Dinophysis and *Cochlodinium* spp. In North American waters

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Harmful algal blooms on the U.S. west coast

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Table 19 Toxic and nuisance algal species reported from the west coast of U.S. (from Horner *et al.* 1997).

1.	Dinoflagellate species that produce saxitoxins that cause paralytic shellfish poisoning (PSP)	*Alexandrium acatenella* *Alexandrium catenella* *Alexandrium fundyense* *Alexandrium hiranoi* *Alexandrium ostenfeldii* *Alexandrium tamarense*
2.	Dinoflagellate species that produce okadaic acid that causes diarrhetic shellfish poisoning (DSP). DSP has not yet been measured in shellfish on the west coast, but the causative organisms are common	*Dinophysis acuminata* *Dinophysis acuta* *Dinophysis fortii* *Dinophysis norvegica*
3.	Diatoms that produce domoic acid that causes domoic acid poisoning, also known as amnesic shellfish poisoning (ASP)	*Pseudo-nitzschia australis* *Pseudo-nitzschia multiseries* *Pseudo-nitzschia pseudodelicatissima* *Pseudo-nitzschia pungens* *Pseudo-nitzschia seriata*
4.	Species associated with fish kills, but not know to be harmful to humans	*Diatoms* *Chaetoceros concavicornis* *Chaetoceros convolutes* *Chaetoceros danicus* *Raphidophyte* *Heterosigma akashiwo*
5.	Species that cause water discolorations. Blooms of these species may kill kish or invertebrates due to oxygen depletion may change or disrupt food-web dynamics or produce noxious compound	*Dinoflagellates* *Ceratium dens* *Ceratium divaricatum* *Ceratium furca* *Ceratium fusus* *Gymnodinium sanguineum* *Gymnodinium flavum* *Lingulodinium poydrum* *Noctiluca scintillans* *Prorocentrum micans* *Protoneridium*

Despite the clear history of HABS in North American waters, the two genera of interest (*Dinophysis* and *Cochlodinium* spp.) are minor in frequency the the North Pacific waters of North America.

Cochlodinium species

- C. helix
- C. catenatum
- C. polykrikoides

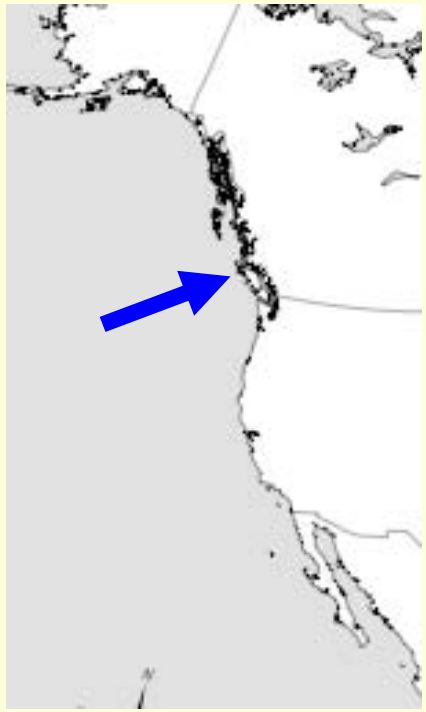
Despite the clear history of HABS in North American waters, the two genera of interest (*Dinophysis* and *Cochlodinium* spp.) are minor in frequency the the North Pacific waters of North America.

Phycologia (2001) Volume 40 (3), 298–304 Published 13 August 2001

First record of blooms of *Cochlodinium* sp. (Gymnodiniales, Dinophyceae) causing mortality to aquacultured salmon on the west coast of Canada

J.N.C. (IAN) WHYTE*, NICOLA HAIGH, NORMA G. GINTHER AND LAURIE J. KEDDY

Fisheries and Oceans Canada, Pacific Biological Station, 3190 Hammond Bay Road, Nanaimo, British Columbia, Canada, V9R 5K6



- ***C. polykrikoides***
- Fish kills observed in 1999/2000
- Up to 56,000 cells/ml
- Strong vertical migration pattern
- Common features of several embayments (11-13C, 29-31 ppt)

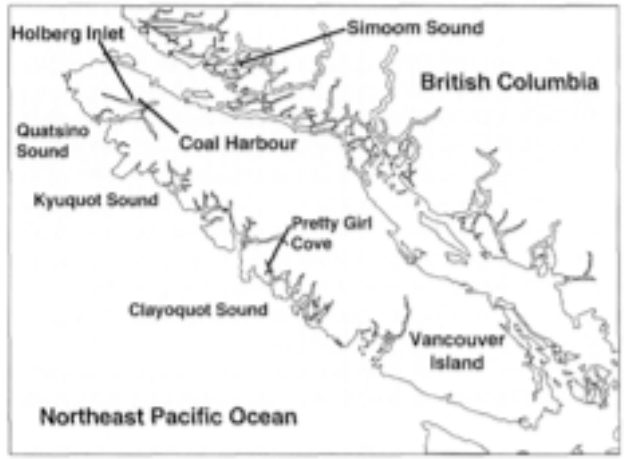


Fig. 1. Locations in British Columbia where blooms of *Cochlodinium* sp. were observed from July to October 1999.

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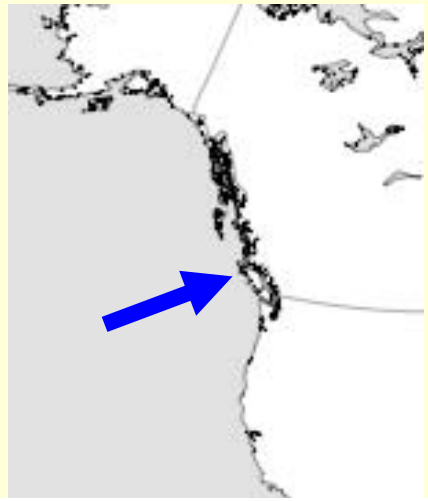


Fish mortalities:

- (against Atlantic Salmon)
- Stop feeding @ 500 cells/ml
- Young (smolts) - toxic @ 3,400 cells/ml
- Mature fish - 50% lethality @ 3,000 - 10,000 cells/ml

- Good relationship between field observations and field bioassays

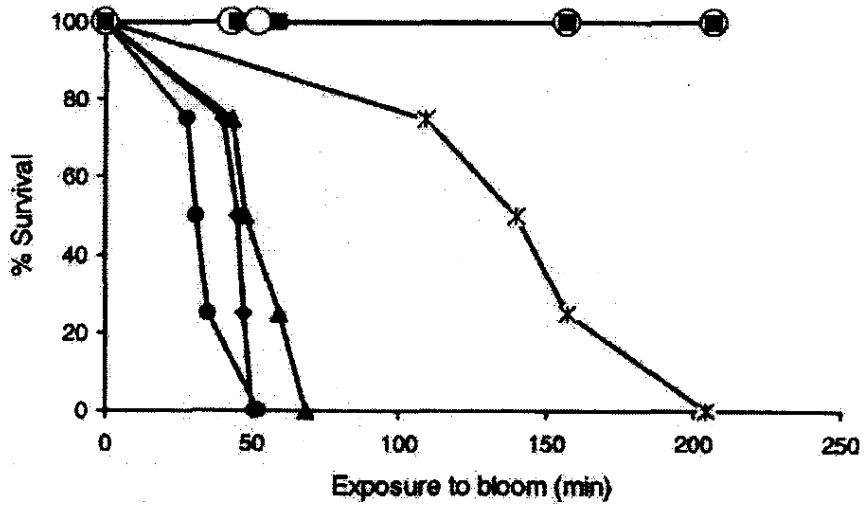


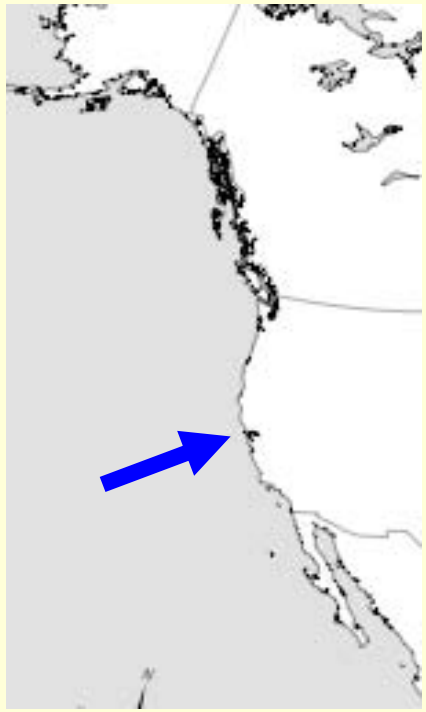
Fig. 4. Percentage survival of juvenile coho salmon, *Oncorhynchus kisutch*, exposed to *Cochlodinium* sp. bloom transported to the laboratory. Assayed using 7600 cells ml^{-1} with aeration (♦); 7900 cells ml^{-1} with aeration (▲); 10,700 cells ml^{-1} without aeration (●) and 9600 cells ml^{-1} without aeration (✱). Control fish in filtered, laboratory seawater with (○) and without aeration (■).

March 3, 2005

Contact: Tim Stephens (831) 459-2495; stephens@ucsc.edu

SCIENTISTS CONCERNED ABOUT POTENTIALLY HARMFUL ALGAE PERSISTING IN MONTEREY BAY

For Immediate Release



2004/2005 - Monterey Bay, California (Mary Silver (UCSC)

•*C. catenatum* - Warm-water variety from Mexico/Central America/San Diego

•July 2004 2-500 cells/ml - correlated to the presence of slime and smell in waters

•Bioassay mussels failed to trive for up to 5 months - long term to recovery.

Spatial Distribution of Phytoplankton Species in Chlorophyll Maximum Layers Off Southern California

F. M. H. Reid; E. Stewart; R. W. Eppley; D. Goodman

Limnology and Oceanography, Vol. 23, No. 2. (Mar., 1978), pp. 219-226.

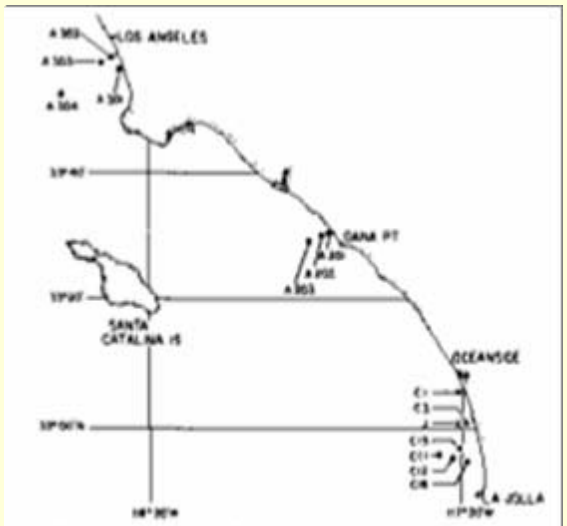


Fig. 1. Station locations, 16–17 March 1976, southern California coastal region.

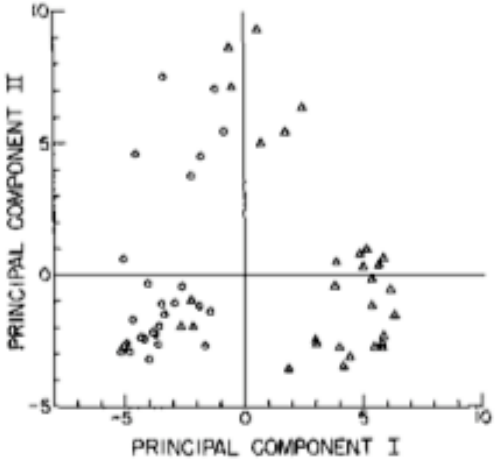
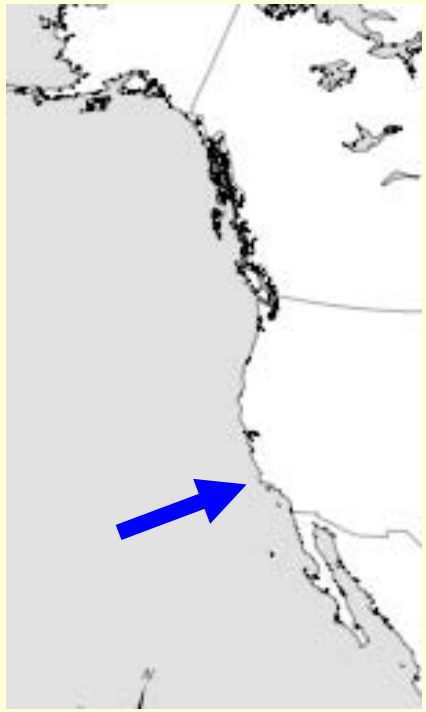


Fig. 5. Principal component II vs. principal component I. △—Samples from the chlorophyll maximum layer; ○—surface samples.



Documenting a dinoflagellate bloom off Scripps pier - a report from the Pier Chlorophyll Program

Mazzillo, F. [1], Carter, M. [1], Busse, L. [1], McGowan, J. [1]

[1]Scripps Institution of Oceanography

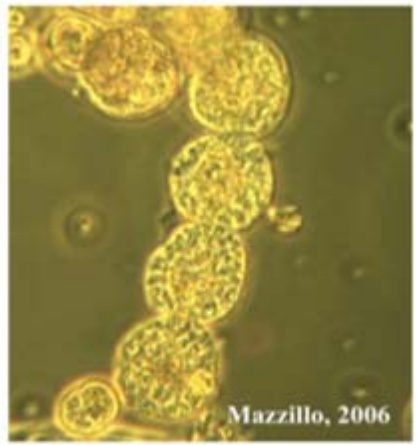
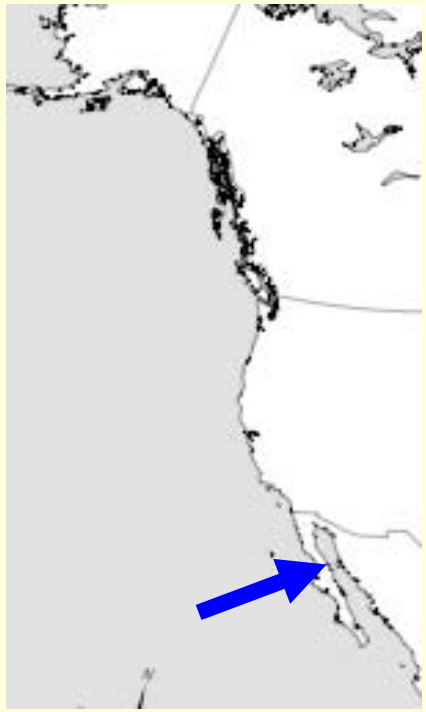


Figure 2: *Cochlodinium* sp.

Blooms of *Cochlodinium polykrikoides* (Gymnodiniaceae) in the Gulf of California, Mexico

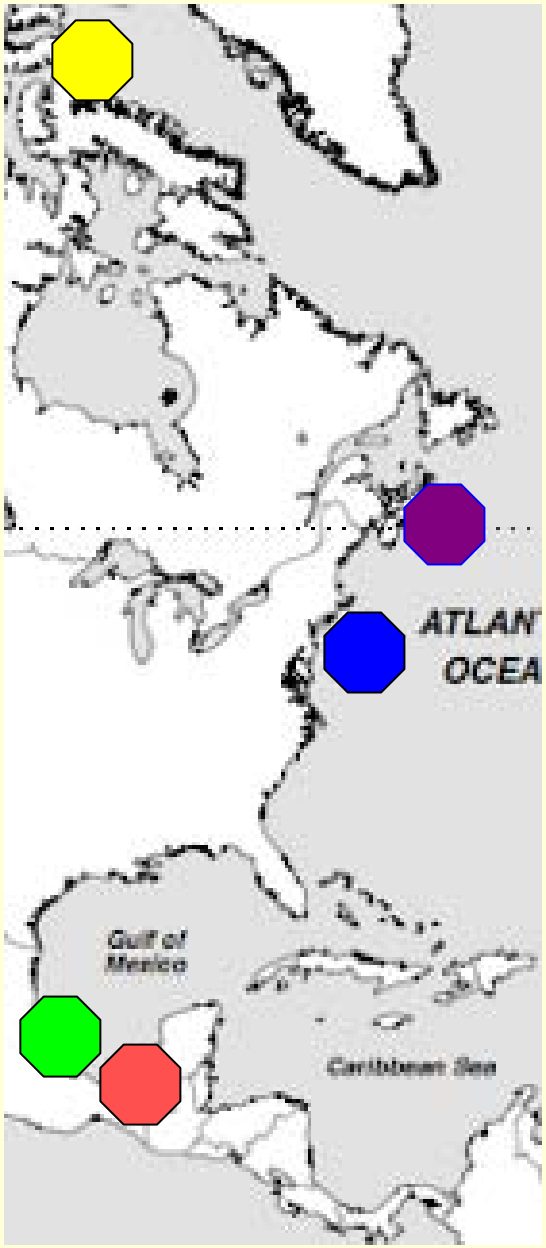
I. Gárate-Lizárraga[1], D.J. López-Cortes[2], J.J. Bustillos-Guzmán[2] & F. Hernández-Sandoval[2]

Rev. biol. trop. v.52 supl.1 San José Sep. 2004



C. polykrikoides

- Blooms Sept. 2000, Nov. 2000, Sept-Nov. 2001
- Chlorophyll levels went from 2 - 60 μg/L
- Cell densities up to 10^4 cells/ml
- Fish deaths, poorly correlated with cell densities
- Co-bloomed with *Mesodinium rubrum*, *Scrippsiella*, and *Noctiluca*.
- Environmental link - storms, runoff, elevated nutrients (?)



Arctic Ocean: *D. novegica.* Okolodkov and Dodge. 1996. J. Experimental Marine Biology 202:19-27

Maine +(Nova Scotia): *D. novegica* Van Dolah et al. 1999

Chesapeake Bay: *D. acuminata.* Soucek and Marshall. 1993. Virginia Journal of Science 44:123.

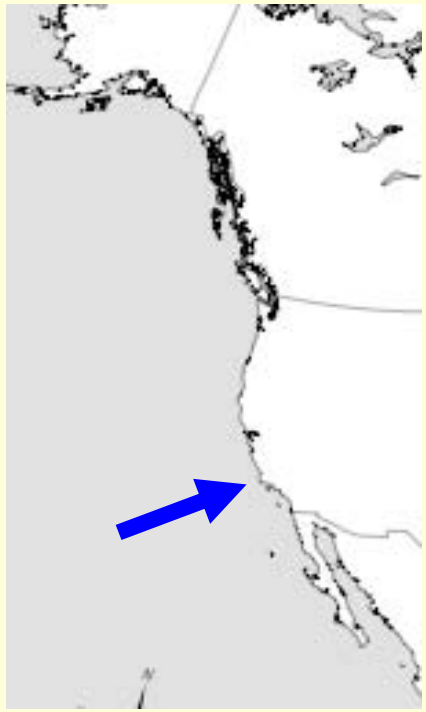
North Carolina: *D. Acuminata.* H.G. Marshall. 1969. American Midland Naturalist 82:241-257.

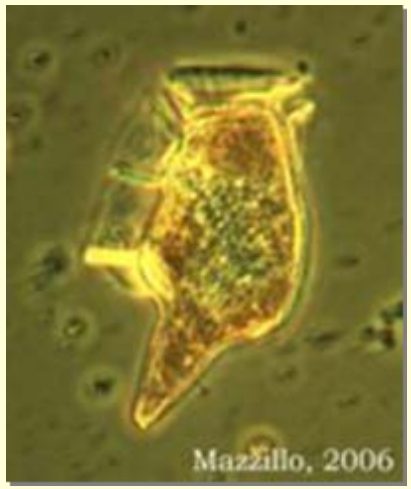
Mexican Caribbean Sea*: D. siankanensis*. Beceril and Hernandez-Beceril and Marshall. 2002. Phycologia 41: 374-381.

Southern Gulf of Mexico: *D. acuta, D. siankanensis, D. caudata*. Licea, Zamudio and Soto. 2004. Phycological Research 52:419-428.

Dinophysis sp.

- Many observations at the 50-100 cells /ml level
- Different species of *Dinophysis* occur in Southern California waters on a regular basis, but to our knowledge, the presence of okadaic acid has to be confirmed in California.





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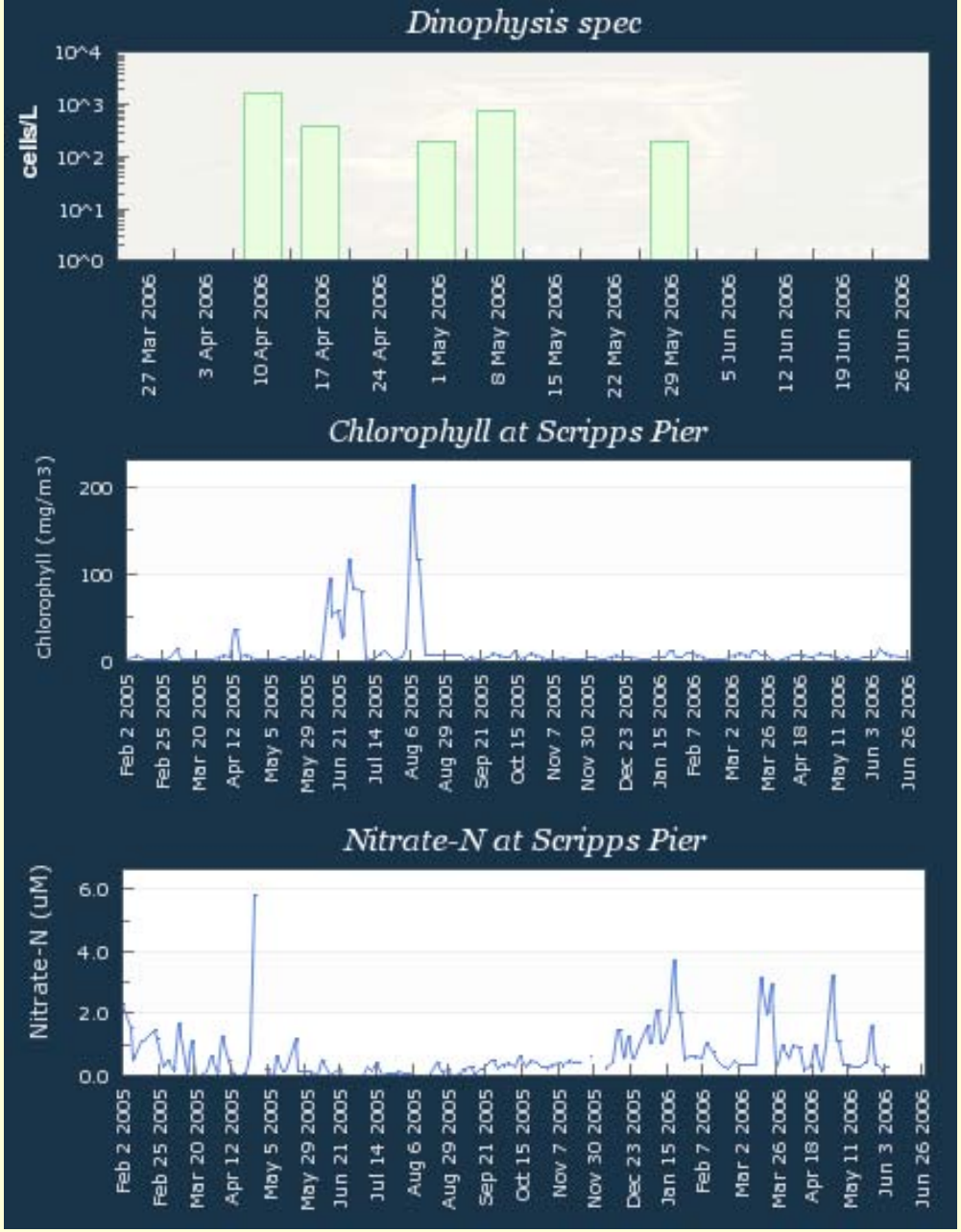
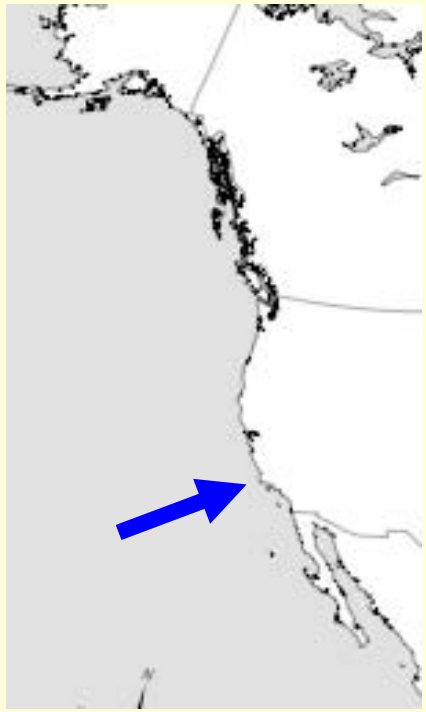
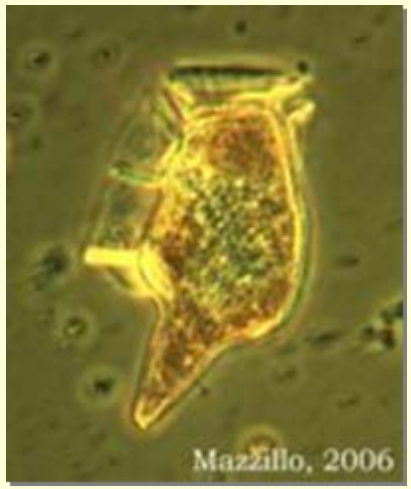
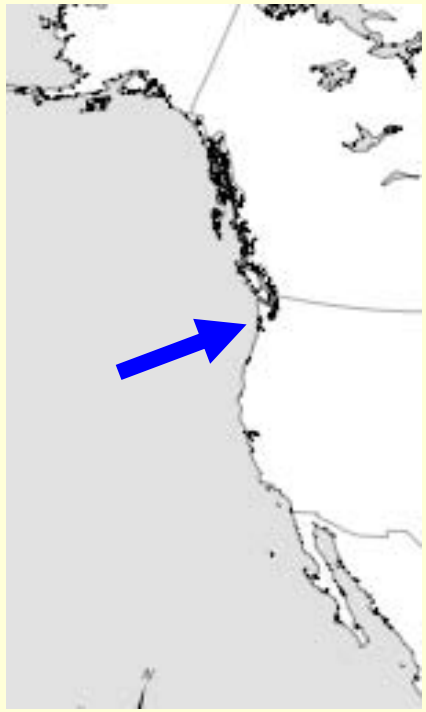

Dinophysis spec
cells/L
10^4
10^3
10^2
10^1
10^0
27 Mar 2006
3 Apr 2006
10 Apr 2006
17 Apr 2006
24 Apr 2006
1 May 2006
8 May 2006
15 May 2006
22 May 2006
29 May 2006
5 Jun 2006
12 Jun 2006
19 Jun 2006
26 Jun 2006
Chlorophyll at Scripps Pier
Chlorophyll (mg/m3)
200
100
0
Feb 2 2005
Feb 25 2005
Mar 20 2005
Apr 12 2005
May 5 2005
May 29 2005
Jun 21 2005
Jul 14 2005
Aug 6 2005
Aug 29 2005
Sep 21 2005
Oct 15 2005
Nov 7 2005
Nov 30 2005
Dec 23 2005
Jan 15 2006
Feb 7 2006
Mar 2 2006
Mar 26 2006
Apr 18 2006
May 11 2006
Jun 3 2006
Jun 26 2006
Nitrate-N at Scripps Pier
Nitrate-N (uM)
6.0
4.0
2.0
0.0
Feb 2 2005
Feb 25 2005
Mar 20 2005
Apr 12 2005
May 5 2005
May 29 2005
Jun 21 2005
Jul 14 2005
Aug 6 2005
Aug 29 2005
Sep 21 2005
Oct 15 2005
Nov 7 2005
Nov 30 2005
Dec 23 2005
Jan 15 2006
Feb 7 2006
Mar 2 2006
Mar 26 2006
Apr 18 2006
May 11 2006
Jun 3 2006
Jun 26 2006




Mazzillo, 2006

DSP toxins are likely present in the Pacific Nothwest but no monitoring is done



- The dinoflagellate species that produce okadaic acid that causes DSP are found in the US Pacific Northwest. DSP is not currently known on the west coast, but the causative organisms are common.

- *D. acuminata*
- *D. acuta*
- *D. fortii*
- *D. norvegica*

DSP toxin analysis in British Columbia shellfish (manila, scallop, Dungeness crab, savoury clam, Pacific oyster, littleneck clam)
June 2003-2005

Highest levels
OA, 0.5 ppm
DTX-1, 0.29 ppm
P2, 0.2 ppm
P2S, 7.5 ppm
P2S7, 4.6 ppm
Total DSP toxins, 9.5 ppm

Gym, 0.2 ppm
Yess, 12 ppm

EU standard is 0.16 ppm for whole animal
(0.8 ppm in digestive gland)

Not all pectenotoxins are used in this calculation
- because not toxic or low toxicity

Courtesy K. Schallie, Ag. Canada

Why are these species prevalent in Asian waters but mostly insignificant in North America?

3 concepts of HABs ecology:

1. Getting there.

2. Being there.

3. Staying there.

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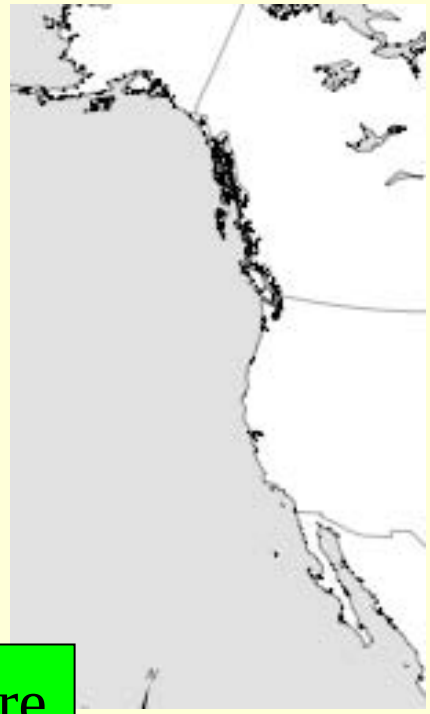


3 concepts of HABs ecology:

1. Getting there.

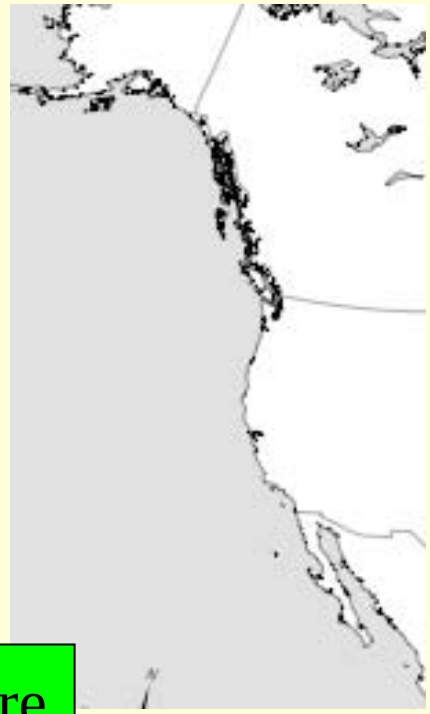
Cosmopolitan

2. Being there. **?**

Suitable light, temperature

3. Staying there.

Why are these species prevalent in Asian waters but mostly insignificant in North America?



3 concepts of HABs ecology:

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Water column stability, organic nutrients

3. Staying there.

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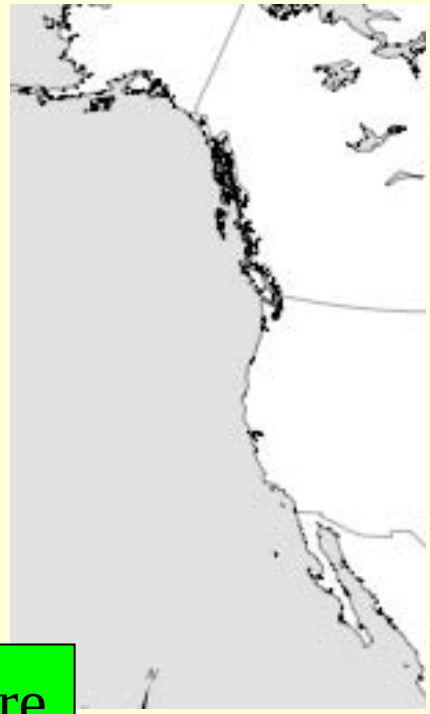

3 concepts of HABs ecology:

1. Getting there. Cosmopolitan

2. Being there. ? Suitable light, temperature

? Water column stability, organic nutrients

3. Staying there. ?? Competition/Grazing/Allelopathy