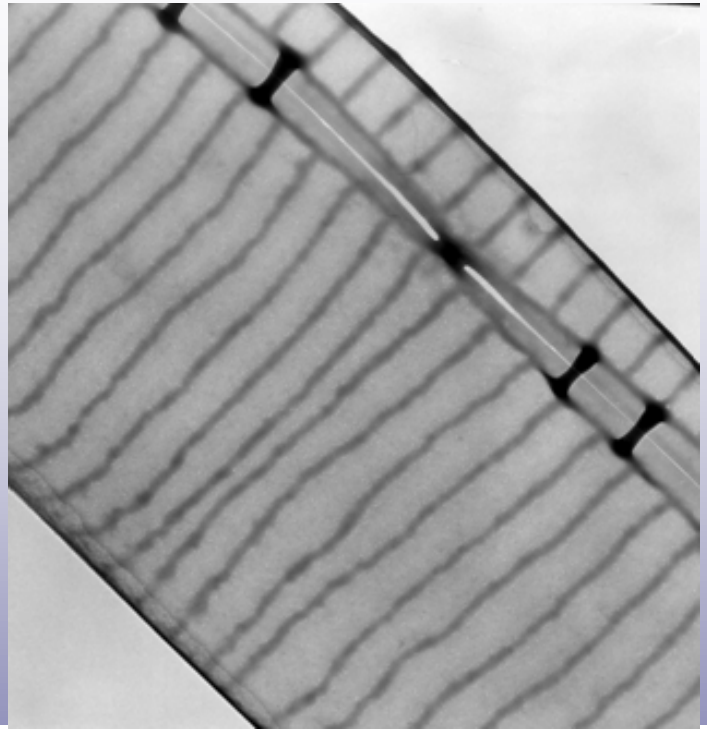
- T.a. 2.5-4 µm
- A.a. 38-50 µm
- No central larger interspace
- 37-44 interstriae in 10 µm
- 23-32 fibulae in 10 µm
- striae with two rows of poroids

Pseudo-nitzschia galaxiae Lundholm et Moestrup





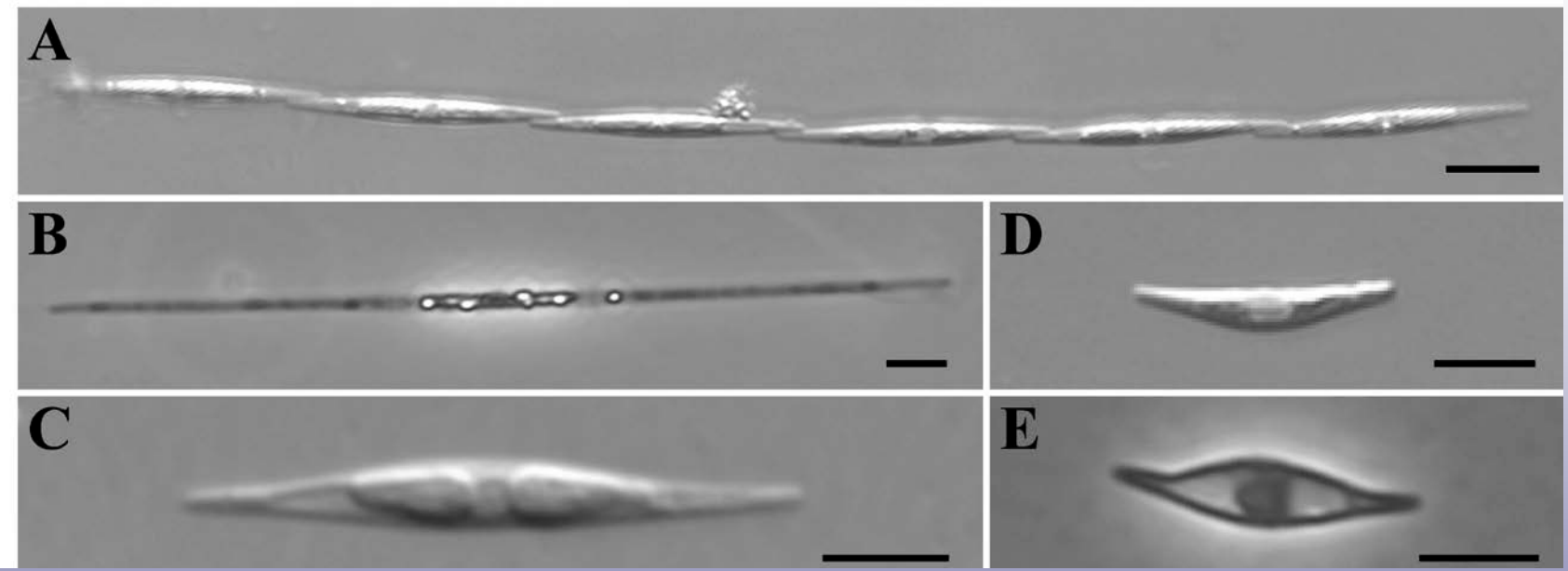




Cellule poco silicizzate, forma lanceolata con apici rostrati

- T.a. 1.2-1.7 µm
- A.a. 25-41 µm
- Central larger interspace
- 56-64 interstriae in 10 µm
- 16-26 fibulae in 10 µm
- strie senza poroidi, con piccole perforazioni

Pseudo-nitzschia galaxiae Lundholm et Moestrup



+ 2 MORFOTIPI: dal Mar Mediterraneo

- Lungo: fino a 82 µm
- Corto fino a 10 µm

Cerino et al. 2004

Distribuzione latitudinale di *Pseudo-nitzschia* spp.

P. seriata in Nord Atlantico

Mediterranean Sea

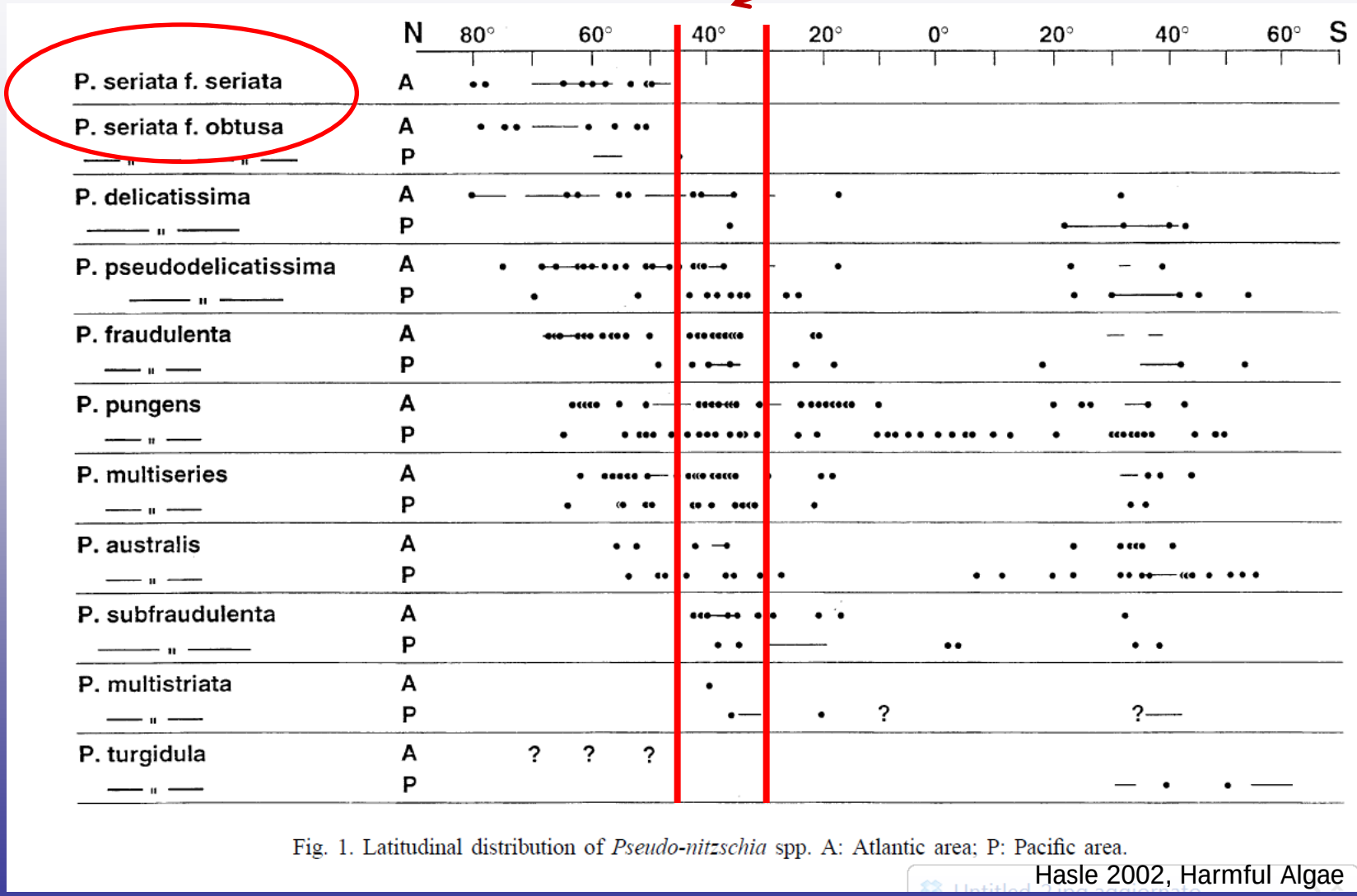
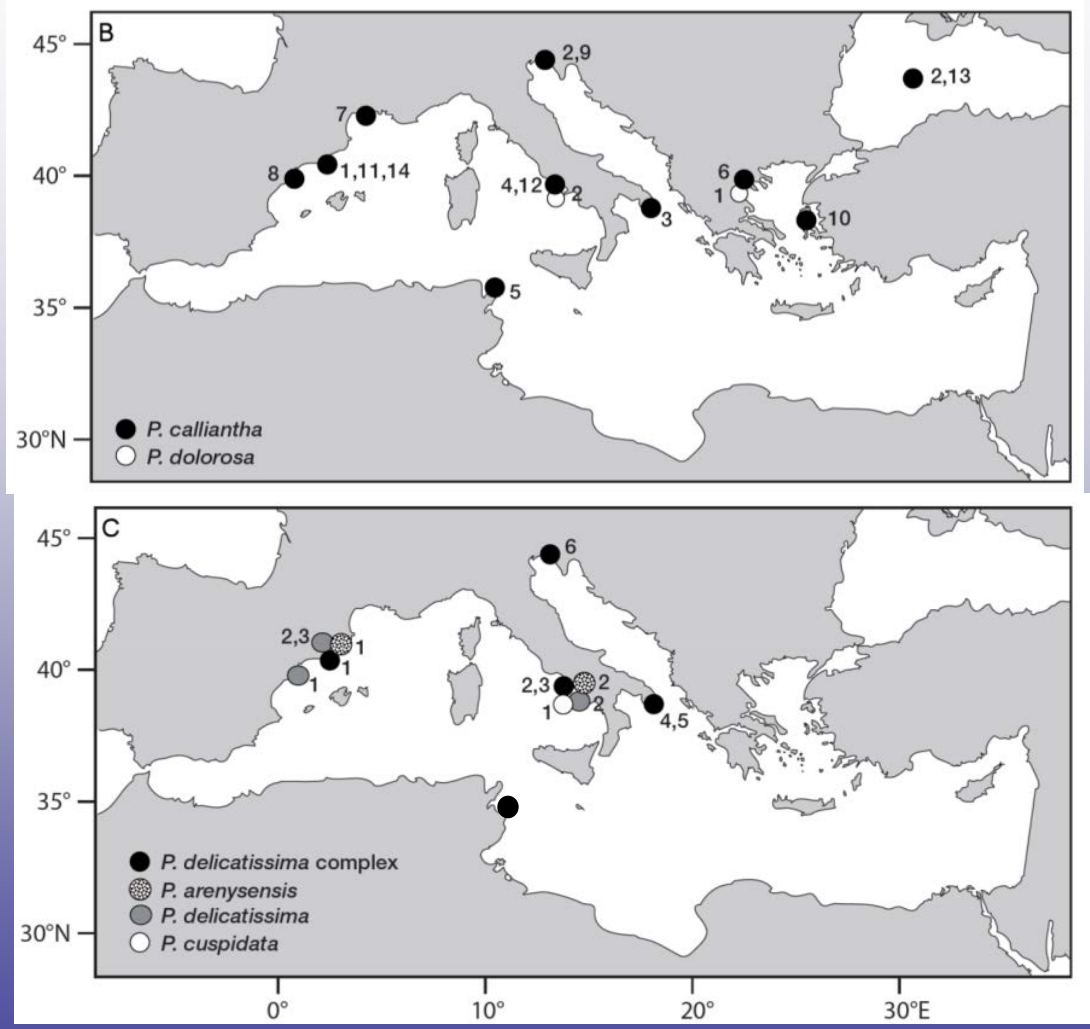


Fig. 1. Latitudinal distribution of *Pseudo-nitzschia* spp. A: Atlantic area; P: Pacific area.

Hasle 2002, Harmful Algae

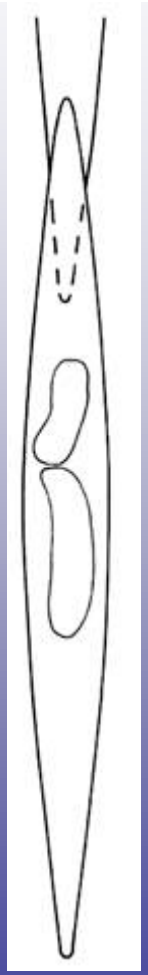
Informazione aggiornata sulla distribuzione delle specie!

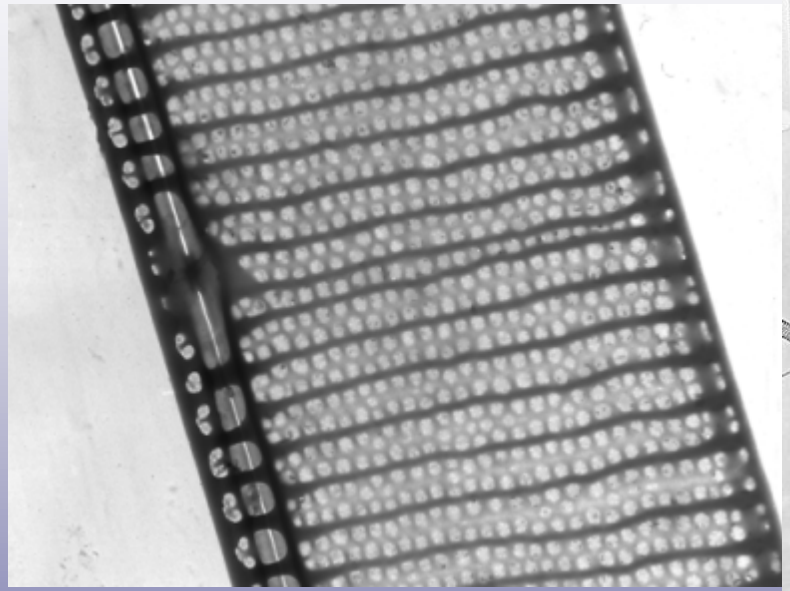


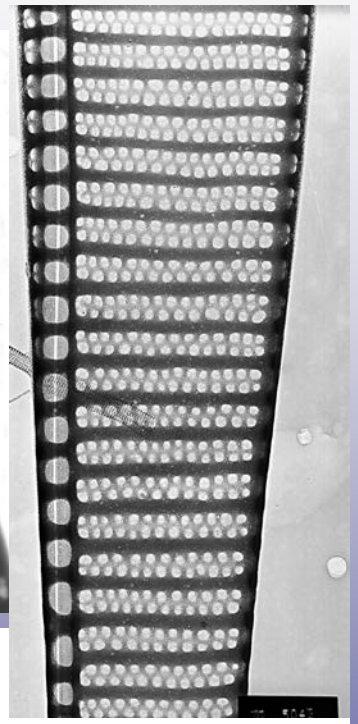
Quijano-Scheggia et al. 2010

Pseudo-nitzschia seriata-group in Campania:

Pseudo-nitzschia fraudulenta (Cleve) Hasle

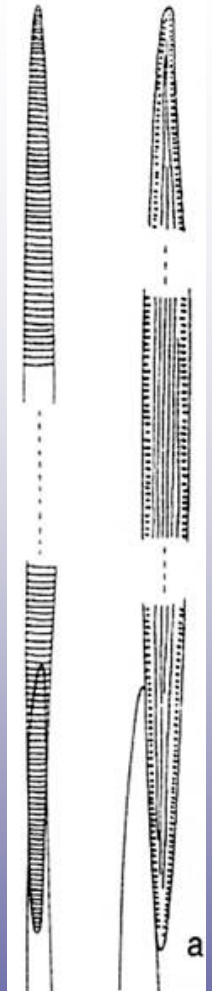






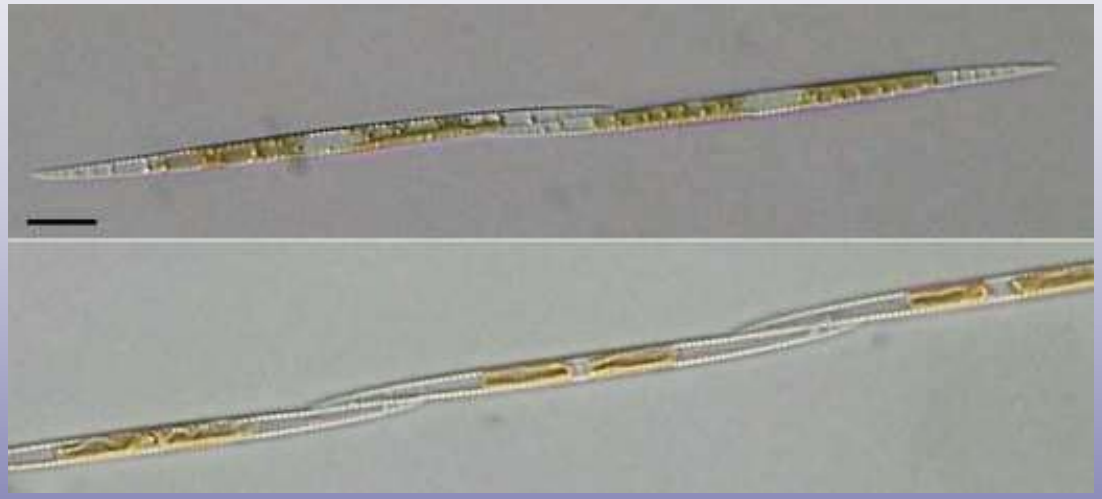
- T.a. 4.5-6.5 µm
- A.a. 64-111 µm
- central larger interspace
- 18-24 interstriae in 10 µm
- 12-24 fibulae in 10 µm
- strie con 2 (3) fila di poroidi

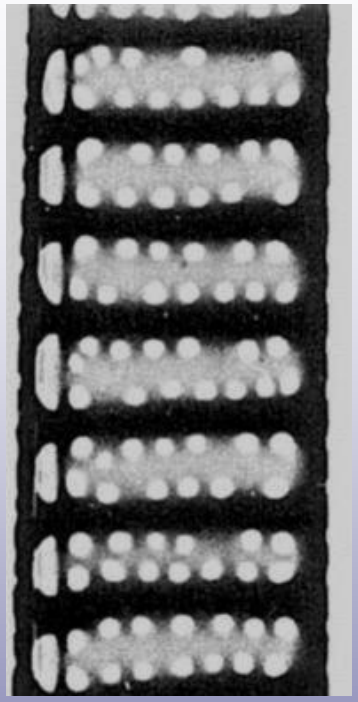
P. pungens (Grunow ex Cleve) Hasle



Molto importante in Adriatico

- Fortemente silicizzata
- Interstriae visibili in LM



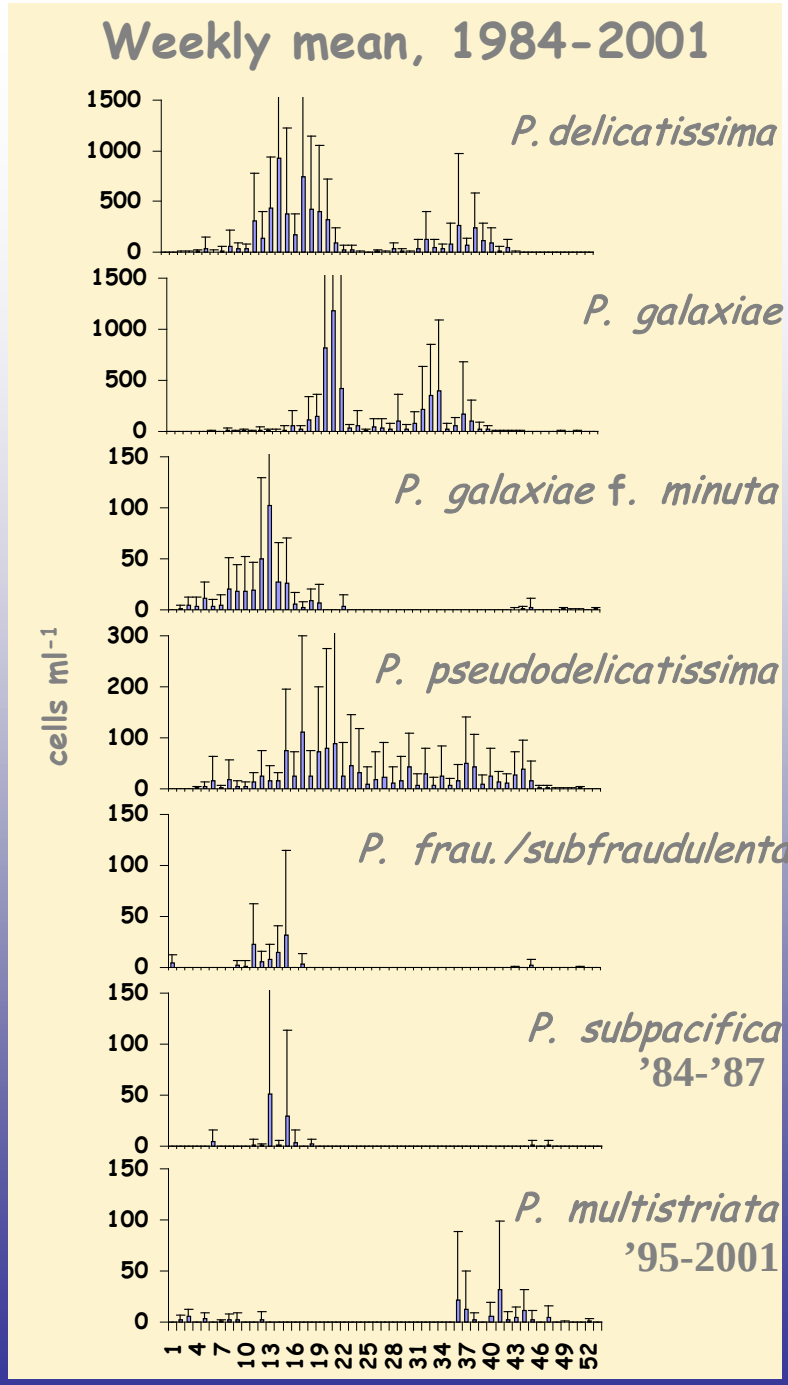


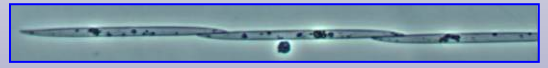
Valve view: lineare/fusiforme con estremità ben appuntite (pungens)

Girdle view: fusiforme, **ampia sovrapposizione** delle cellule in catena (1/3 della lunghezza della cellula)

- T.a. 3-4.5 µm
- A.a. 74-142 µm
- **senza** ***central larger interspace***
- 9-15 interstriae in 10 µm
- 9-15 fibulae in 10 µm
- strie con **2 file di poroidi**

Pseudo-nitzschia : un genere per tutte le stagioni



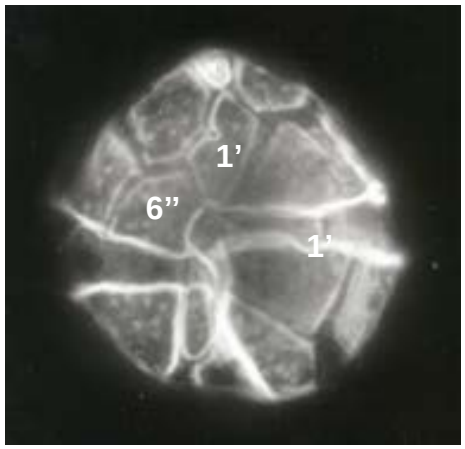


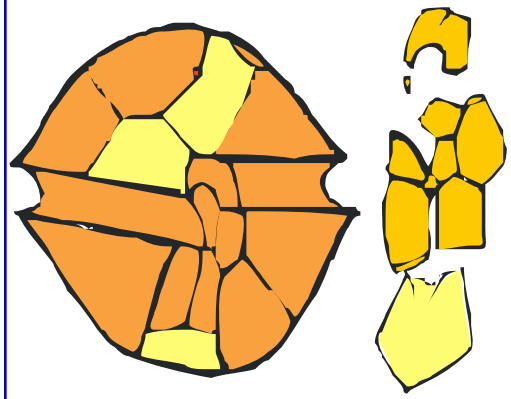
Zingone, Sarno, Nardella & Licandro, in preparation

PSP: Paralytic Shellfish Poisoning

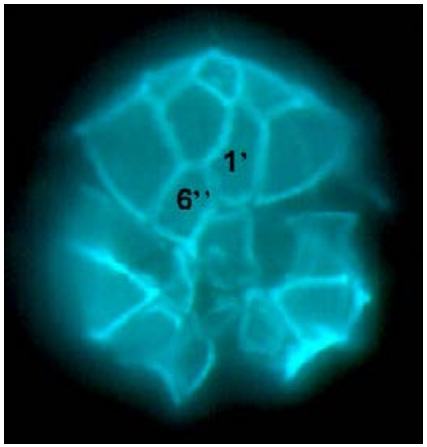
SPECIE	HAB	STAGIONALITA’
Alexandrium andersonii Balech *	PSP	Giu-Ott
A. minutum Halim*	PSP	Giu-Ott
A. tamarense (Lebour) Balech	PSP	Giu-Ott

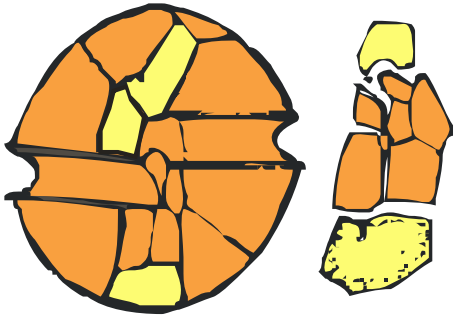
the *tamarense ~ minutum*-group



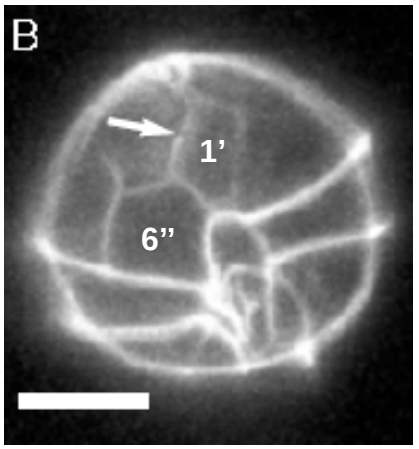


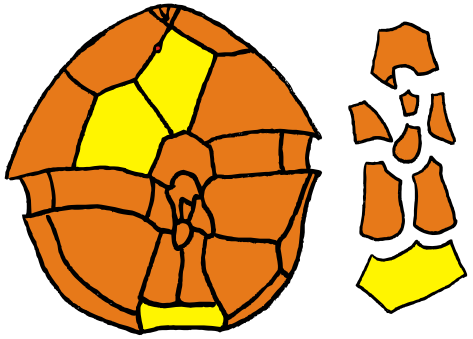
A. tamarense





A. minutum

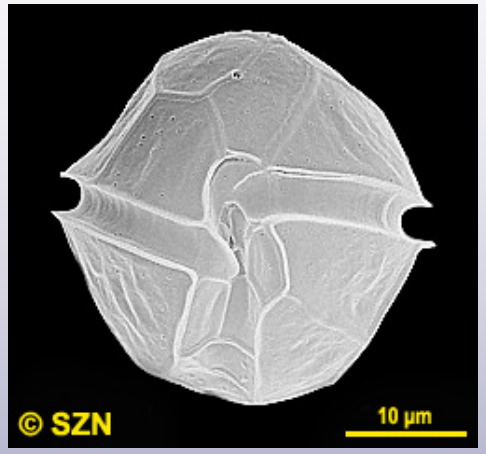




A. tamutum

From Larsen & Nguyen 2004, Montresor et al. 2004, Pitcher et al. 2007

Alexandrium tamarense



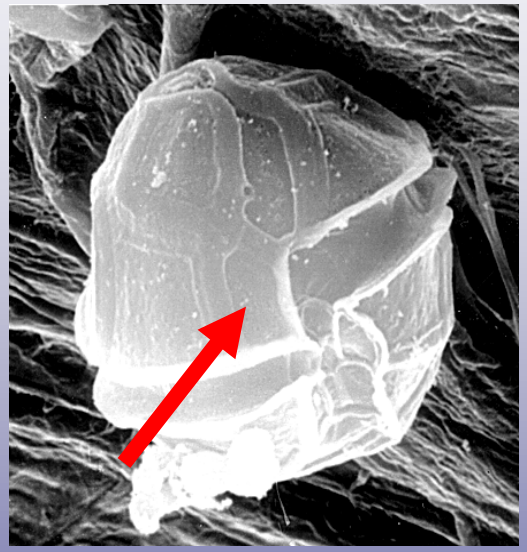
Retinate Golfo di Napoli

L’importanza dello studio tassonomico

Alexandrium andersonii *

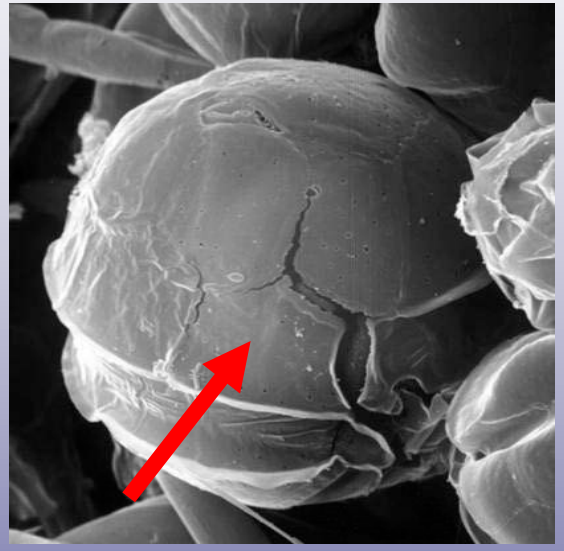
La specie è stata identificata in seguito alla germinazioni delle cisti

Alexandrium minutum *



TOSSICO

Alexandrium tamutum

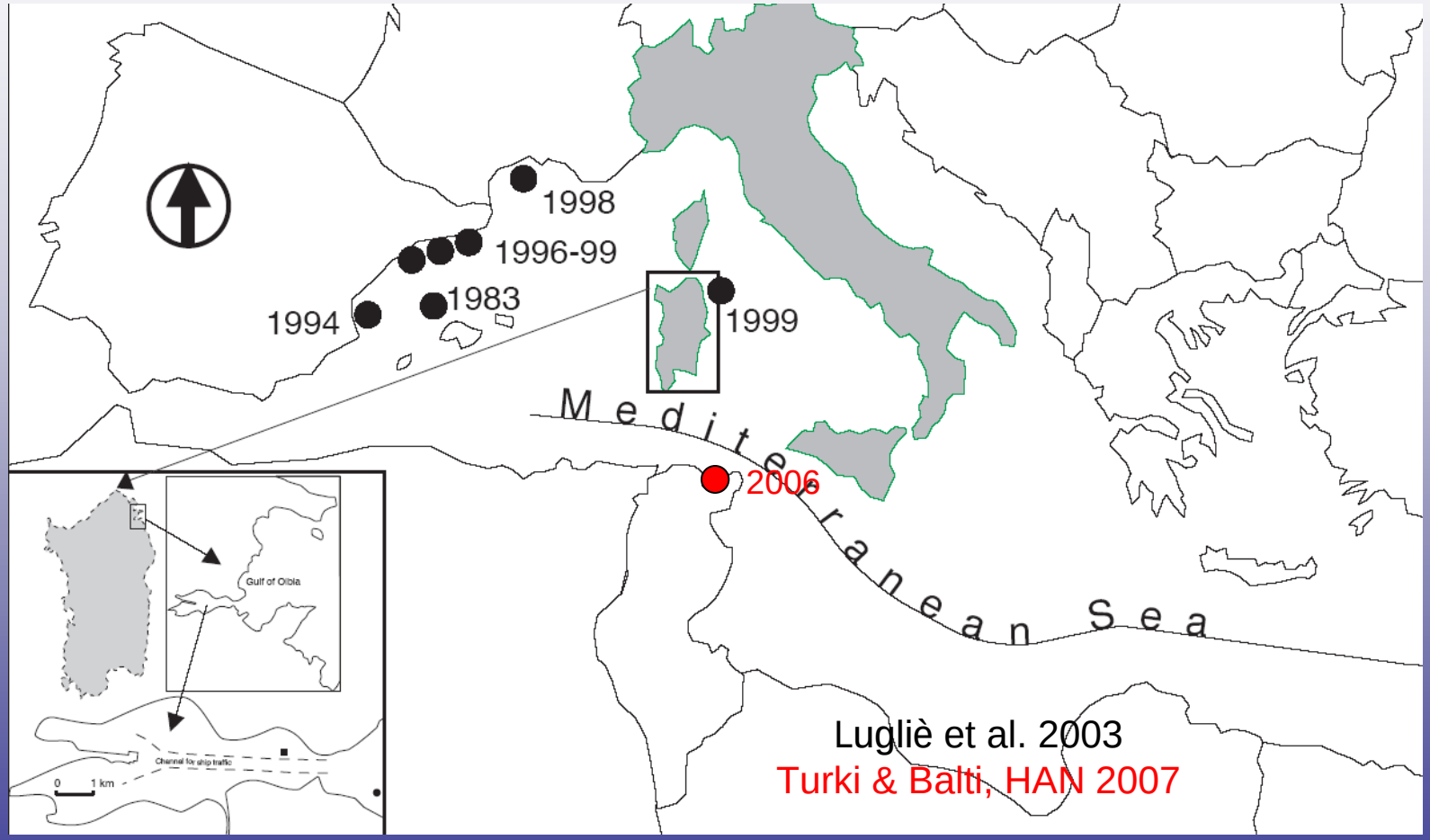


NON TOSSICO

(Montresor et al., 2004 *Journal of Phycology*)

*** Tossina identificata in Campania**

Range expansion of *Alexandrium pacificum (= A. catenella)* across the Western Mediterranean Sea



Tossine liposolubili: acido okadaico, pectenotossine

Dinophysis caudata

Dinophysis fortii

Dinophysis mitra

Dinophysis sacculus

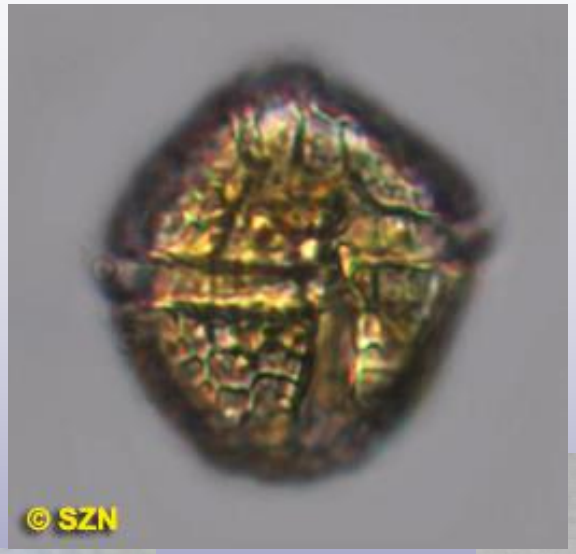
Dinophysis tripos

Phalacroma rotundatum

Foto da www.marbot.gu.au

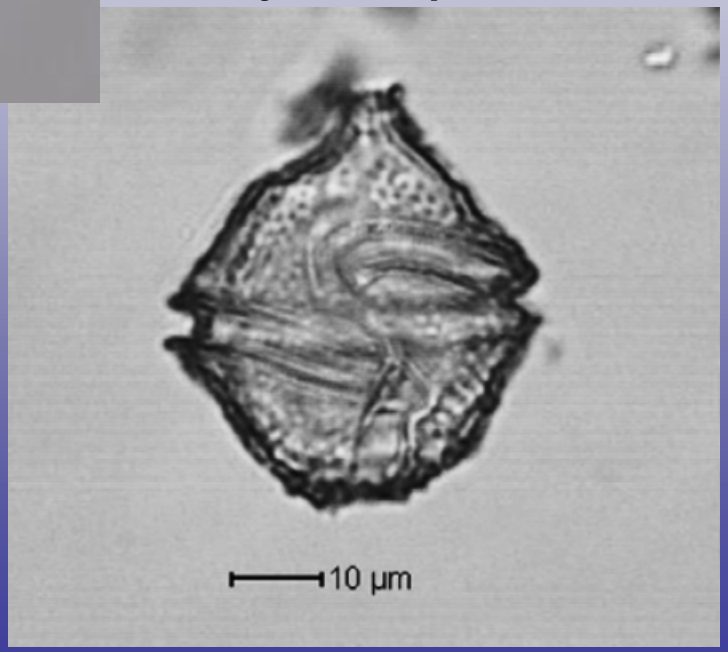
Tossine liposolubili: yessotossine

Protoceratium reticulatum



Lingulodinium polyedra

Gonyaulax spinifera

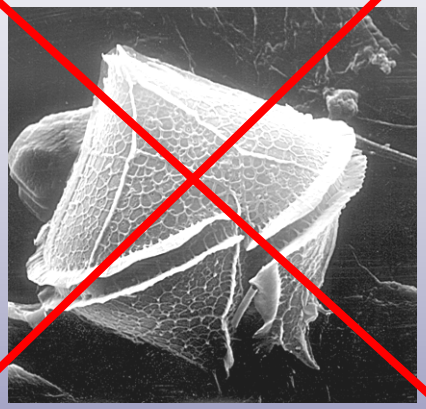


Riccardi et al. 2009 Harmful Algae

Azaspiracidi (AZA)

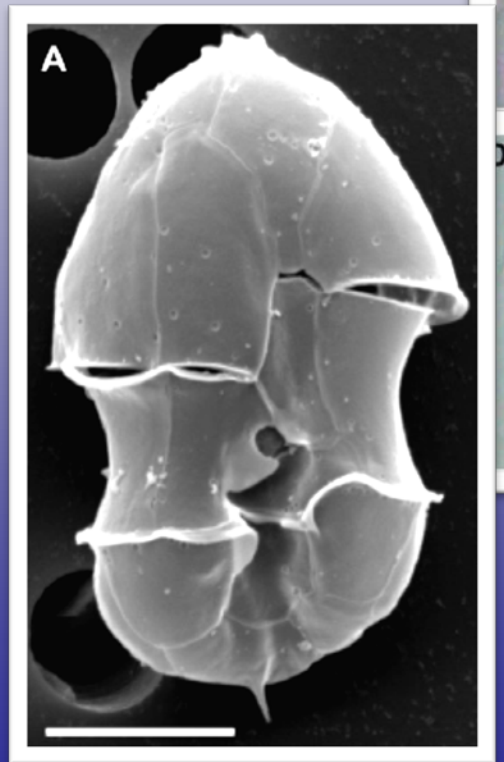
Sindrome diarroica da molluschi bivalvi (AZP)

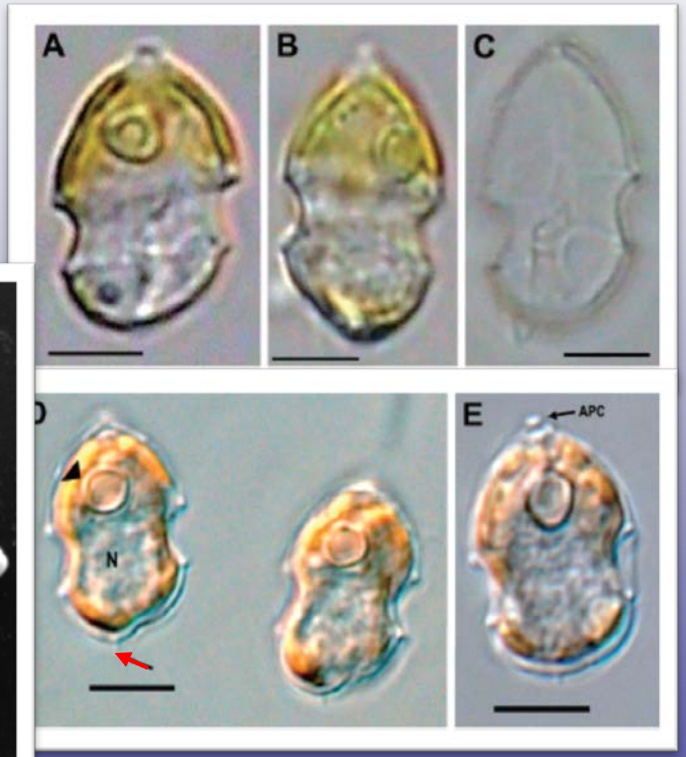
Protoperidinium cfr. crassipes



Retinate Golfo di Napoli

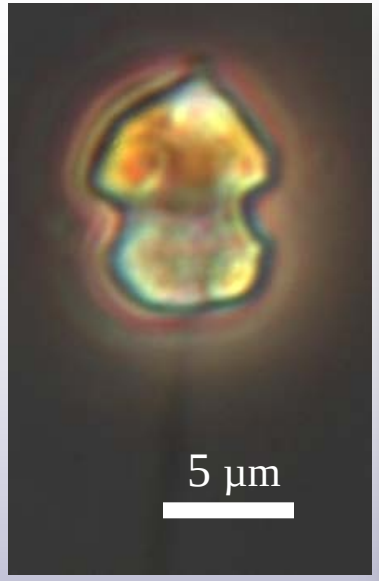
Azadinium spinosum
Elbrächter et Tilmann 2009

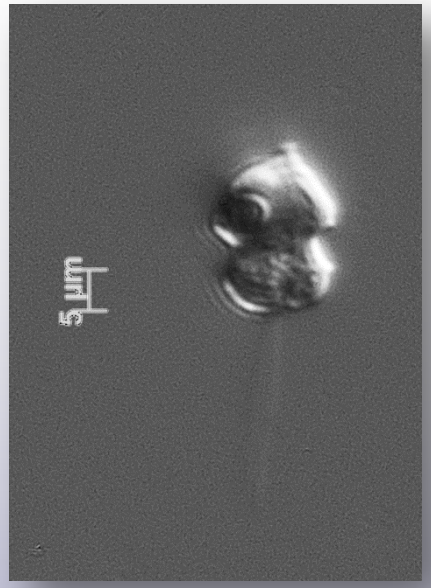


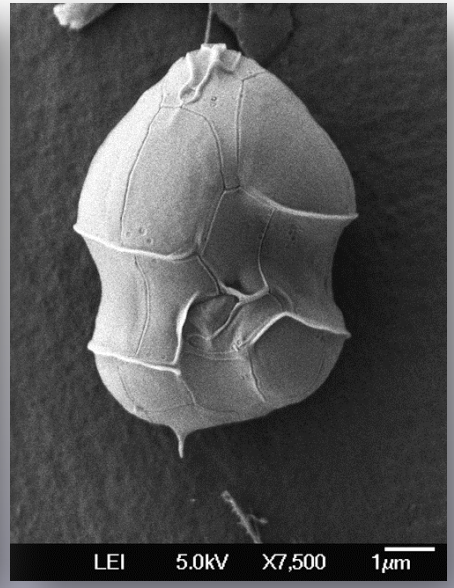


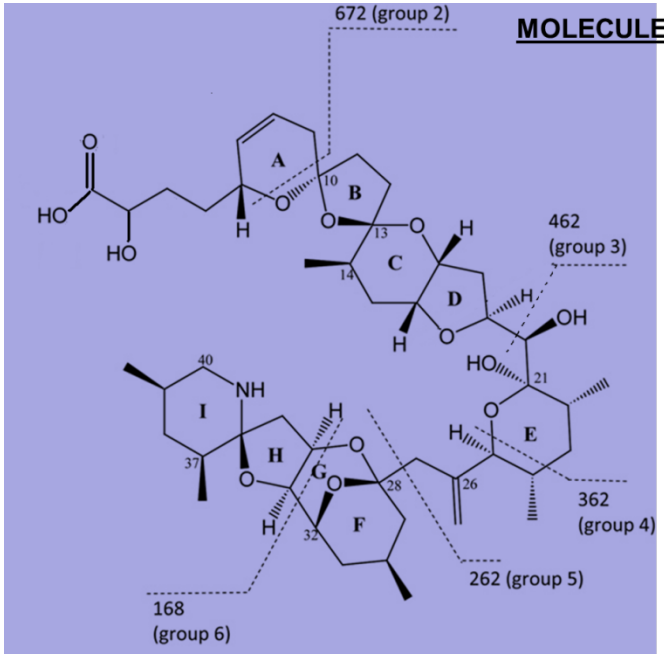
Azadinium dexteroporum

2013
primo ritrovamento
di *Azadinium*
in Mediterraneo

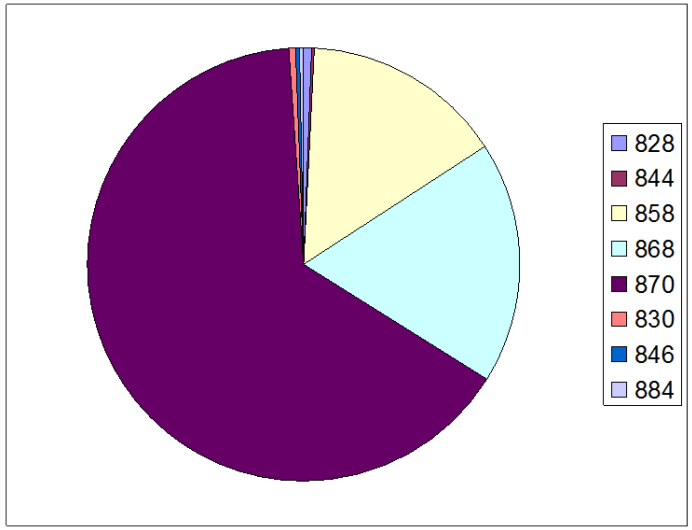


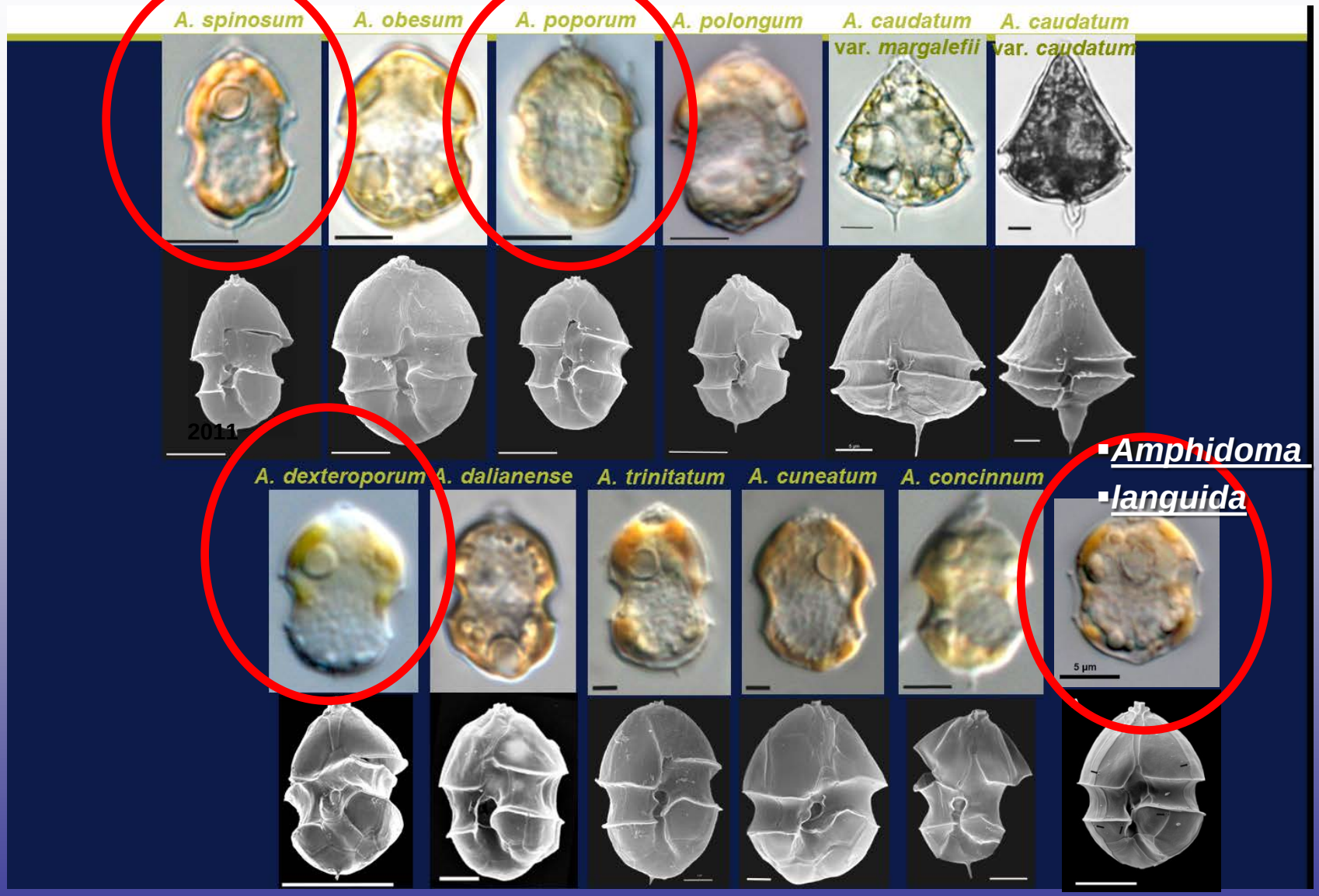






Composizione percentuale di Azaspiracidi prodotti da *A. dexteroporum*





- ***Amphidoma languida***

modificato da Mona Hoppenrath, APC 11

I dinoflagellati nudi: rivoluzione tassonomica

Phylogeny of some of the major genera of dinoflagellates based on ultrastructure and partial LSU rDNA sequence data, including the erection of three new genera of unarmoured dinoflagellates

N. DAUGBJERG[1], G. HANSEN[2], J. LARSEN[2] AND Ø. MOESTRUP[1]* (2000)

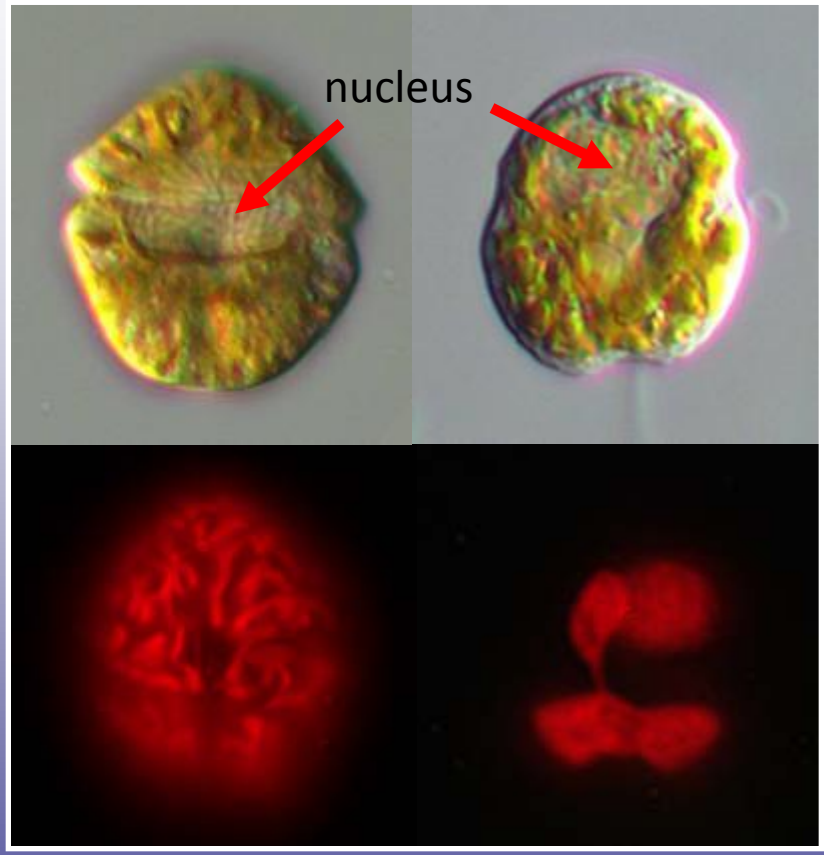
[1]*Department of Phycology, Botanical Institute, University of Copenhagen, Øster Farimagsgade 2D, DK-1353 Copenhagen K, Denmark*

[2]*IOC-Danida Science and Communication Centre on Harmful Algae, Botanical Institute, University of Copenhagen, Øster Farimagsgade 2D, DK-1353 Copenhagen K, Denmark*

Characters useful for identification of genera and species

In light microscopy….

- ✓ cell shape and dimensions
- ✓ arrangment of cingulum and sulcus
- ✓ shape, dimensions and position of the nucleus
- ✓ numbers, shape, position of chloropasts
- ✓ swimming behaviour



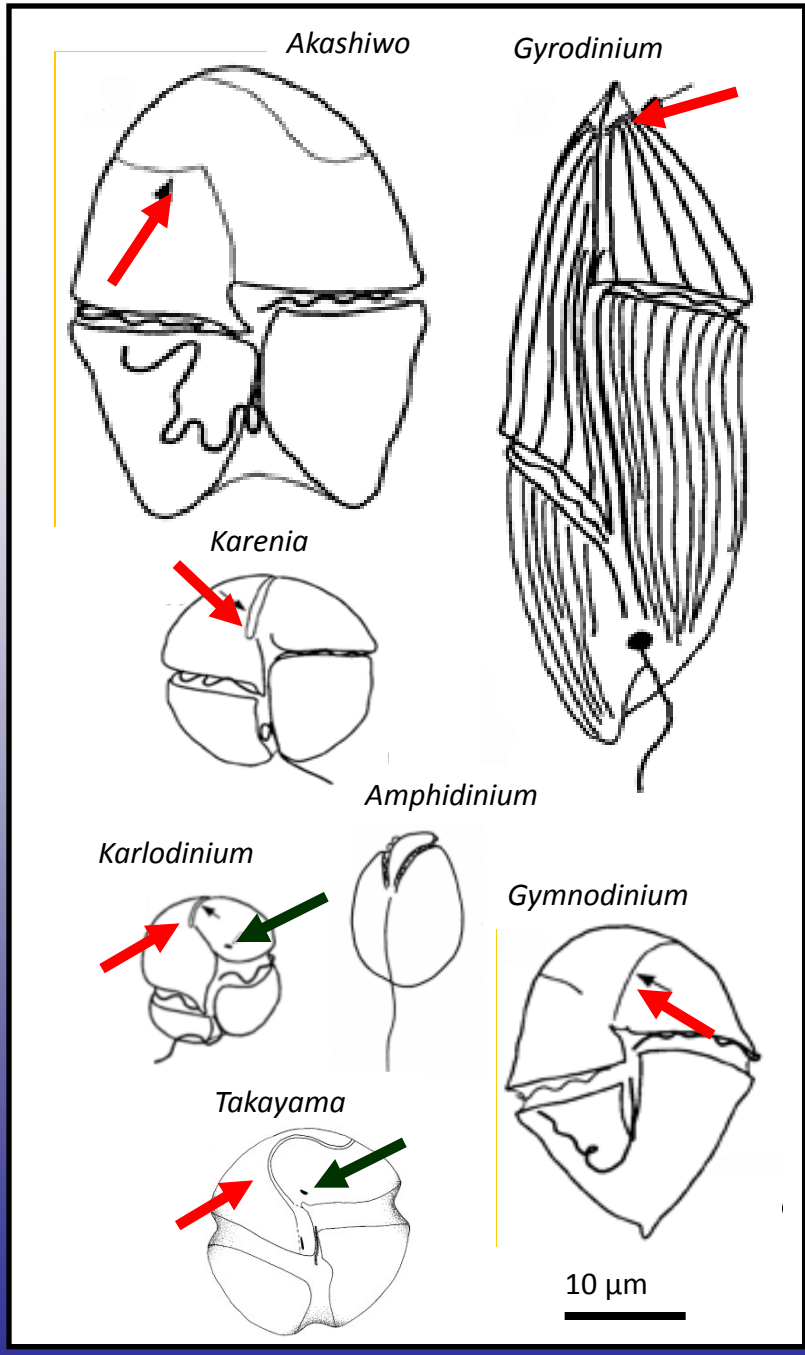
pictures by R. Siano - SZN

Characters useful for identification of genera and species

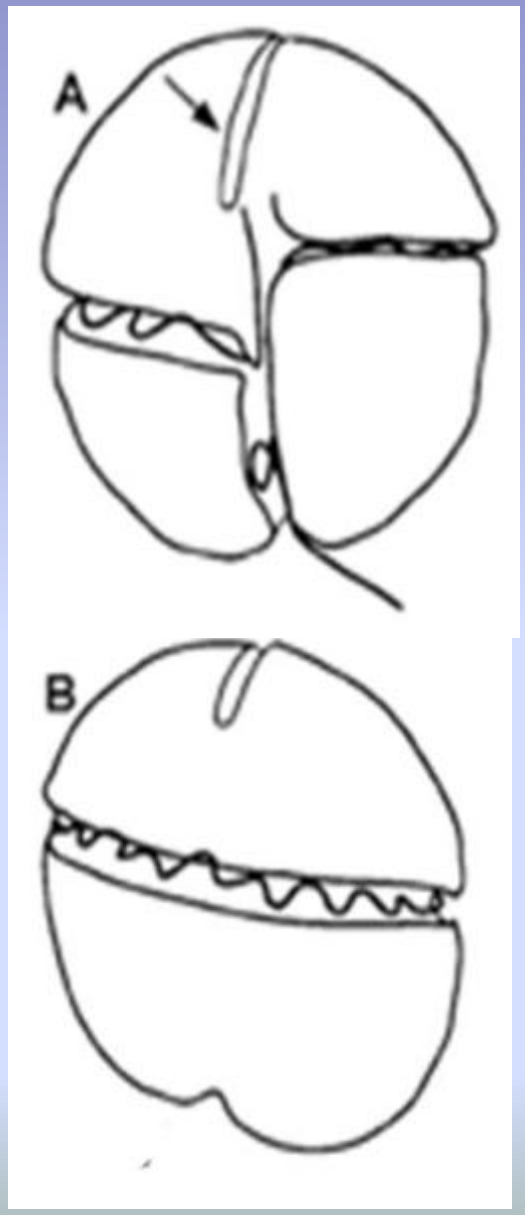
In light microscopy....but mostly at SEM!

✓ Shape, lenght and arrangement of the **acrobase** (apical groove)

✓ presence/absence of **pores** on cell surface



Karenia Hansen & Moestrup



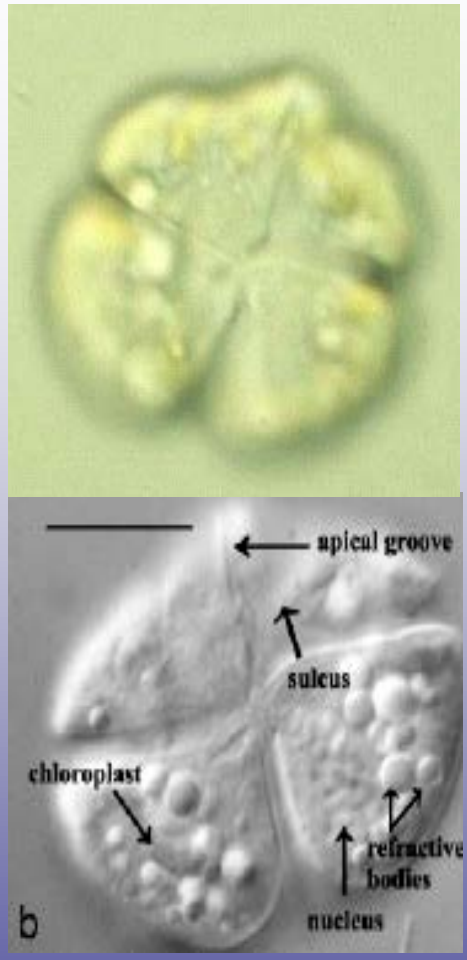
- variable sizes (10-40 µm)
- most of the species are dorsoventrally flattened
- straight acrobase
- sulcal intrusion onto epicone present (open or closed)
- chloropasts with lenticular pyrenoids
- nuclear envelope chambers absent
- “falling-leaf”-like swimming behaviour

(Daugbjerg et al., 2000; Haywood et al., 2004)

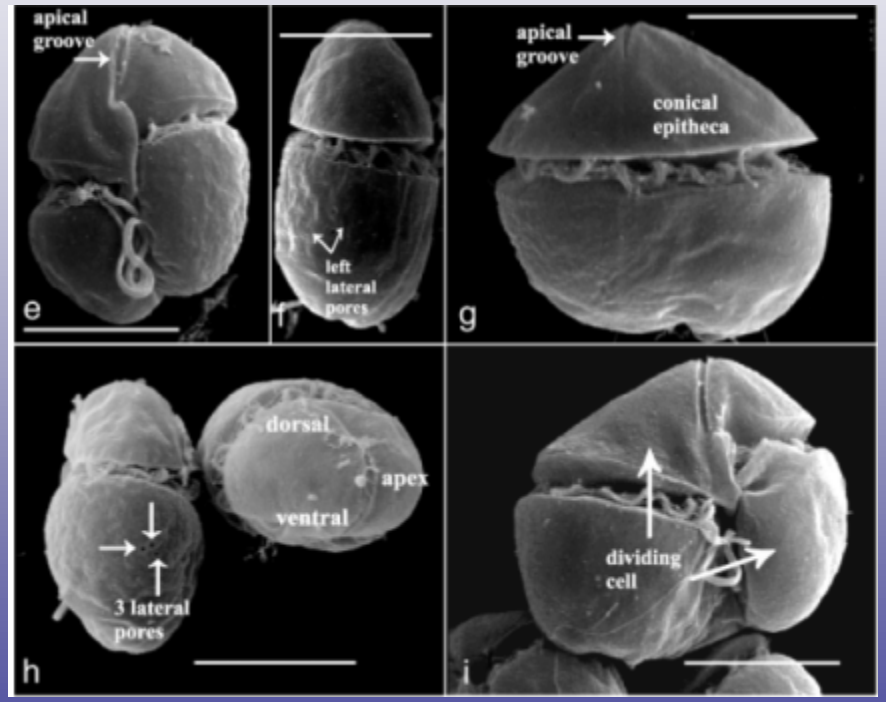
Species considered to belong to the genus:

K. asterichroma de Salas, Bolch & Hallegraeff		
K. bicuneformis Botes, Sym & Pitcher		(TOXIC)
K. bidigitata Haywood & Steidinger	(could be synonymous of *K. bicuneiformis*	
K. brevis (Davis) Hansen & Moestrup	(type species)	(TOXIC)
K. brevisulcata (Chang) Hansen & Moestrup		(TOXIC)
K. concordia Chang & Ryan		(TOXIC)
K. cristata Botes, Sym & Pitcher		(TOXIC)
K. digitata Yang, Takayama, Matsuoka & Hodgkiss		(TOXIC)
K. longicanalis Yang, Hodgkiss & Hansen		
K. mikimotoi (Miyake & Kominami ex Oda) Hansen & Moestrup		(TOXIC)
K. papilionacea Haywood & Steidinger		(TOXIC)
K. selliformis Haywood, Steidinger & MacKenzie		(TOXIC)
K. umbella de Salas, Bolch & Hallegraeff		(TOXIC)

K. brevis (type species)



- spherical nucleus in the left hypocone
- bilobate hypotheca
- bulbous protrusion of the apical groove

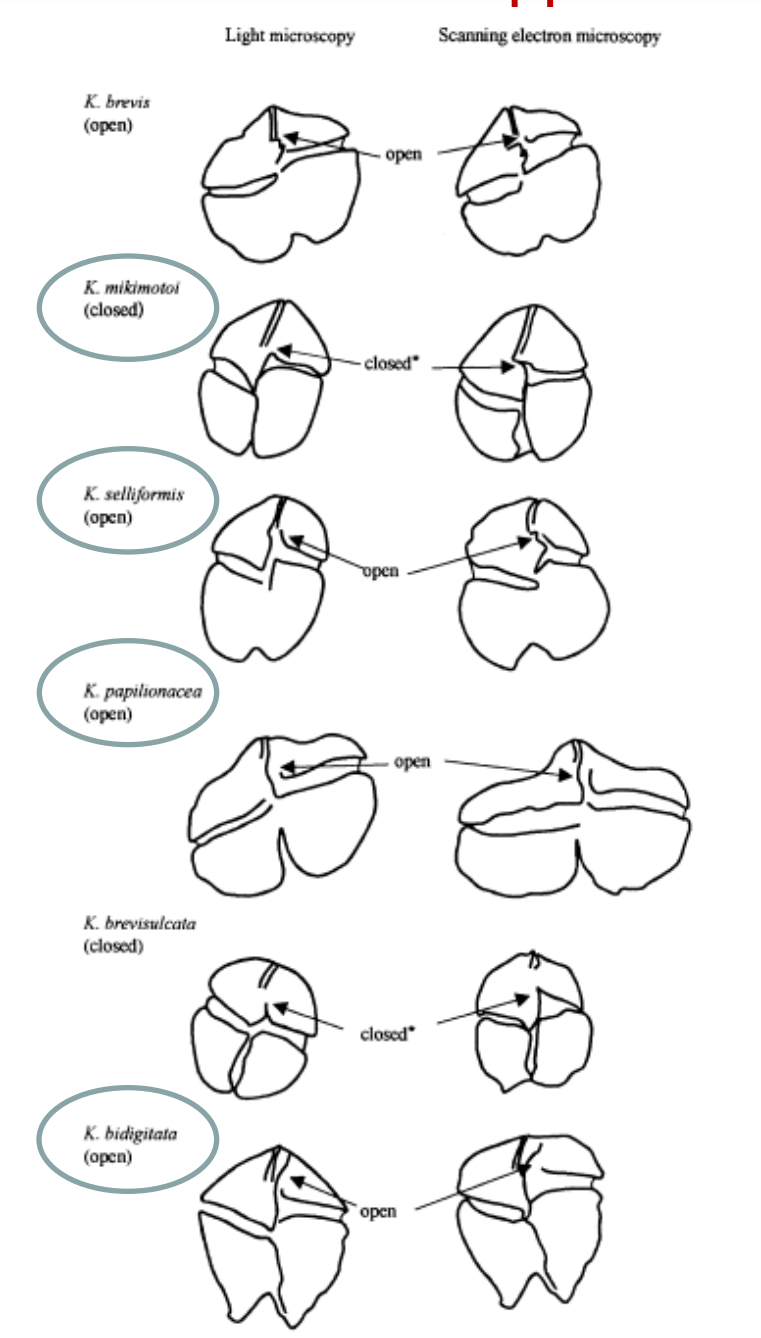


(Haywood et al., 2004)

Marine animal mortalities, NSP, respiratory irritation

Non segnalata in Mediterraneso

Karenia spp.

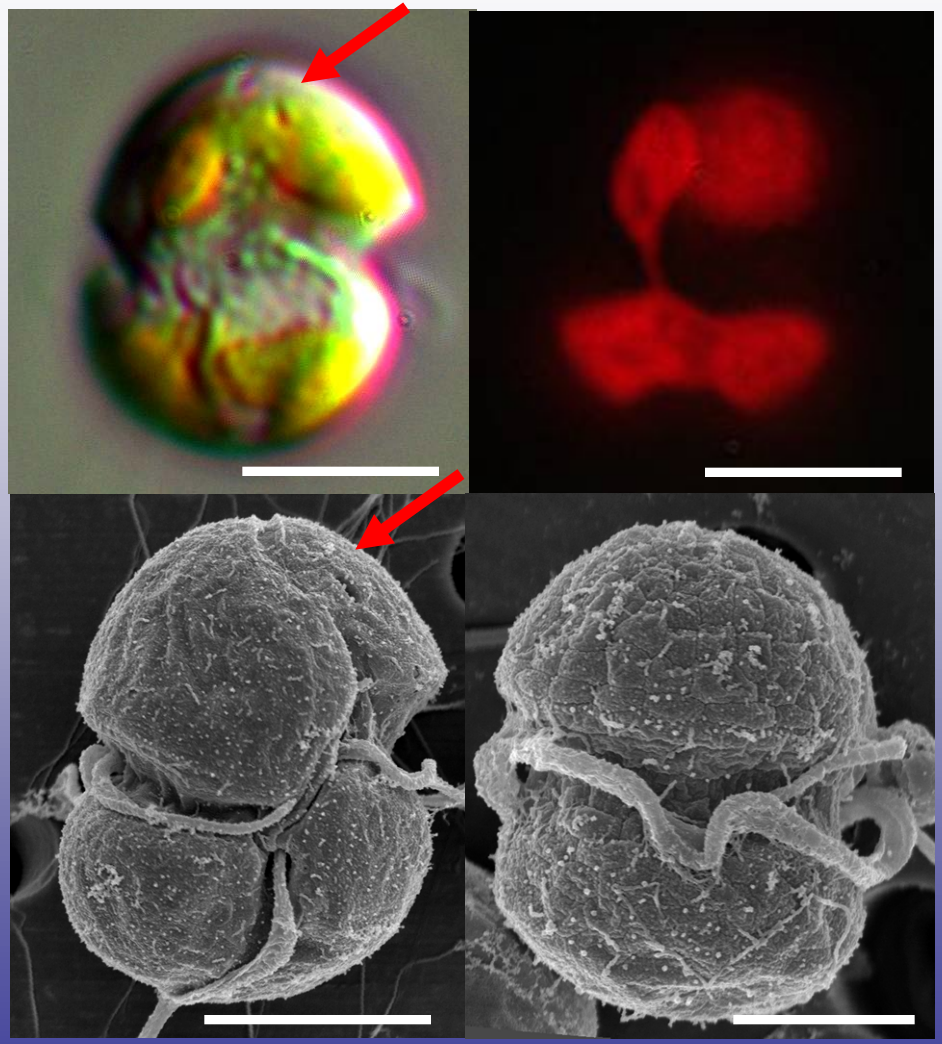


Haywood et al 2004

Karlodinium : l'importanza dello studio tassonomico

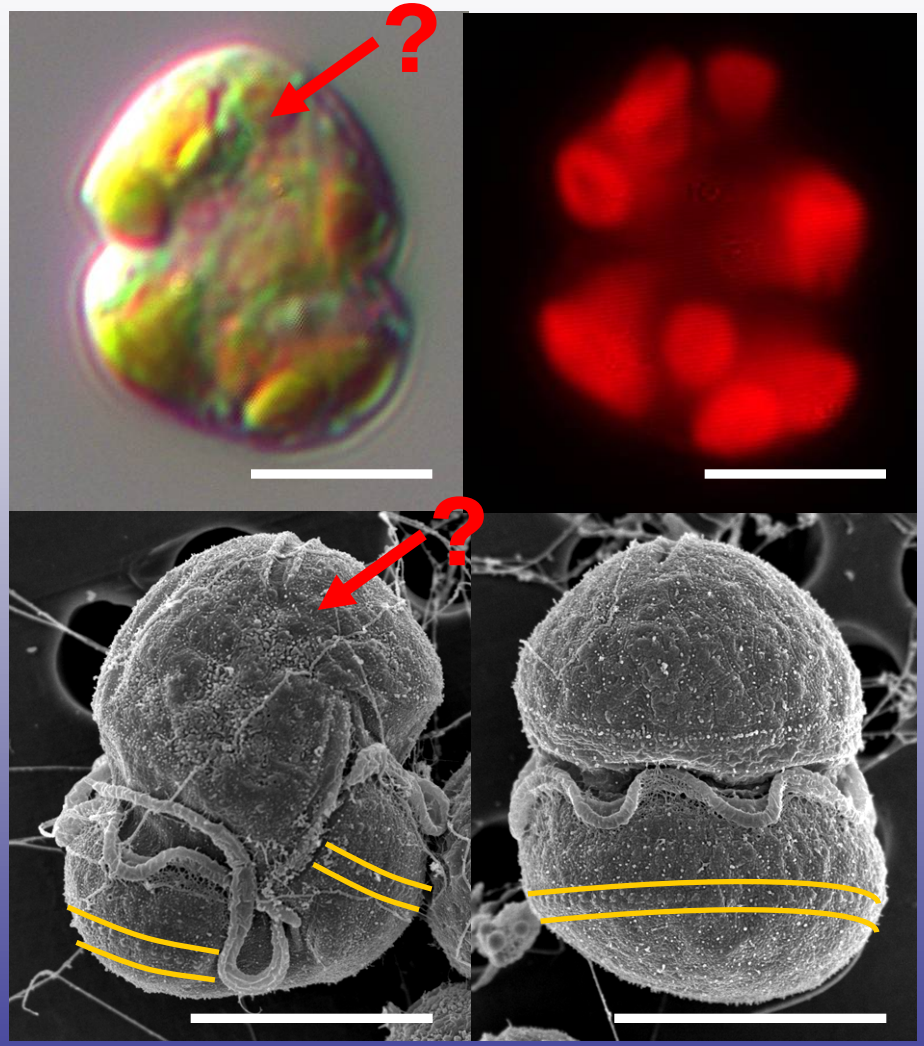
Karlodinium veneficum

Sin. ***Karlodinium micrum***



Ittiotossicità e colorazioni anomale

Karlodinium ballantinum

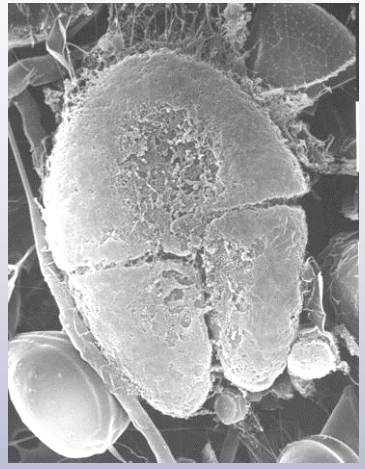


Non tossico

Altre dinoflagellati ittiotossici

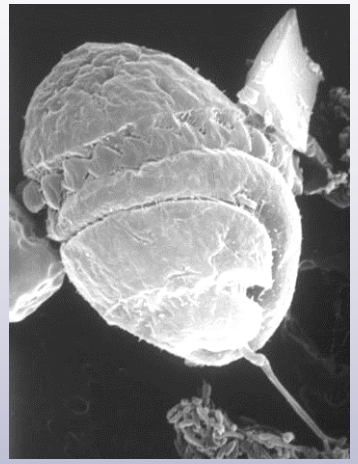
Akashiwo sanguinea

(=Gymnodinium sanguineum)



Margalefidinium polykrikoides

(= Cochlodinium polykrikoides)



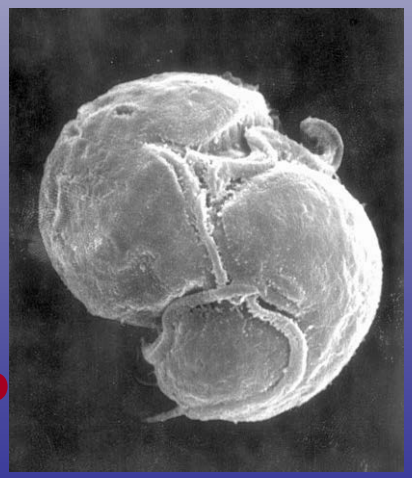
Prorocentrum cordatum
(P. minimum)

***Karenia* spp.**

Ittiotossiche + NSP

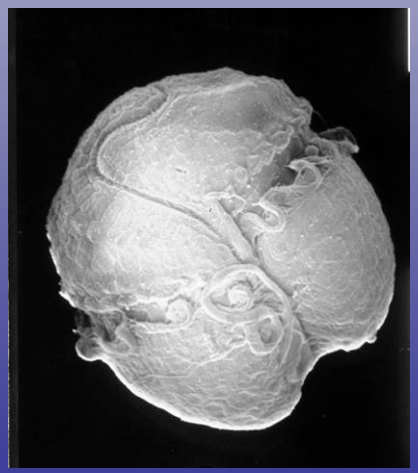
Karlodinium corsicum

(= Gyrodinium corsicum)



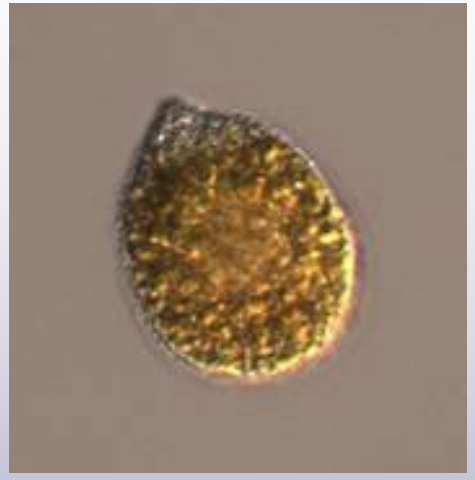
Takayama* cfr.*cladochroma

(= Gymnodinium pulchellum)

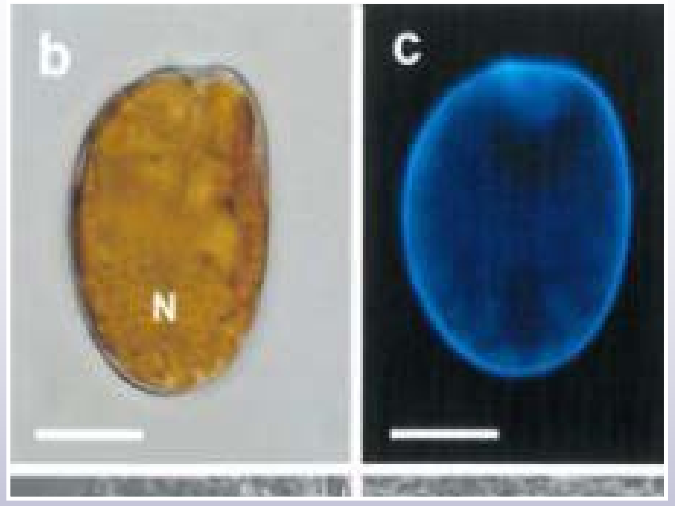


Bloom in tutto il Golfo di Napoli Sett-Ott 2001

Microalghe bentoniche tossiche

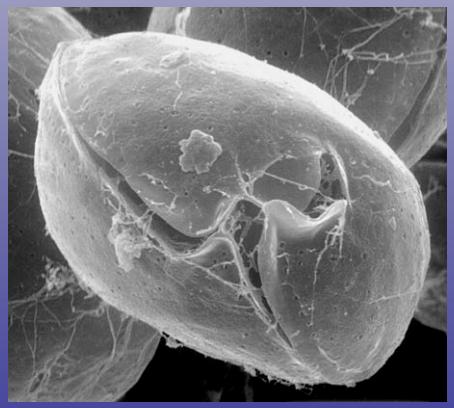


Ostreopsis cf. *ovata*



Prorocentrum rhatymum

Coolia monotis



Fitobenthos del Golfo di Napoli

Prorocentrum lima

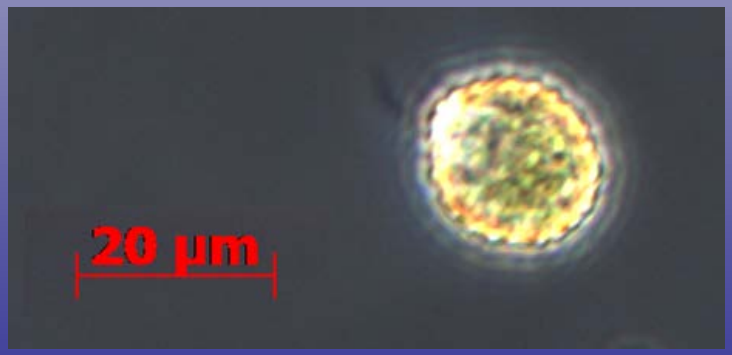
Altri flagellati potenzialmente tossici in Campania

Raphidophyceae
Chattonella subsalsa
Heterosigma akashivo
Fibrocapsa japonica

Prymnesiophyceae
Chrysochromulina leadbeateri
Chrysochromulina polylepis
Phaeocystis sp.
Prymensium calathiferum
Prymensium patelliferum

Dictyochophyceae
Pseudochattonella verrucolosa
Vicicitus globulus

Chattonella subsalsa



Pseudochattonella verrucolosa

- Fioritura osservata in campione non fissato in giugno 2016
- Difficile da identificare in campioni fissati

Dinoflagellati e flagellati – Colorazioni anomale

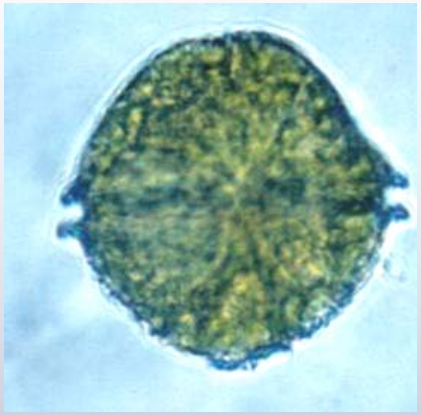
Prorocentrum triestinum		Acque brune #		
Alexandrium balechii #		Acque bruno-dorate #		
Pyramimonas sp. #		Acque verdi#		
Tetraselmis wettsteinii #	-	Acque verdi #		
Chattonella subsalsa * #		Toxic to marine fauna **Acque brune#**		

*# rilevato in Campania

Fioriture con colorazione anomala dell'acqua

Alexandrium balechii

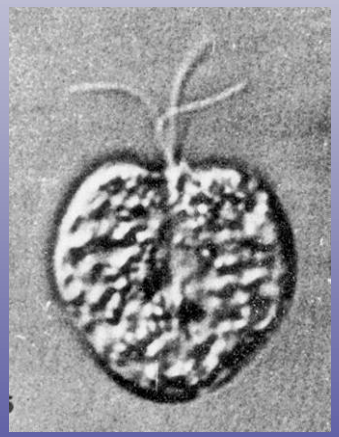
Golfo di Salerno,
Luglio-agosto 1980-1981
4 x 10^6 cell/l
Marrone dorato,
bioluminescenza



Prorocentrum triestinum

Golfo di Salerno,
Maggio 1983-1984
10^6 cell/l
Marrone dorato

Tetraselmis wettsteinii



Golfo di Napoli,
15 luglio 1987
5 x 10^7 cell/l,Verde smeraldo

***Pyramimonas* sp.**

Golfo di Salerno,
Estate 2003 e 2004
verde intenso

Chattonella subsalsa

olfo di Salerno,
ago Fusaro (Napoli)
state 1987

Golfo di Policastro,
Estate 2005
Marrone rossastro

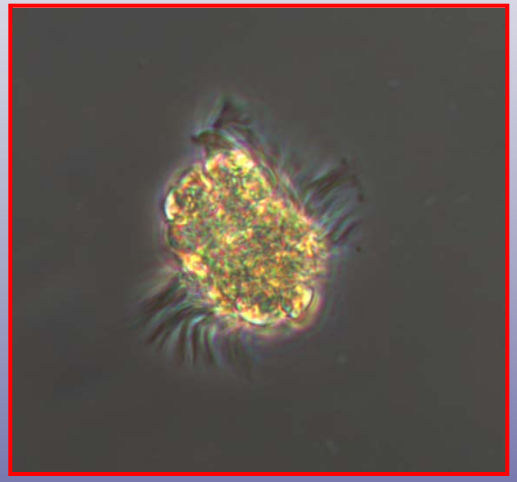
(Zingone, et. al. 2006 *Harmful Algae*)

...non solo fitoplancton!

Portici 18 Maggio 2006:
ACQUE VERDE-MARRONE
Diatomee

+

Ciliato: *Mesodinium rubra*

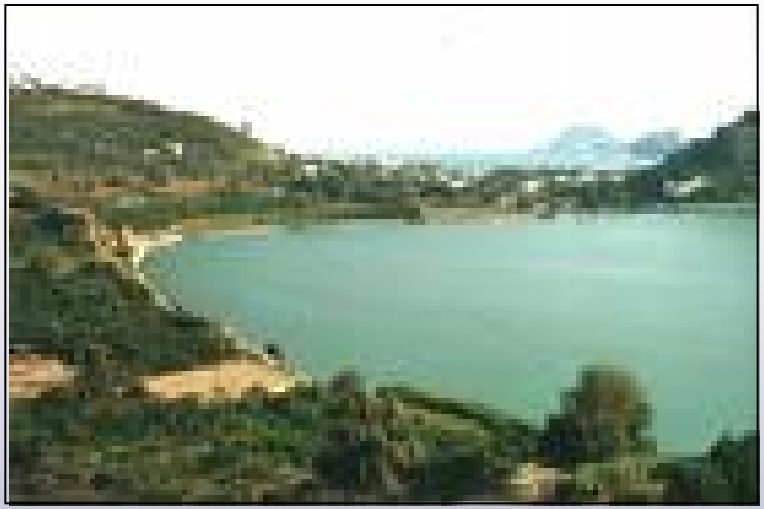


Biomassa: 5,6 µg C/ml

LA PIÙ ALTA BIOMASSA DI *M. RUBRUM* OSSERVATA IN MEDITERRANEO

(Siano et al., 2006 Harmful Algal News)

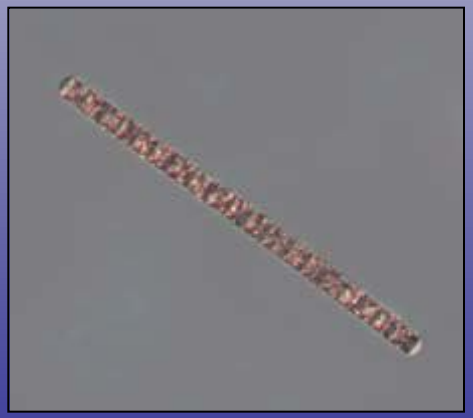
Non solo mare: il lago d'Averno



In condizioni normali...

a marzo-aprile 2007

Fioritura di *Planktothrix rubescens*
(Cyanophyceae, Oscillatoriales)



fino a 1,4 x 10^9 cellule/litro

STAGIONALITA' DELLE SPECIE TOSSICHE nelle acque campane

Amnesic Shellfish Poisoning

P. calliantha	ignota
P. delicatissima	Mar-Apr – Ago-Ott
P. galaxiae	Feb-Ago
P. multistriata	Set-Ott
P. fraudulenta	Mar-Apr

Diarrhetic Shellfish Poisoning

D. caudata	M
D. fortii	M
D. mitra	M
D. rapa	M
D. tripos	M
D. rotundata	Mar-Ott
D. sacculus	Mar-Ott
L. polyedrum	Mag-Giu
P. lima	Giu-Lug
P. reticulatum	Apr

Specie ittiotossiche

A. sanguinea	Giu-Lug
C. polykrikoides	ignota
Karenia cf. mikimotoi	Giu
C. corsicum	ignota
	ignota
chladocroma	Sett-Ott
	estate
ri	ignota
	ignota
m	ignota
	ignota

Periodo di massima allerta: primavera-estate

Neurotoxic Shellfish Poisoning

Karenia cf. *bicuneiformis*	Giu
Karenia cf. *cristata*	Giu
Karenia cf. *papilionacea*	Gen
Karenia cf. *selliformis*	Apr

Colorazioni anomale

A. balechii	Ago
Pyramimonas spp.	estate
Phaecystis spp.	ignota
T. wettsteinii spp.	Mag

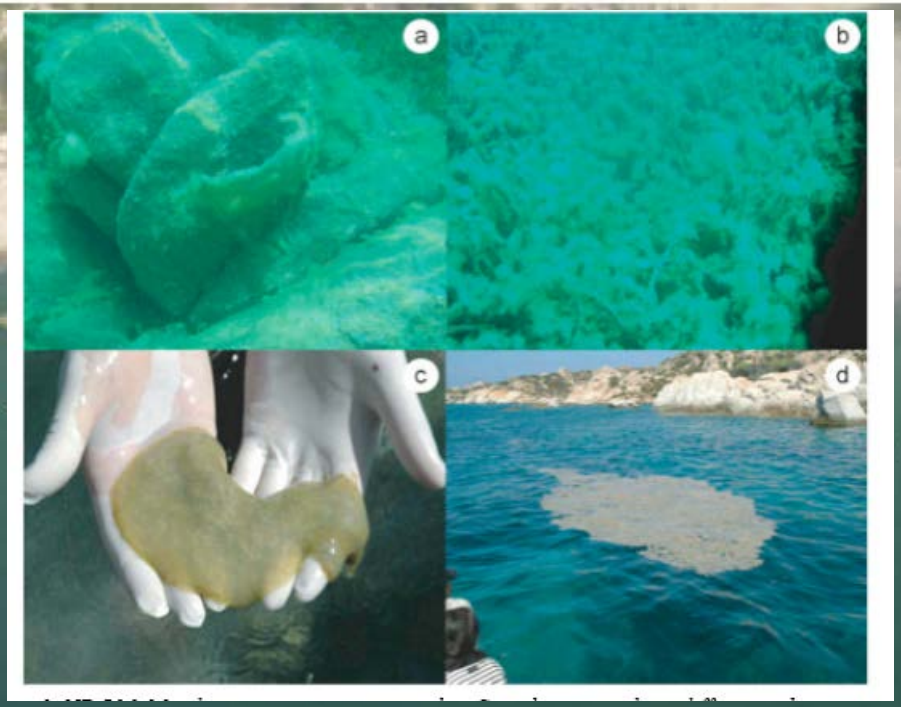
Azaspiracid Shellfish Poisoning

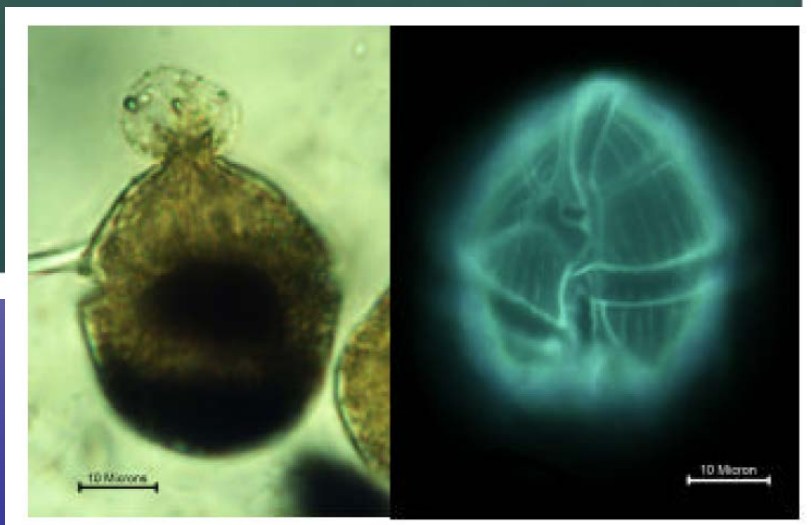
P. crassipes	Mar-Giu

Altre tossine

C. monotis	Giu
O. ovata	Giu-Lug

What is *Chrysophaeum taylorii* Lewis & Bryan doing in Sardinia (Tyrrhenian Sea, Mediterranean)?





Gonyaulax fragilis, N. Sampedro, L. Arin, S. Quijano, A. Reñé & J. Camp, HAN 33,

Chrysophaeum taylorii Lewis & Brown

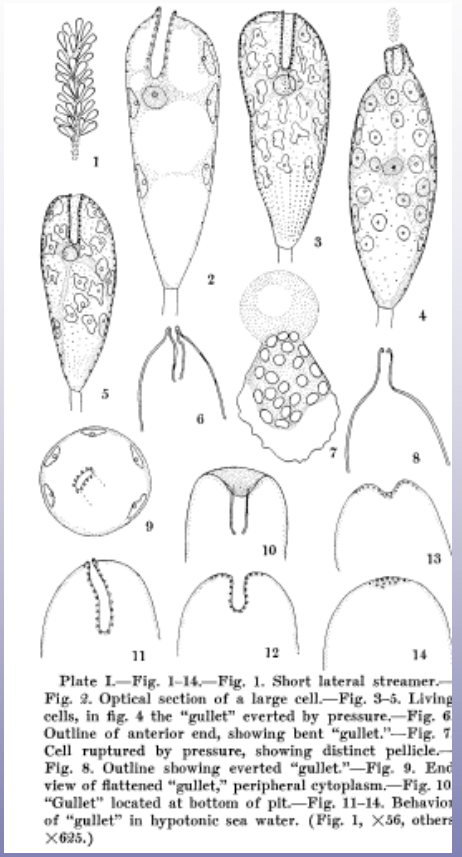
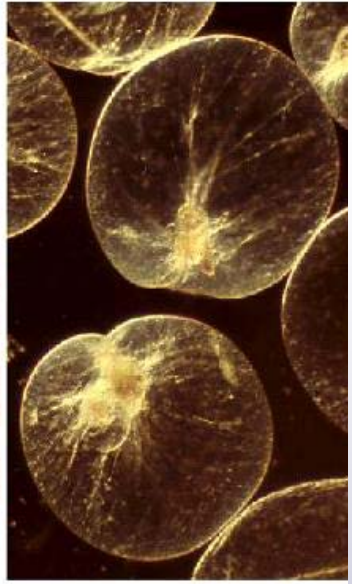


Plate L.—Fig. 1–14.—Fig. 1. Short lateral streamer.—Fig. 2. Optical section of a large cell.—Fig. 3–5. Living cells, in fig. 4 the "gullet" everted by pressure.—Fig. 6 Outline of anterior end, showing bent "gullet."—Fig. 7 Cell ruptured by pressure, showing distinct pellicle.—Fig. 8. Outline showing everted "gullet."—Fig. 9. End view of flattened "gullet," peripheral cytoplasm.—Fig. 10 "Gullet" located at bottom of pit.—Fig. 11–14. Behavior of "gullet" in hypotonic sea water. (Fig. 1, ×56, others ×625.)

- Microalga coloniale bentonica
- Descritta come criptoficea, poi nelle crisoficee
- E' una pelagoficea
- Alloctona in Mediterraneo
- Dal 2007 fioriture Sardegna nord-occidentale con produzione di mucillagini

A New Protophyte from the Dry Tortugas: Lewis & Bryan. American Journal of Botany, Vol. 28, No. 4 (1941)

Noctiluca scintillans, Seto Inland Sea (JAPAN)

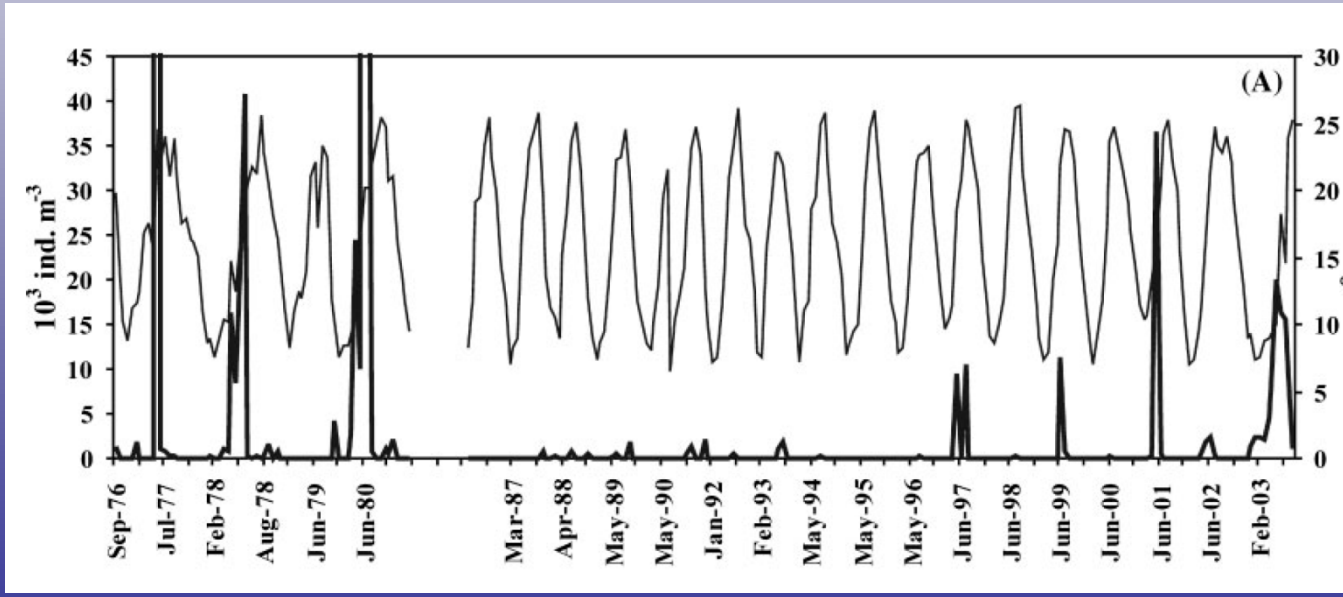


IOC-WESTPAC-HAB

Noctiluca scintillans

North Adriatic, Gulf of Trieste

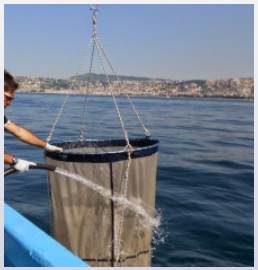
No relationships with T or nutrients



Fonda Umani et al., JPR 2003

Approcci molecolari: eDNA metabarcoding

combina tre concetti:



eDNA → DNA extracted from environmental samples → complex mixture of genomic DNA from different organisms

DNA barcode → **DNA-based identification** → *standardized gene* **markers** *enabling species discrimination*

Generation Sequencing → **High-throughput DNA sequencing** → Bypass the PCR and Sanger Sequencing

HTS DNA-metabarcoding is a rapidly evolving method for assessing biodiversity

Assign a species name to an e-DNA sequence

ANALYSIS

SEQUENCING

AMPLIFICATION

EXTRACTION

SAMPLE COLLECTION

Bioinformatic

HTS

DNA barcode

eDNA

Comparison with a reference database

18s – V4 rDNA is the most used marker

36 Harmful microalgal species at LTER MC (2011-2013)

Bad V4 discrimination (10)

- *Alexandrium pseudogonyaulax*
- *Dinophysis caudata*
- *Dinophysis cf. acuta*
- *Dinophysis fortii*
- *Dinophysis infundibulum*
- *Dinophysis ovum*
- *Dinophysis sacculus*
- *Karenia cf. papilionacea*
- *Prorocentrum cordatum*
- *Prorocentrum rhathymum*

Recorded with both HTS and Light Microscopy (16)

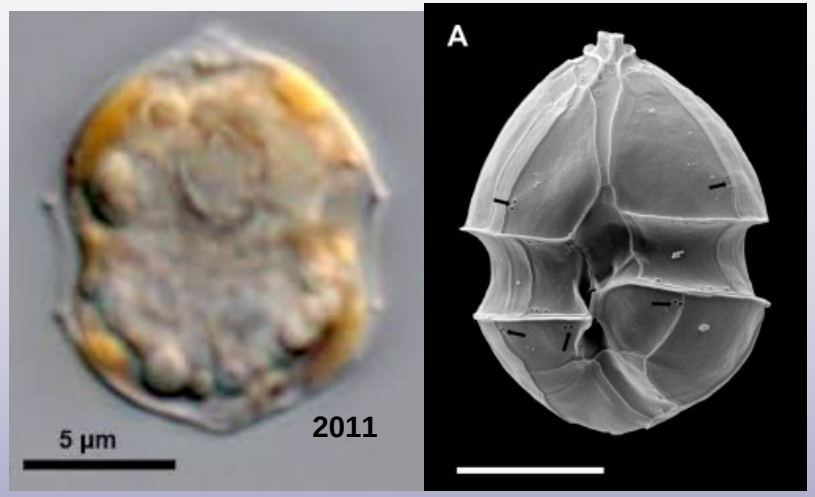
- *Azadinium dexteroporum*
- *Heterosigma akashiwo*
- *Ostreopsis cf. ovata*
- *Phalacroma rotundatum*
- *Protoceratium reticulatum*
- *Margalefidinium polykrikoides*
- *Alexandrium minutum*
- *Gonyaulax spinifera*
- *Lingulodinium polyedrum*
- *Pseudo-nitzschia delicatissima*
- *P. fraudulenta*
- *P. fraudulenta/subfraudulenta*
- *P. galaxiae*
- *P. galaxiae "small morphotype"*
- *P. multistriata*
- *P. pseudodelicatissima*

Recorded only with HTS (10)

- *Alexandrium andersonii*
- *Alexandrium ostenfeldii*
- ***Amphidoma languida****
- ***Azadinium poporum****
- *Chattonella subsalsa*
- *Phaeocystis cordata*
- *Phaeocystis globosa*
- *Pseudo-nitzschia calliantha*
- ***Pseudo-nitzschia pungens****
- ***Vicicitus globosus****

New entry nel GoN

4 new entries nel GoN

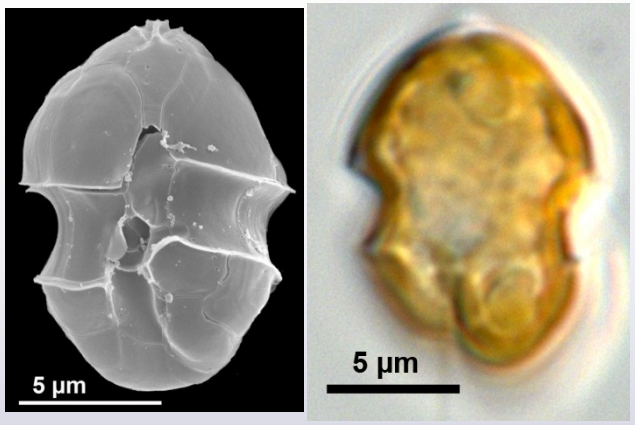


▪ ***Amphidoma languida****

Tillmann et al. 2002

▪ ***Vicicitus globosus****

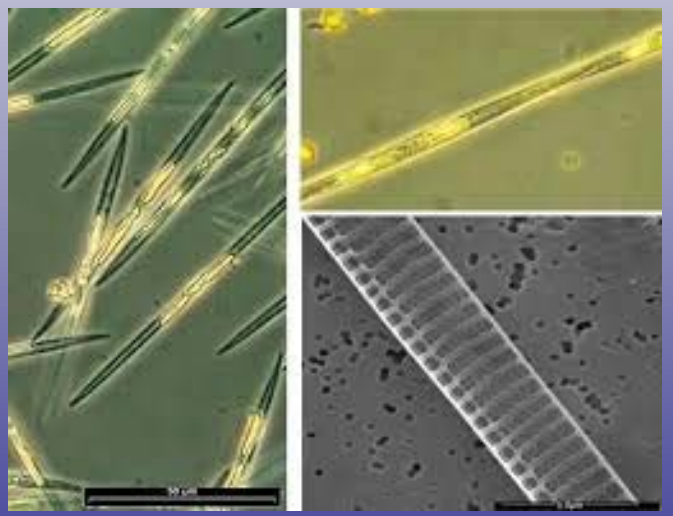
▪ *(syn Chattonella globosa)*



▪ ***Azadinium poporum****

Successivamente osservati in LM

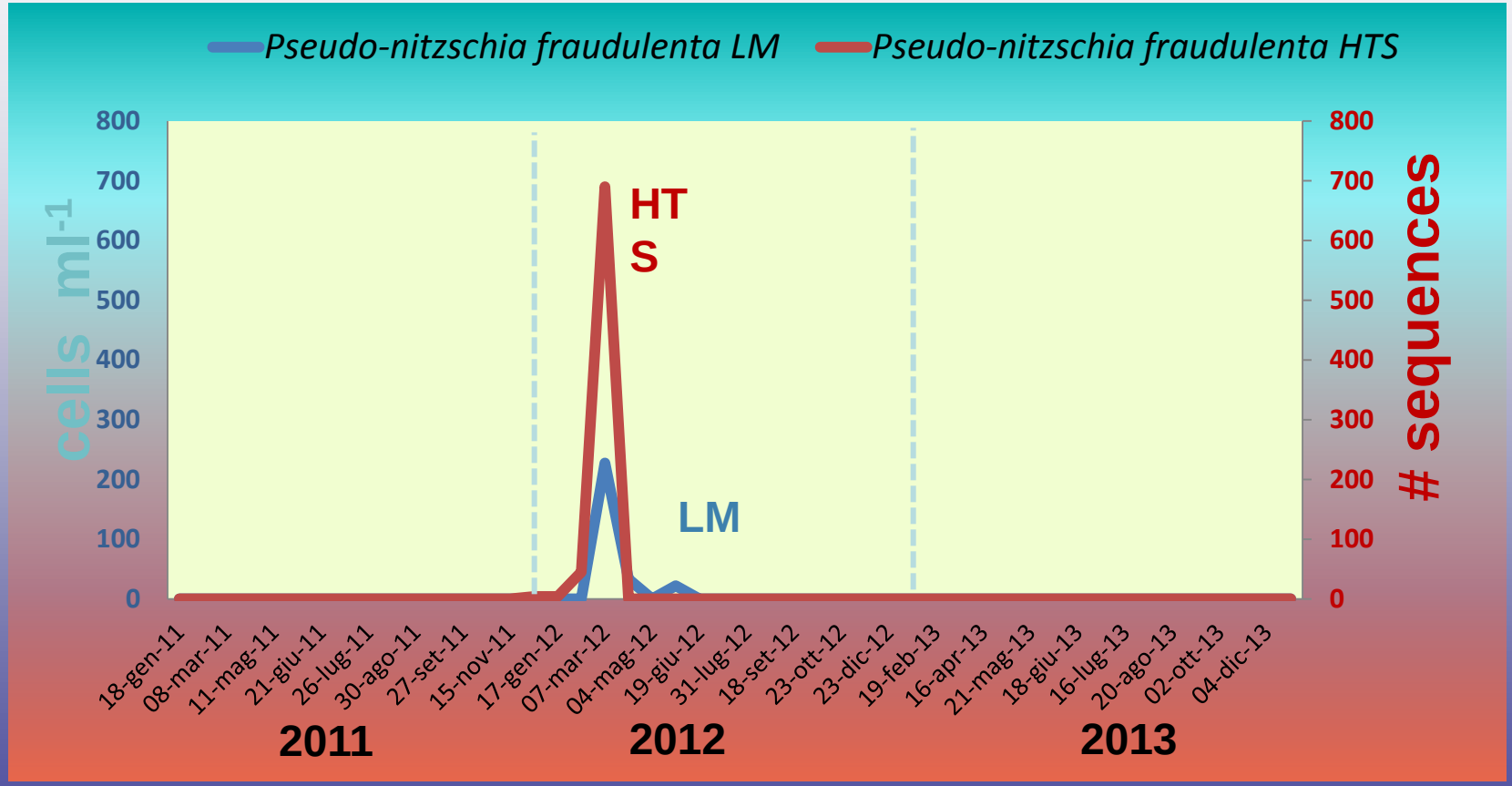
2013



▪ ***Pseudo-nitzschia pungens****

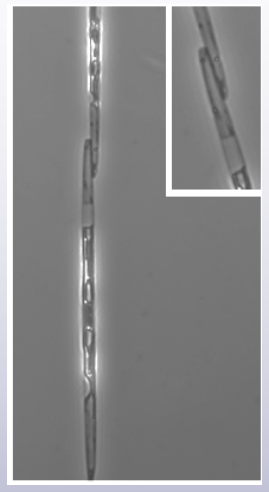
Comparing molecular and LM counts:

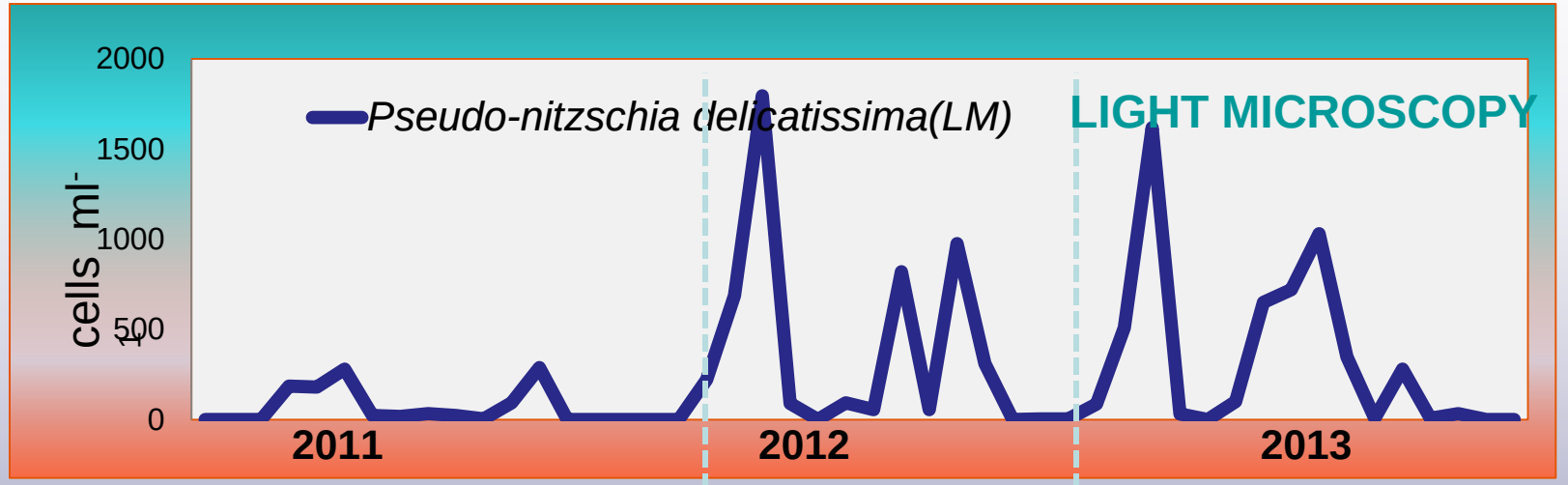
Pseudo-nitzschia fraudulenta detected once over 3 years with both V4 and bottle sample LM



Match of HTS and Light Microscopy data

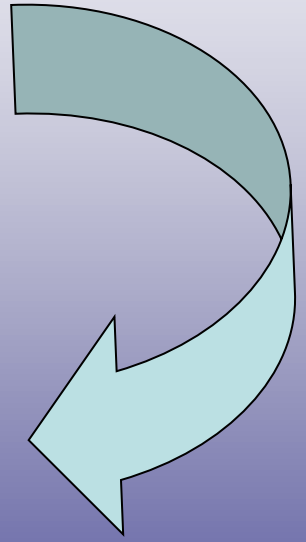
Comparing sequence and LM counts in cryptic species :





Il paradosso delle coste campane

Molte alghe potenzialmente dannose



Danni limitati o assenti

Le condizioni necessarie per avere un HAB

1. Presenza di specie tossiche o dannose

+

2. Raggiungimento di concentrazioni soglia per creare danno

+

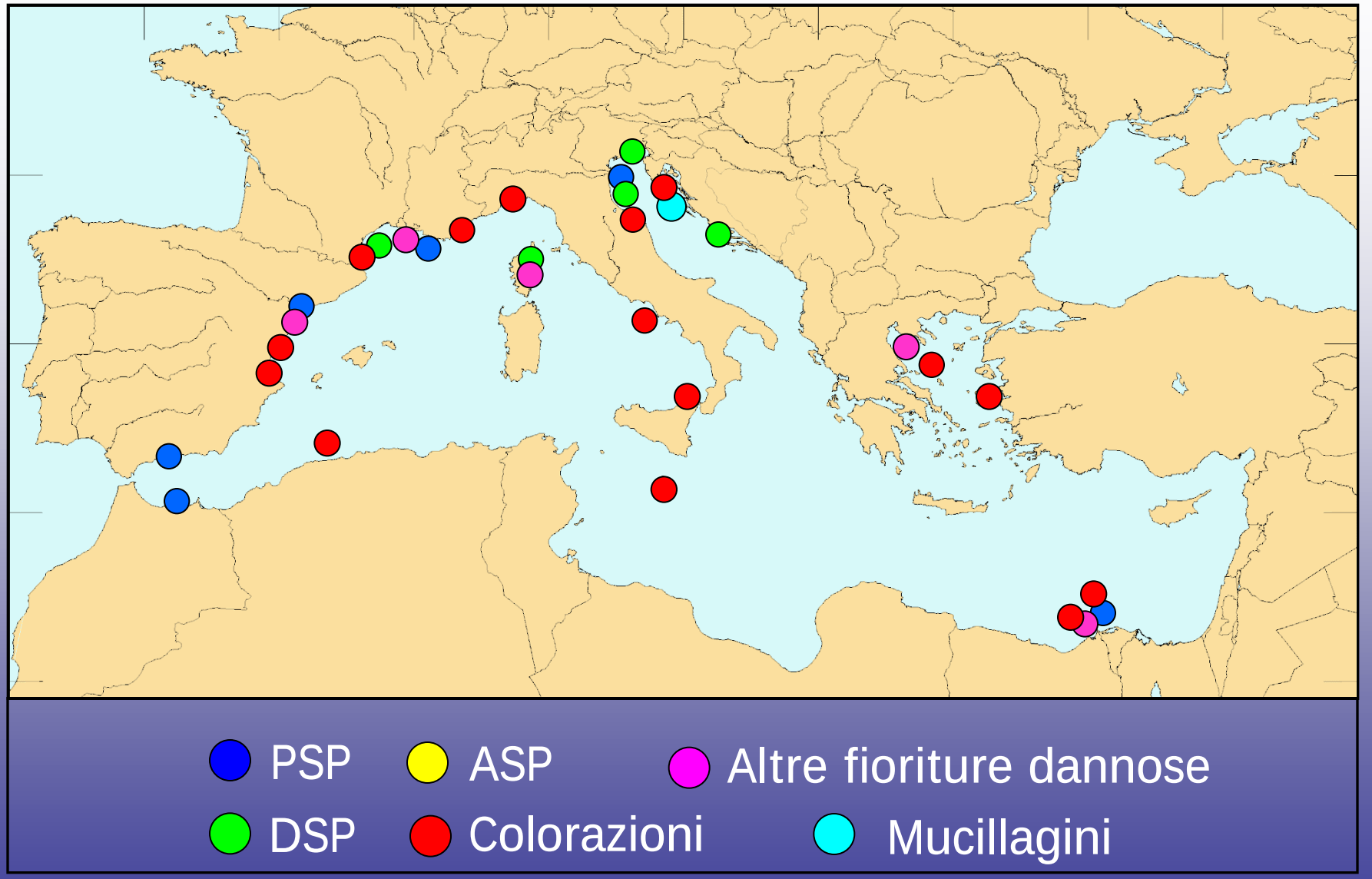
3. Espressione del danno (produzione di tossina, colorazioni anomale, anossia, etc.)

+

4. Presenza di una risorsa oggetto di impatto

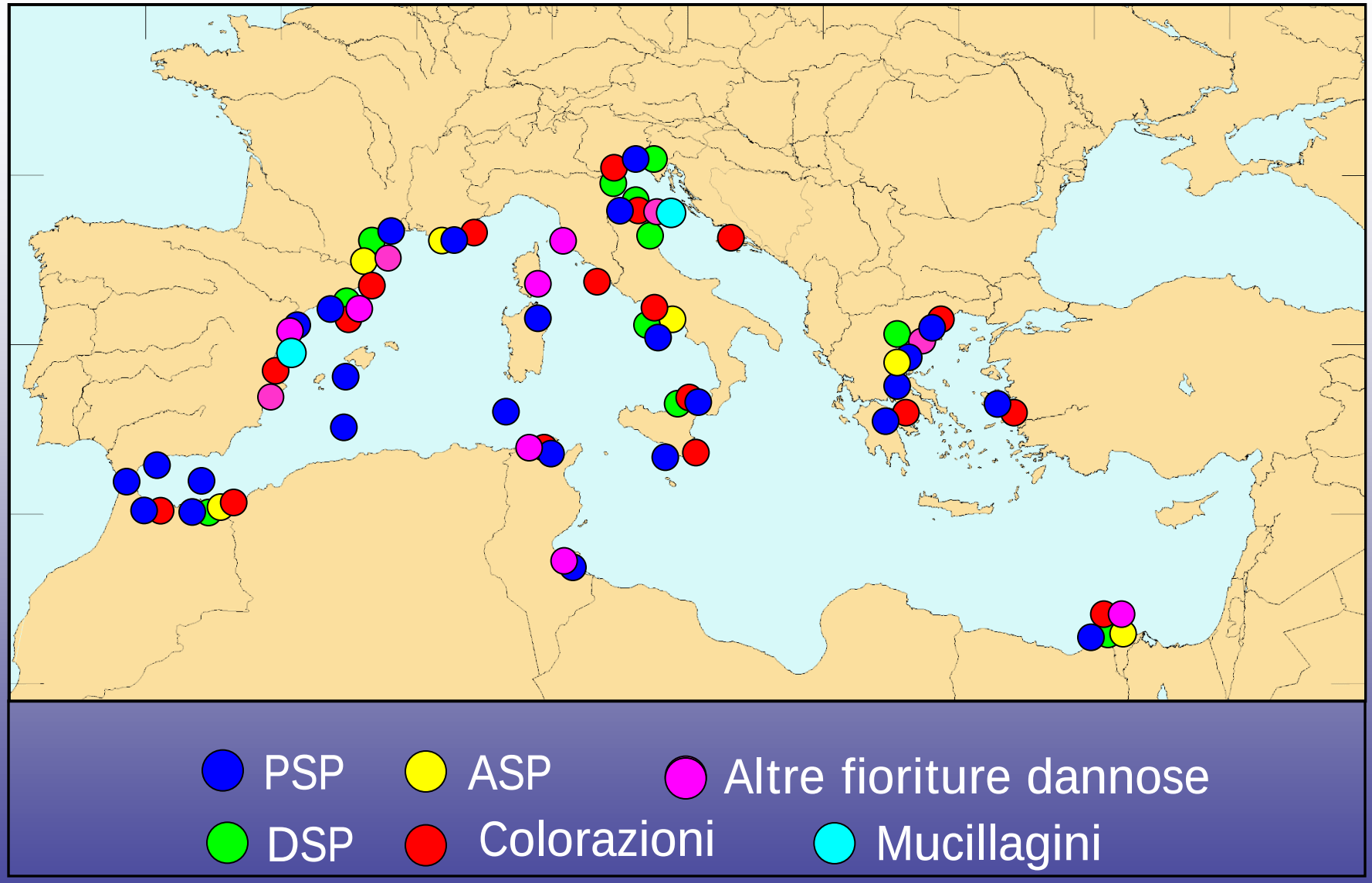
=

HAB



Datl da Honsell et al. 1995 and Jacques and Sournia 1975-76

HABs nel Mediterraneo



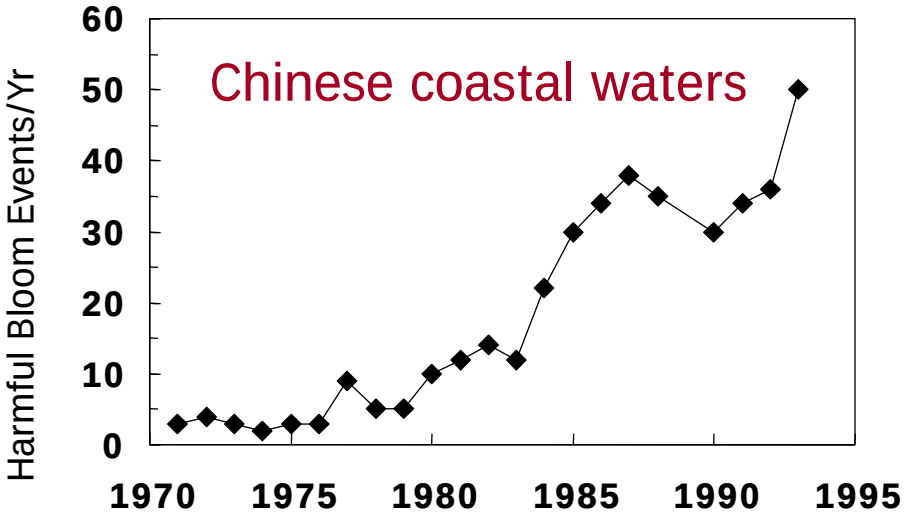
DATI RILEVATI AL 2008

Zingone, dati non pubblicati

L'aumento globale degli HABs potrebbe essere apparente *o reale*

- aumento dell'informazione
- sistemi di monitoraggio più efficaci
- maggiori interazioni con il mare
- sviluppo dell'acquacultura

L'eutrofizzazione **è un processo che porta ad un aumento dell'arricchimento organico, generalmente attraverso un aumento nella disponibilità dei nutrienti (Nixon 1995)**



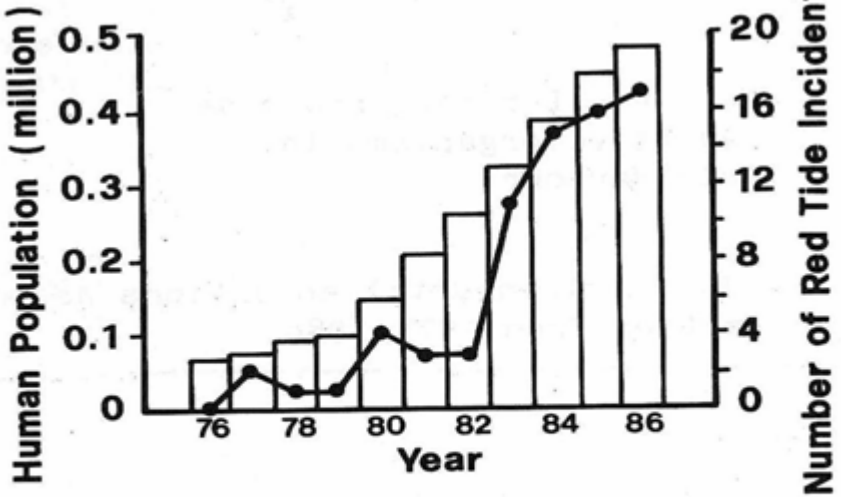


FIG. 6. Corresponding increase of red tide incidents with rising human population.

Gestione degli HABs

1. Controllo / Eliminazione
2. Mitigazione
3. Prevenzione
4. Previsione

1. Controllo

- Virus e batteri
- Uso di fanghi

2. Mitigazione

- Monitoraggio continuo ed estensivo
- Spostamento delle gabbie con pesci
- Chiusura degli impianti di acquacultura
- Detossificazione

3. Prevenzione:

- Riduzione dell'eutrofizzazione
- Riduzione di porti, moli, barriere
- Scelta della destinazione d'uso delle aree costiere

4. Previsione

- Monitoraggio a lungo termine
- Modelli predittivi
- Ricerca sulla dinamica delle fioriture

Importanza del monitoraggio

Identificazione tassonomica

I Workshop MOTax

La tassonomia degli organismi marini: creazione di un network nazionale integrato

MOTax

MARINE ORGANISMS TAXONOMY

Stazione zoologica Anton Dohrn
26-27 ottobre 2016