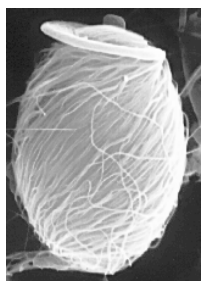
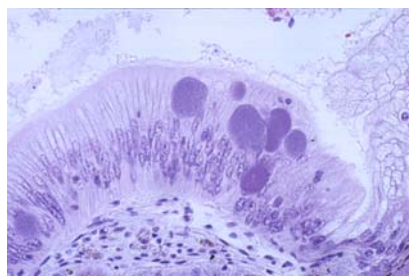
Impacts of disease on cultured and wild marine invertebrate populations

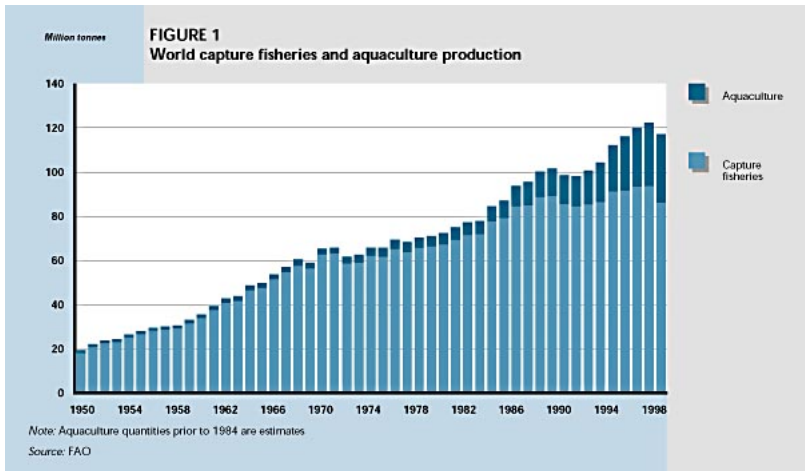
Carolyn S. Friedman
School of Aquatic and Fishery Sciences
University of Washington
Seattle, WA USA





Aquaculture

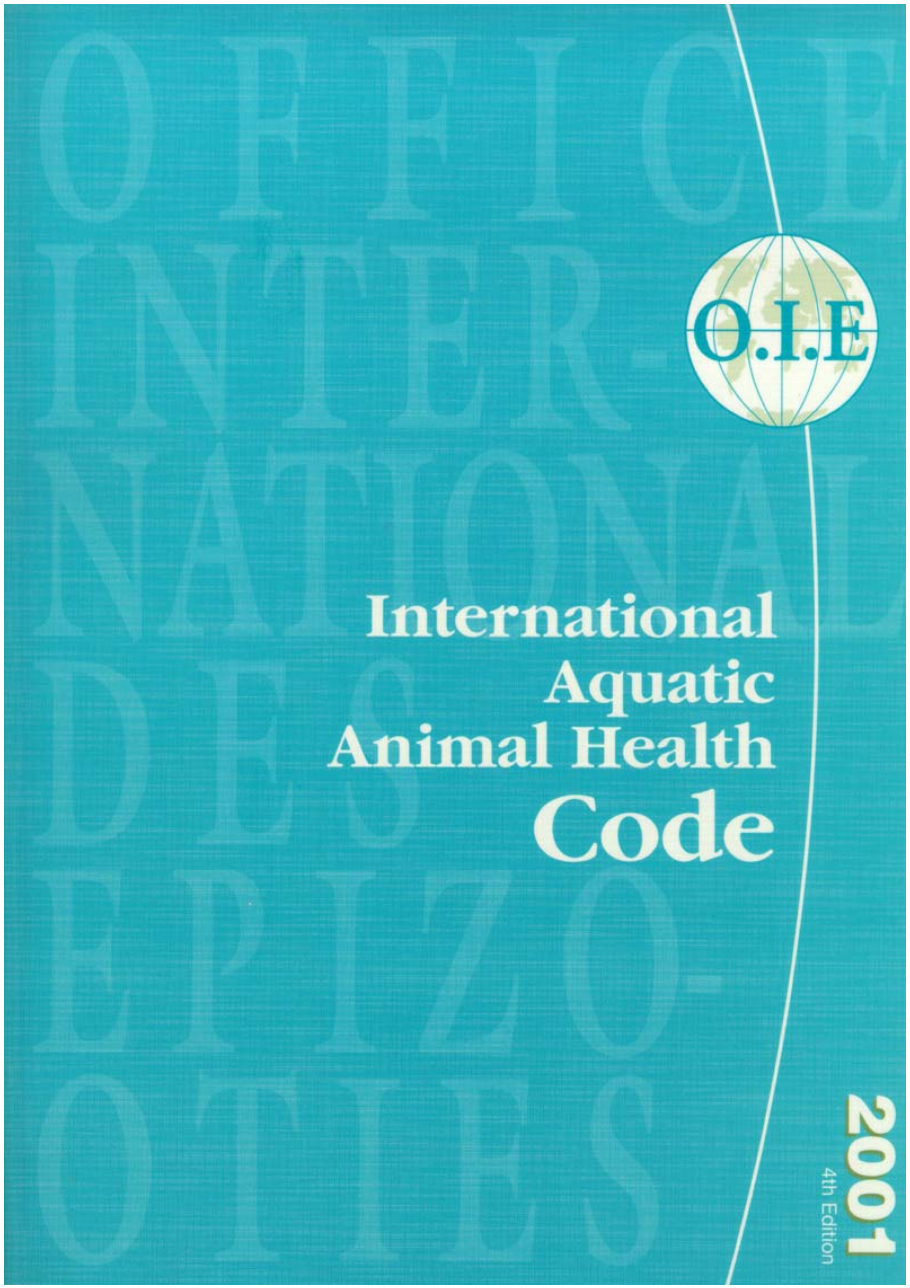
- Has been practiced for millennia
- Commercialization is relatively new
- Involves the culture of endemic or exotic species
- Culture of both local and exotic species involves risk due to disease
    - Exposure to new or seemingly new diseases
        - Movement of product
        - Intensification



Exotic or Introduced Species

- Growing threat to living marine resources world-wide and a variety of vectors exist:
  - Ship ballast water or hull fouling
  - Container traffic
  - Intentional release
  - Aquariums: commercial and home
  - Aquaculture farms
  - Live bait
  - Other means:
    - Forestry
    - Research and education
    - Air traffic
    - Agriculture

    From Carlton 2001
- Natural Vectors: Birds, ENSO events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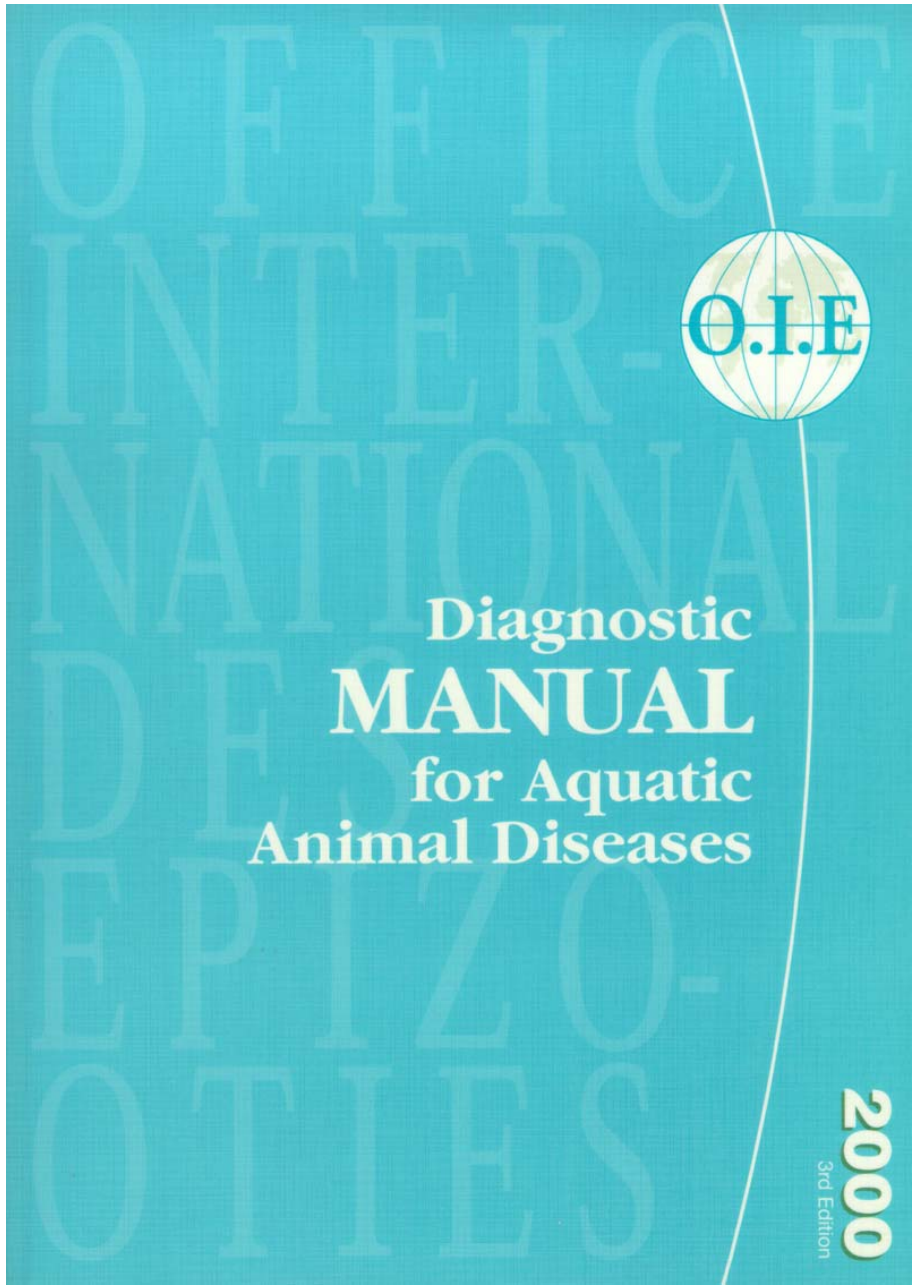
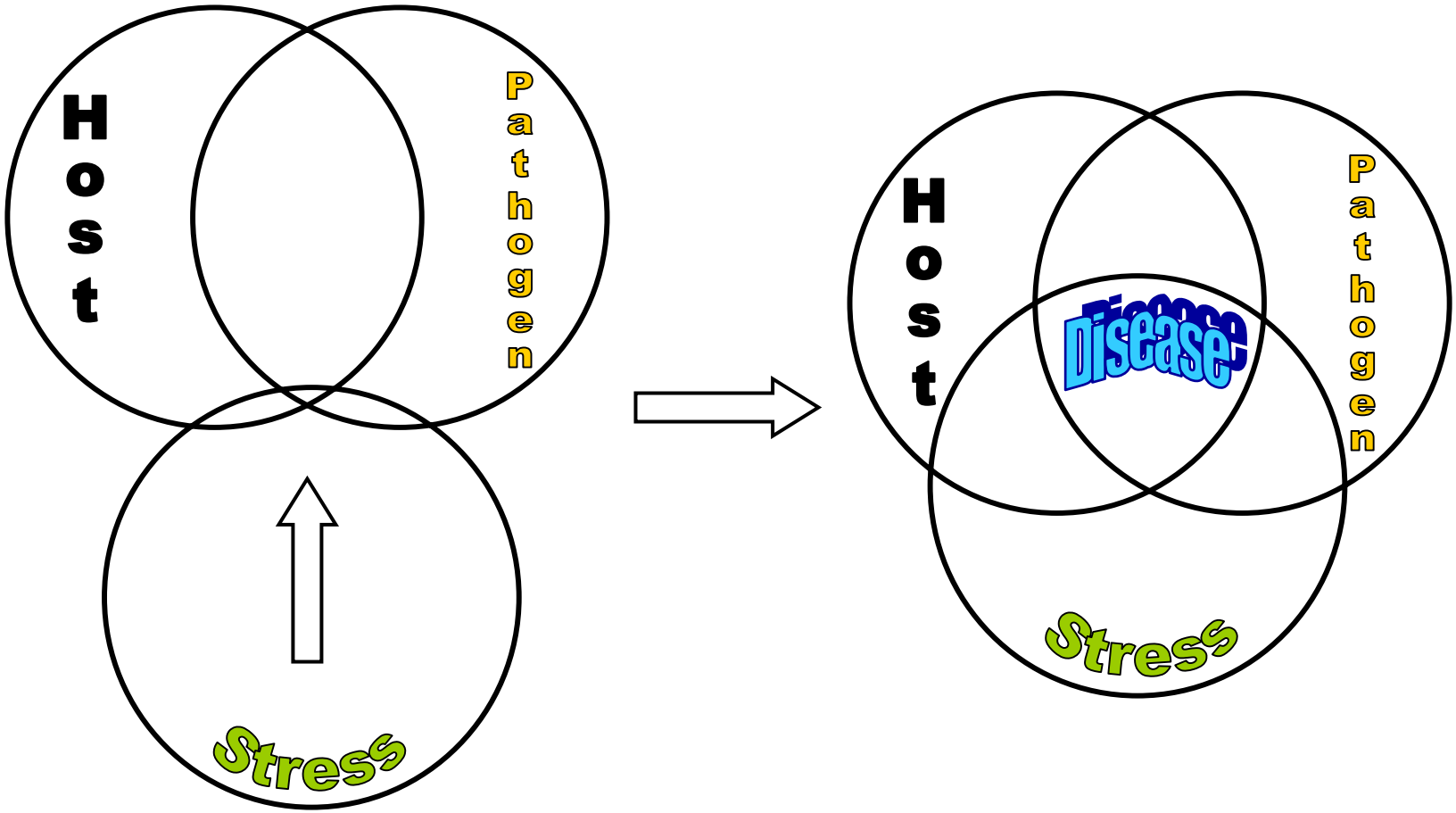

O.I.E
Diagnostic
MANUAL
for Aquatic
Animal Diseases
2000
3rd Edition

Infectious Diseases

- Organisms have a natural tolerance to infection
  - Varies between species, life stage, genetic make-up, amount of stress experienced, etc

Potential pathogens are usually present in the environment but do not always cause disease

Classic disease model



http://www.wlf.state.la.us/apps/netgear/clientFiles/lawlf/images/1008675977.jpg

Haplosporidiosis 1

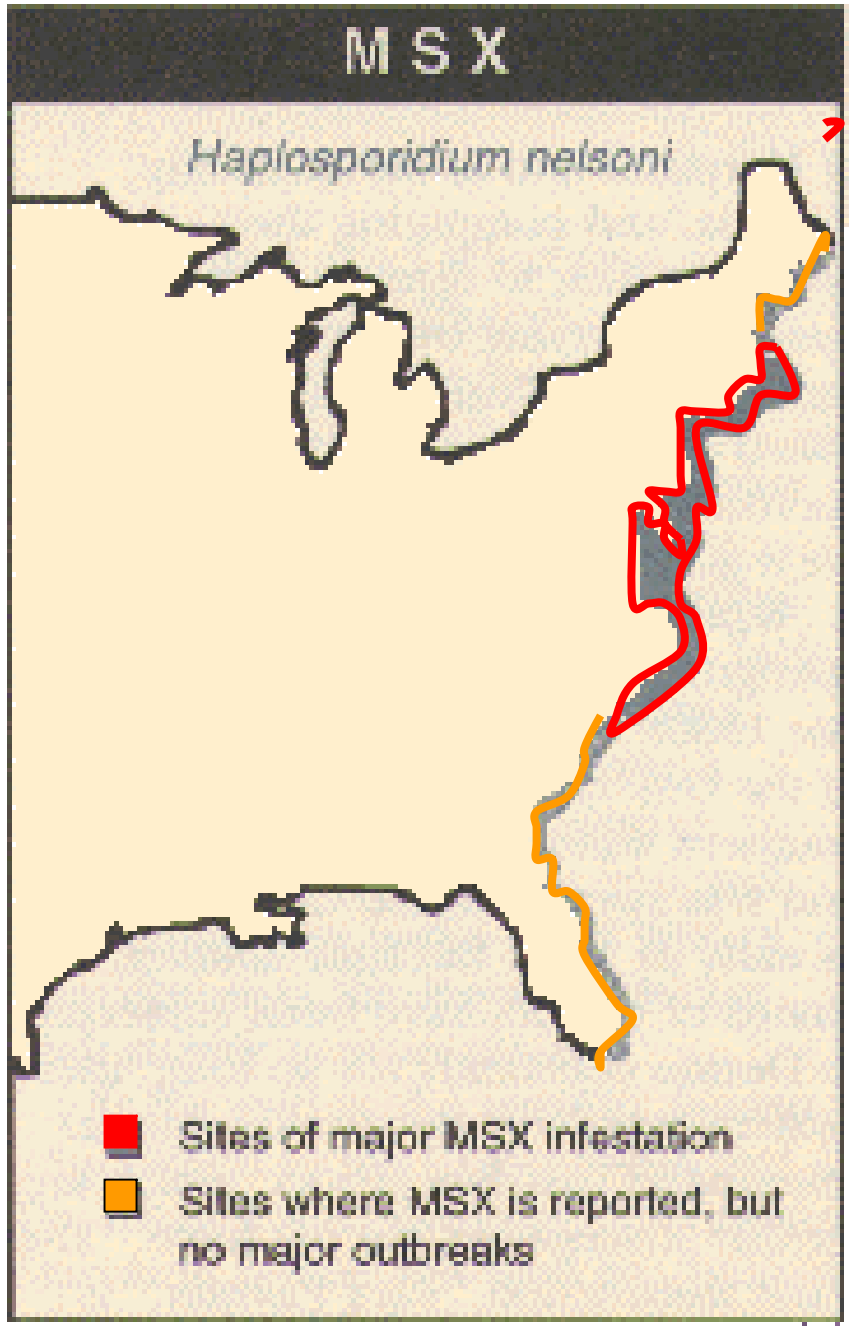
- **MSX or Delaware Bay Disease**
- ***Haplosporidium nelsoni* (= *Minchinia nelsoni*)**
- **Affects *Crassostrea virginica* along east coast of North America from Florida to Maine, USA and Nova Scotia, Canada (2002)**

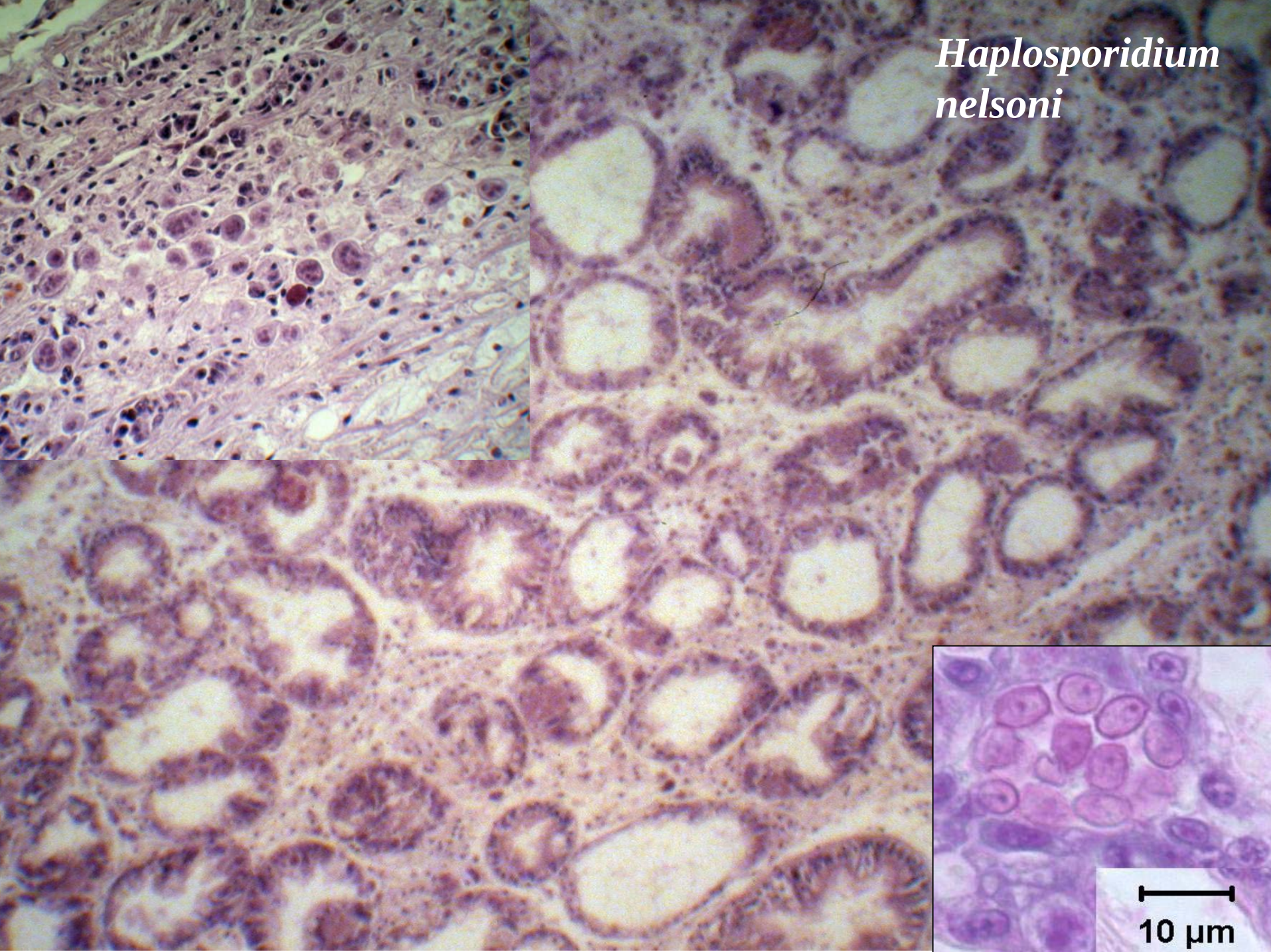
First MSX epidemic was observed in 1957 in Delaware Bay, MD

Three years after an initial observation of a morphologically similar parasite

MSX caused over 90% mortality of eastern oysters in high salinity areas within 2 yr

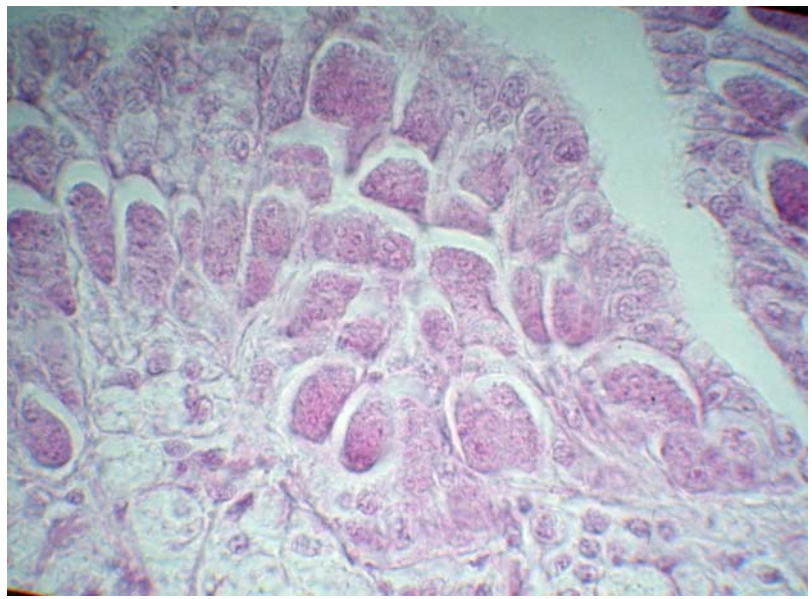
By this time *H. nelsoni* had spread to Chesapeake Bay where it subsequently devastated oyster populations

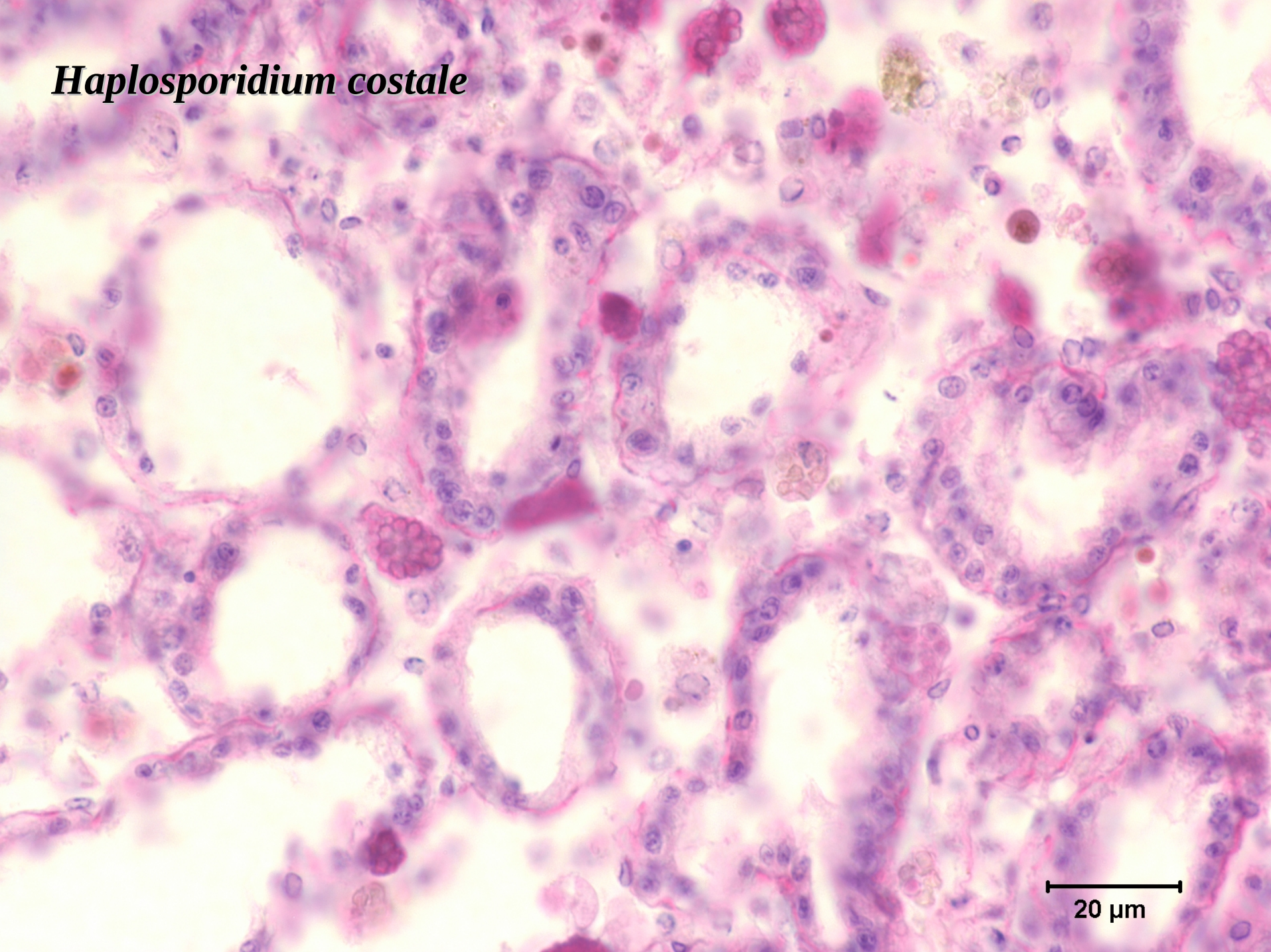



Haplosporidium nelsoni
10 µm

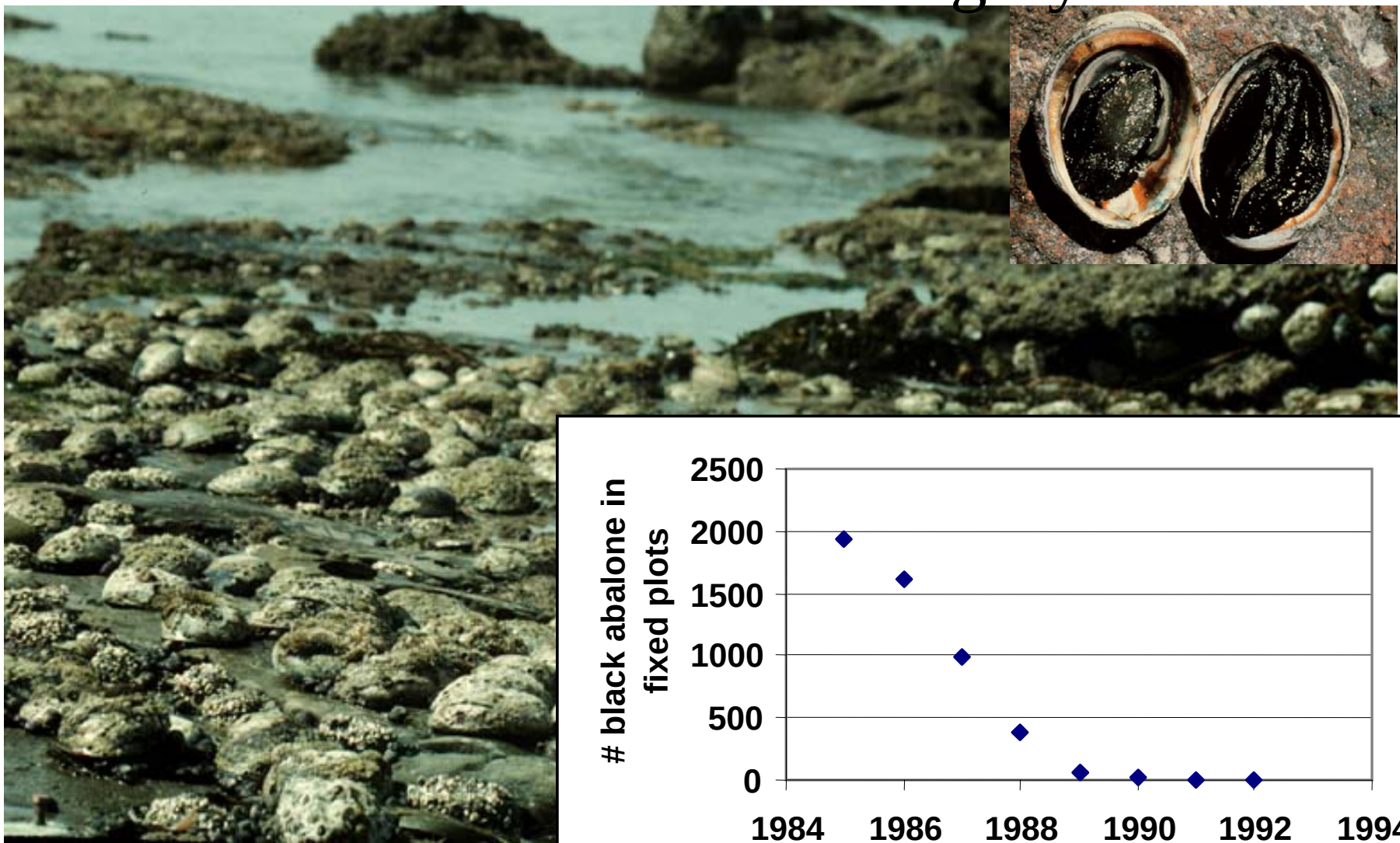
Haplosporidiosis 2

- ~1990 observed in *C. gigas* from Matsushima & Watanoha Bays, Japan
- Little or no mortality in *C. gigas*
  - Usually limited to subclinical infections in cardiac epithelium
- Burreson et al. 2001: Provided molecular evidence that *H. nelsoni* was introduced to the US from Japan via Pacific oyster imports to the west coast




Haplosporidium costale
20 µm

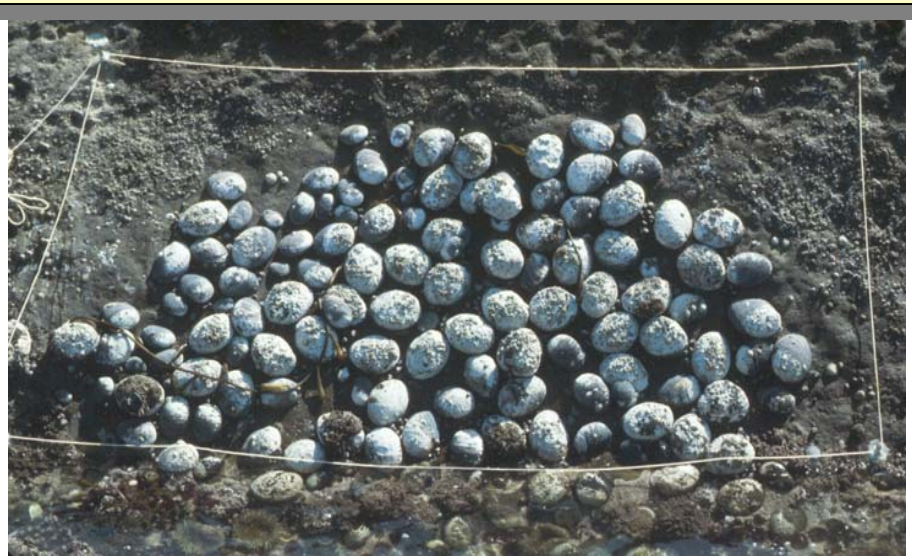
Haliotis cracherodii on Channel Islands before losses due to Withering Syndrome



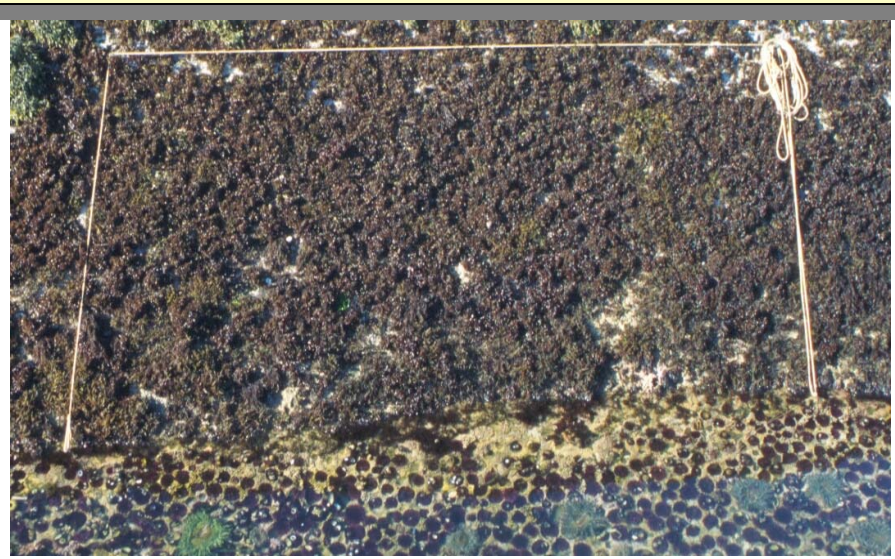
Ecological Impacts of WS

- Initial observation far from populated areas and coincided with strong 1982-83 ENSO event → suggests natural vector or (?) shipping industry
- Change in population structure
- Reduction in abalone population size below sustainability
- Reduced or eliminated recruitment
- Survival of some apparently WS-resistant abalone but Allee effects may influence recovery

San Miguel Island: March 1985

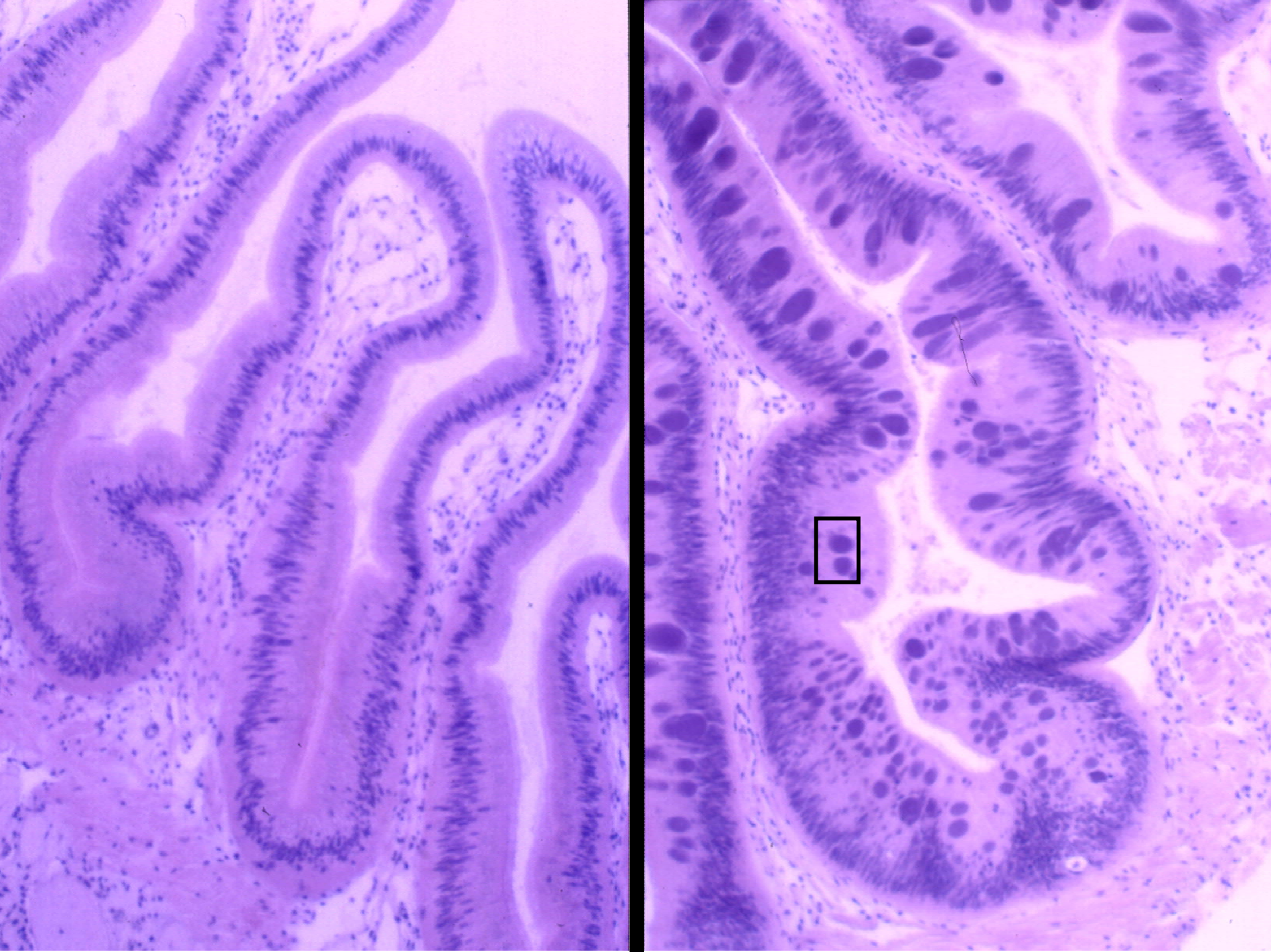


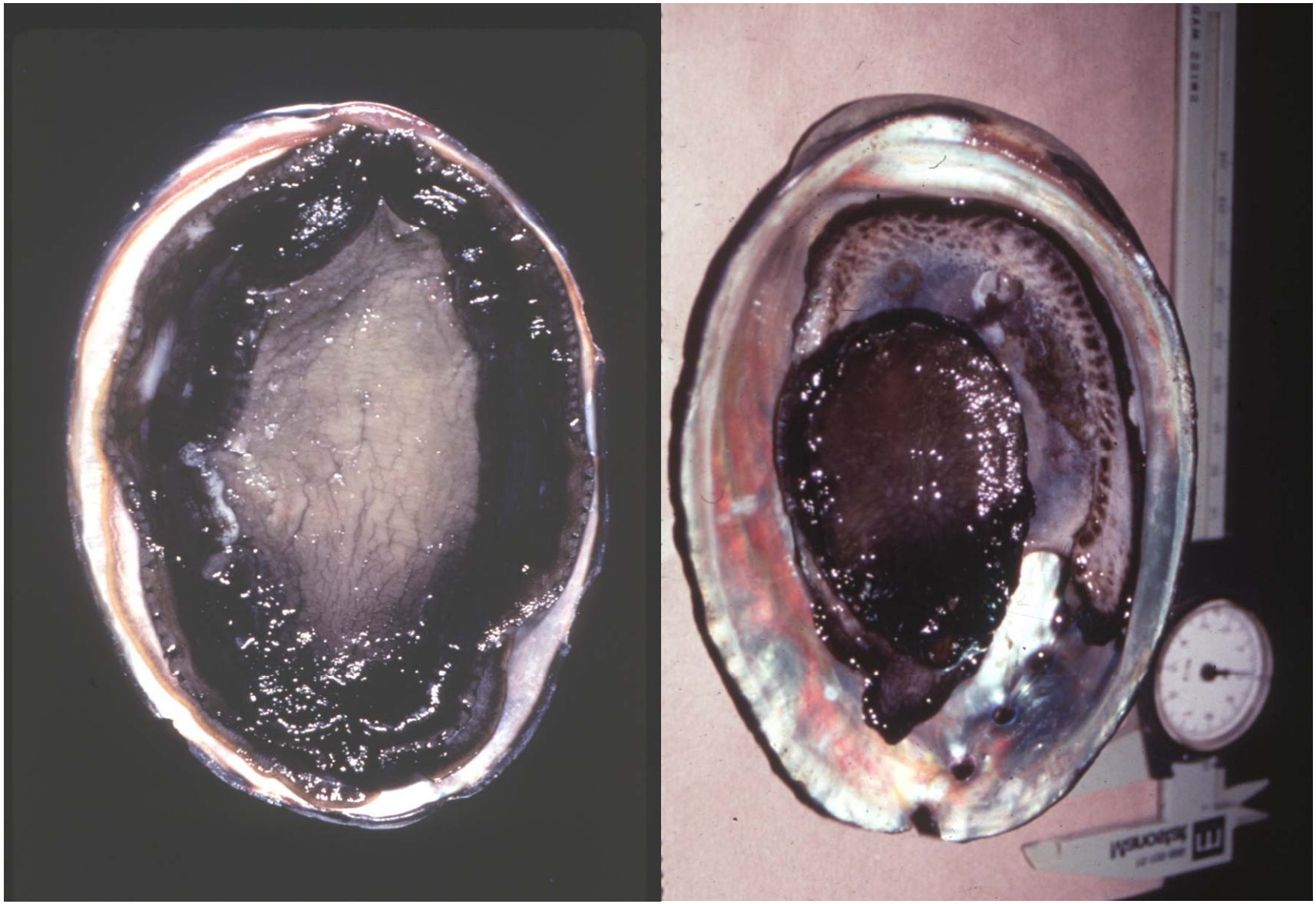
May 1998

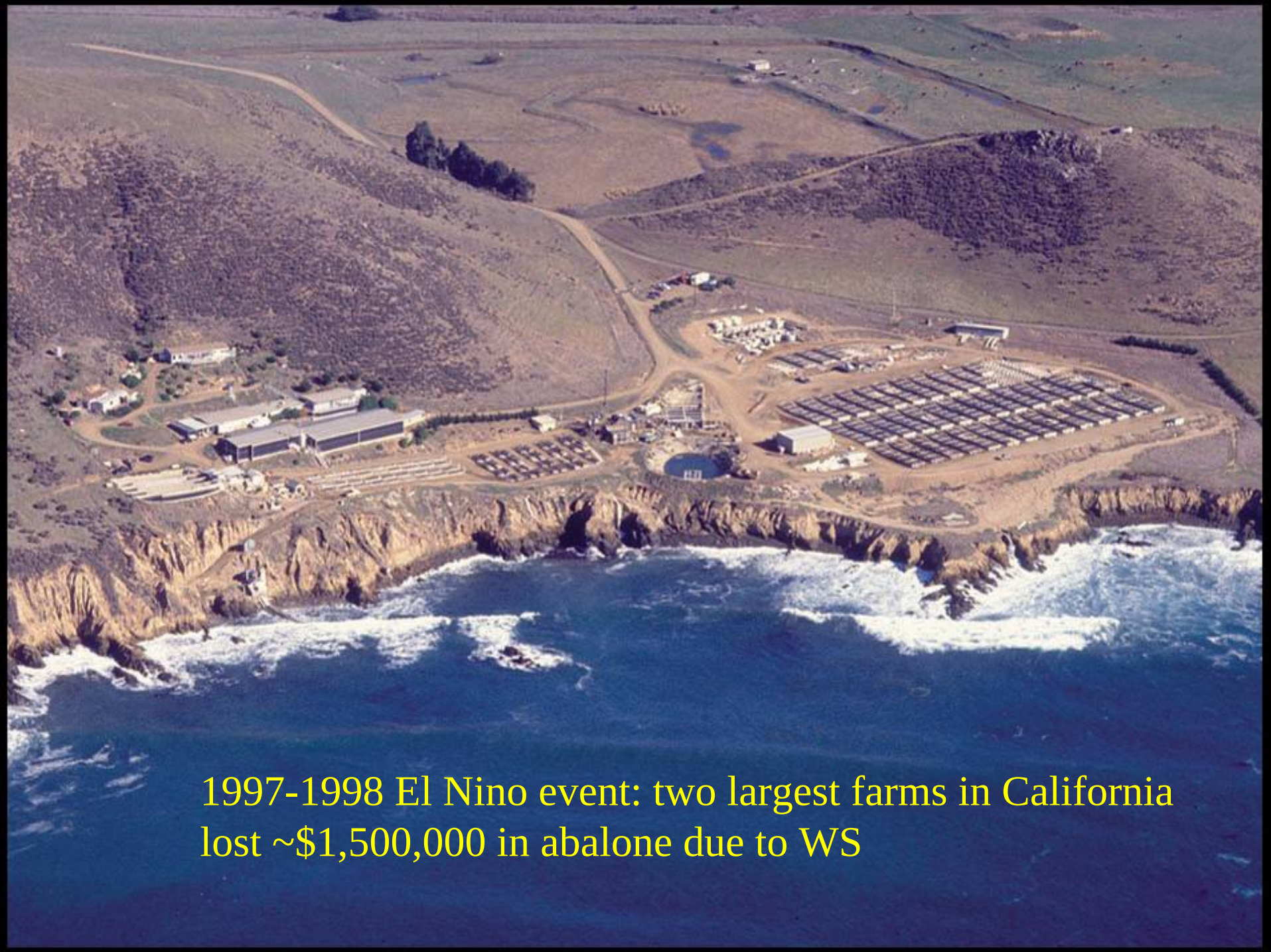


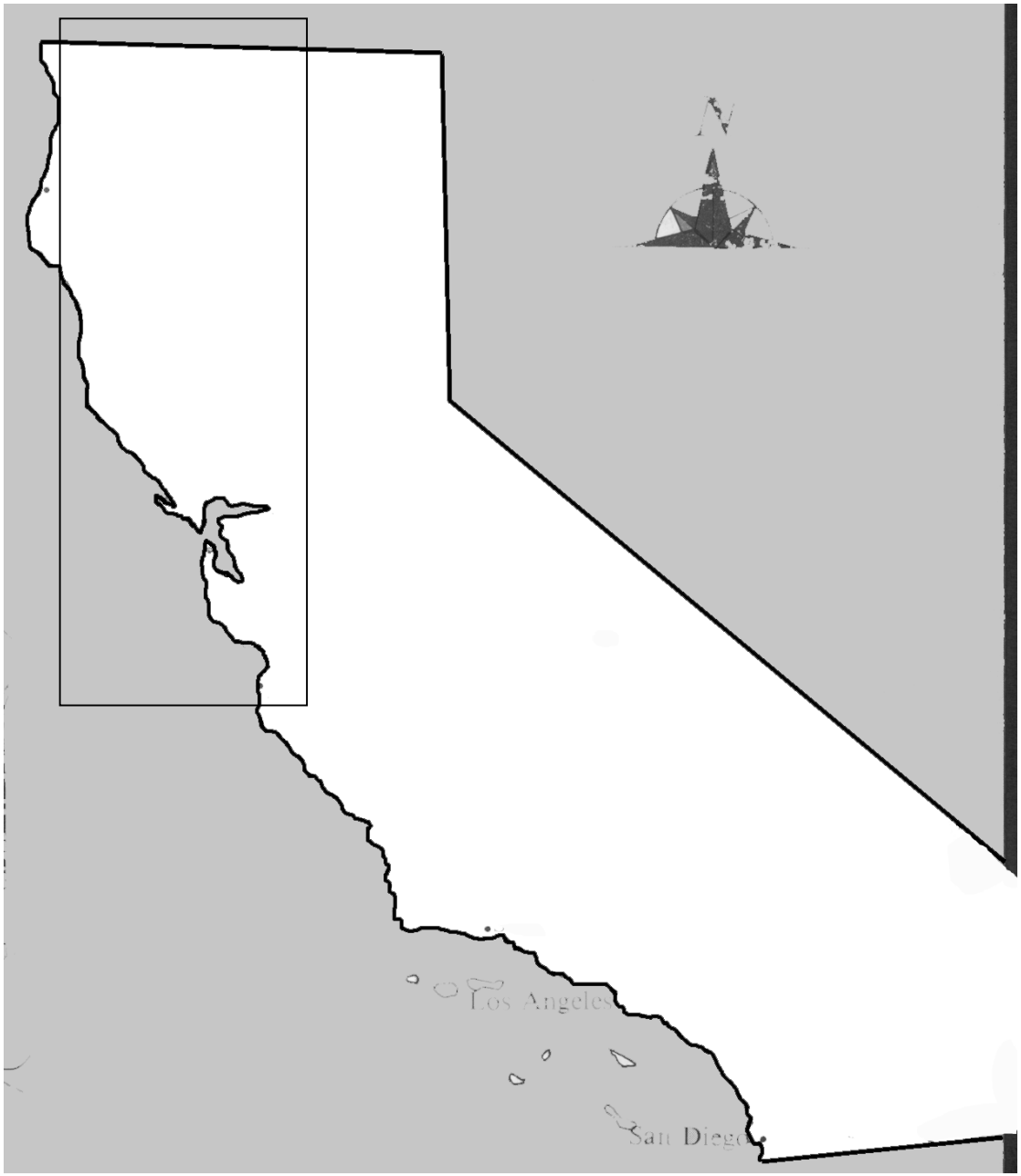
Santa Rosa Island: November 1986

November 1987






1997-1998 El Nino event: two largest farms in California
lost ~$1,500,000 in abalone due to WS



Crescent City

Trinidad

Shelter Cove

MacKerricher

Casper Cove

Van Damme

Moat Creek

Salt Point & Pedotti Reef

Bodega Bay

Point San Pedro

Scott's Creek

Monterey

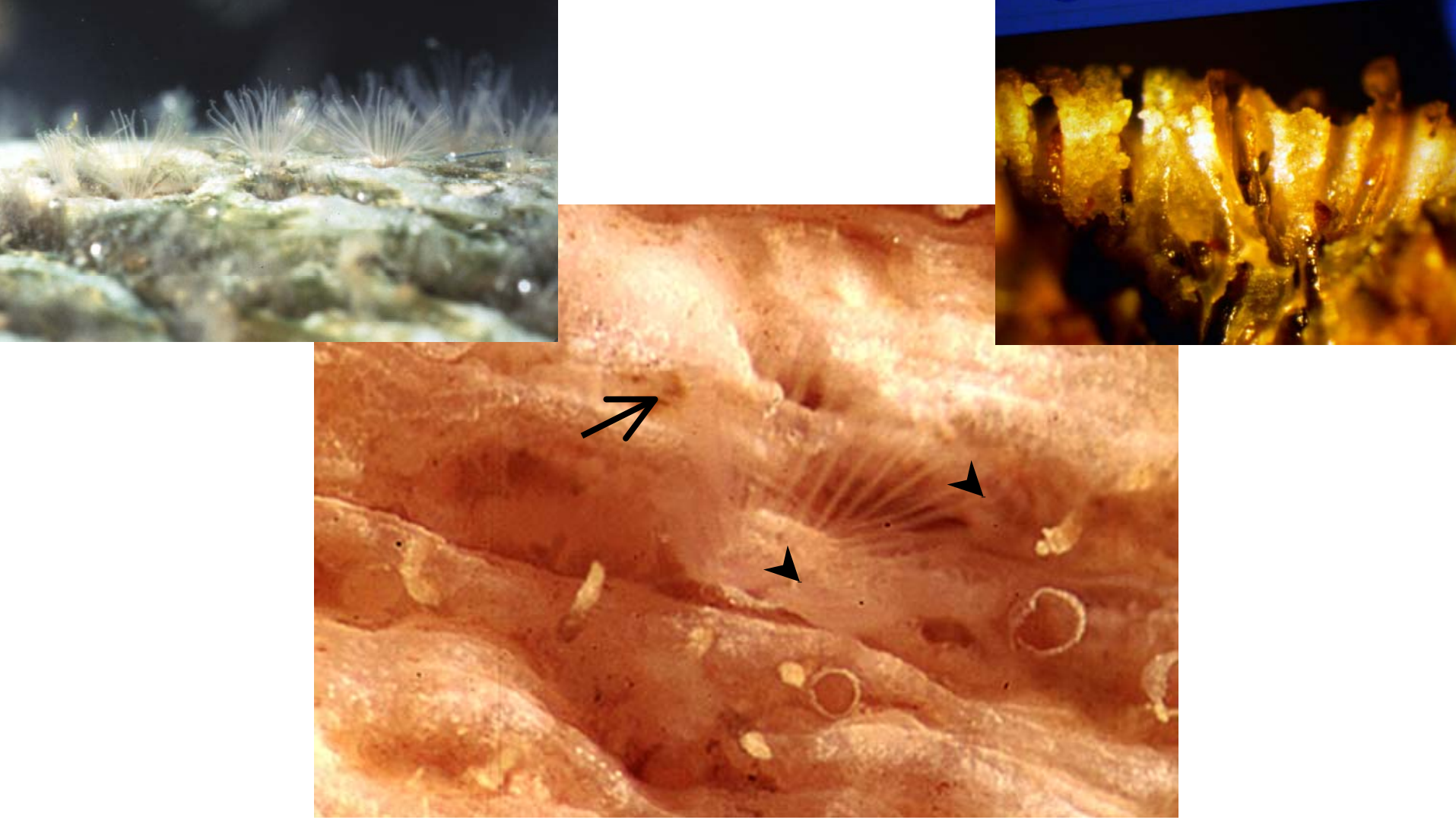
Sabellid Polychaetes 1

- Recently identified polychaete
  - *Terebrasabella heterouncinata*

- Infests various gastropods:
  - Primarily problematic in farmed abalone
  - Also infests *Tegula* spp., limpets, etc.

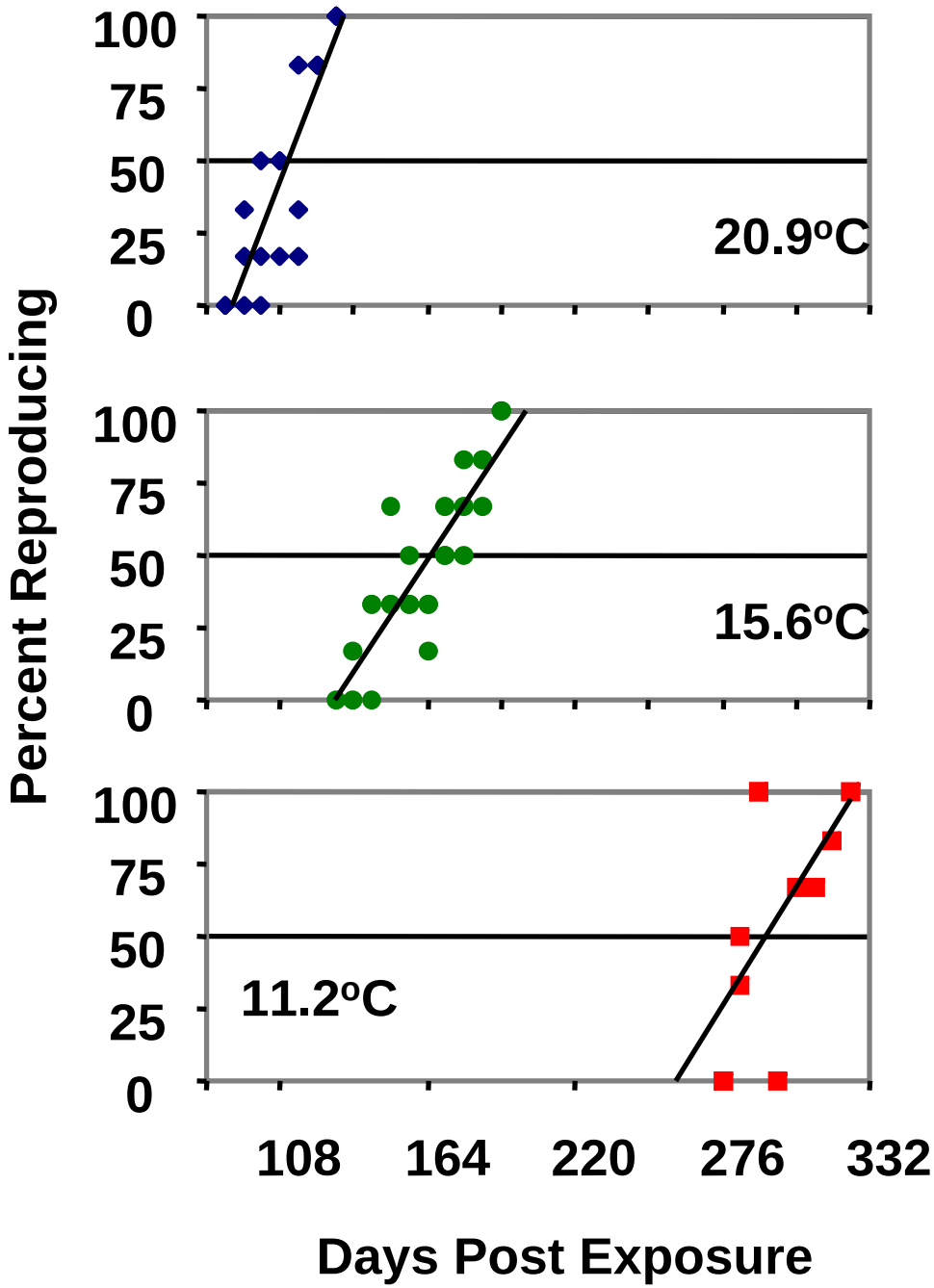
- Introduced into California USA from South Africa (mid-1980s) via aquaculture: intentional introduction *through proper channels*

- By 1995 every abalone farm in California was infested



An infested abalone shell with a sabellid (arrow). The branchial crown is the only visible portion of the worm. Other tubes (arrow heads), with the sabellids retracted are visible.

Temperature controls reproduction but this sabellid can reproduce at a wide range of temperatures!



Commercial Abalone Farms

- Multi-million dollar annual industry
- Long culture cycle
- Prior to sabellids = ~19 registered abalone farms in California
  - 9 actively raising abalone
- Loss of revenue or defunct from sabellids
- Currently all farms appear free of sabellids

Establishment in the Wild

- 1996 Kuris and Culver detected pest on *Tegula funebralis*, at abalone farm discharge outfall

- Habitat dense with *Tegula spp.* (snails) and other gastropods (100,000s)



- Sabellids opportunistic in finding alternate hosts

- Mark & recapture study showed transmission in the field (active infestations)

Discharge

Outfall

1.6 million gastropod hosts removed July 1997

Intertidal Monitoring

- 1995 first transect surveys
  – 28% wild *Tegula* infested
- 1996-1999 quarterly surveys, downward trend in prevalence
- 1999 only 4 old infestations
- 2000-2002 multiple surveys, zero sabellids found
- **May = *FIRST Eradication* of an introduced pest**

Conclusions

- Aquaculture is a growing industry and is based on the culture of both native and exotic species
- Although diseases are a natural component of ecosystems their spread needs to be minimized
- Transfer of diseased individuals or culture of native species may result in disease expression in the cultured or adjacent wild organisms
- The impact of diseases of cultured and wild populations has resulted in an improved understanding of disease processes and has heightened our awareness of the importance of health management for both aquaculture and resource management
- Animal transfers are likely to continue and we need to minimize risks associated with these animal movements through research that is linked to policy formulation

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  - CA Sea Grant College
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Importance of Diseases

- Wild Organisms
  - Death → Controlling abundance
  - Poor performance
  - Poor growth
  - Poor reproduction
  - Susceptible to predation
  - Alter species composition
- Cultured/Ornamental Organisms
  - Death
  - Poor growth
  - Increased costs/Reduced production
  - Use of drugs/chemicals

Urosporidium Parasite of Abalone

- Affects cultured *Haliotis iris* in New Zealand.
- Mass mortality of farmed paua associated with infections in 2001