**Workshop on Building Capacity to Combat Impacts of Aquatic Alien Invasive Species and Associated Trans-boundary Pathogens in ASEAN**

**13-16 July 2004, Penang, Malaysia**

# Molluscan Pathogens of Concern to ASEAN


**Melba G. Bondad-Reantaso (MD DNR, Oxford, USA)**

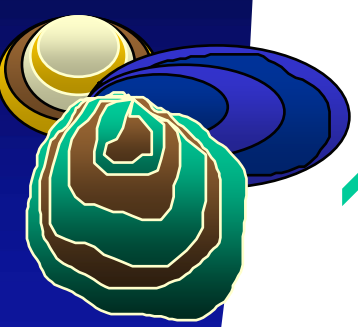
**and**

**Franck C.J.Berthe (IFREMER, France)**

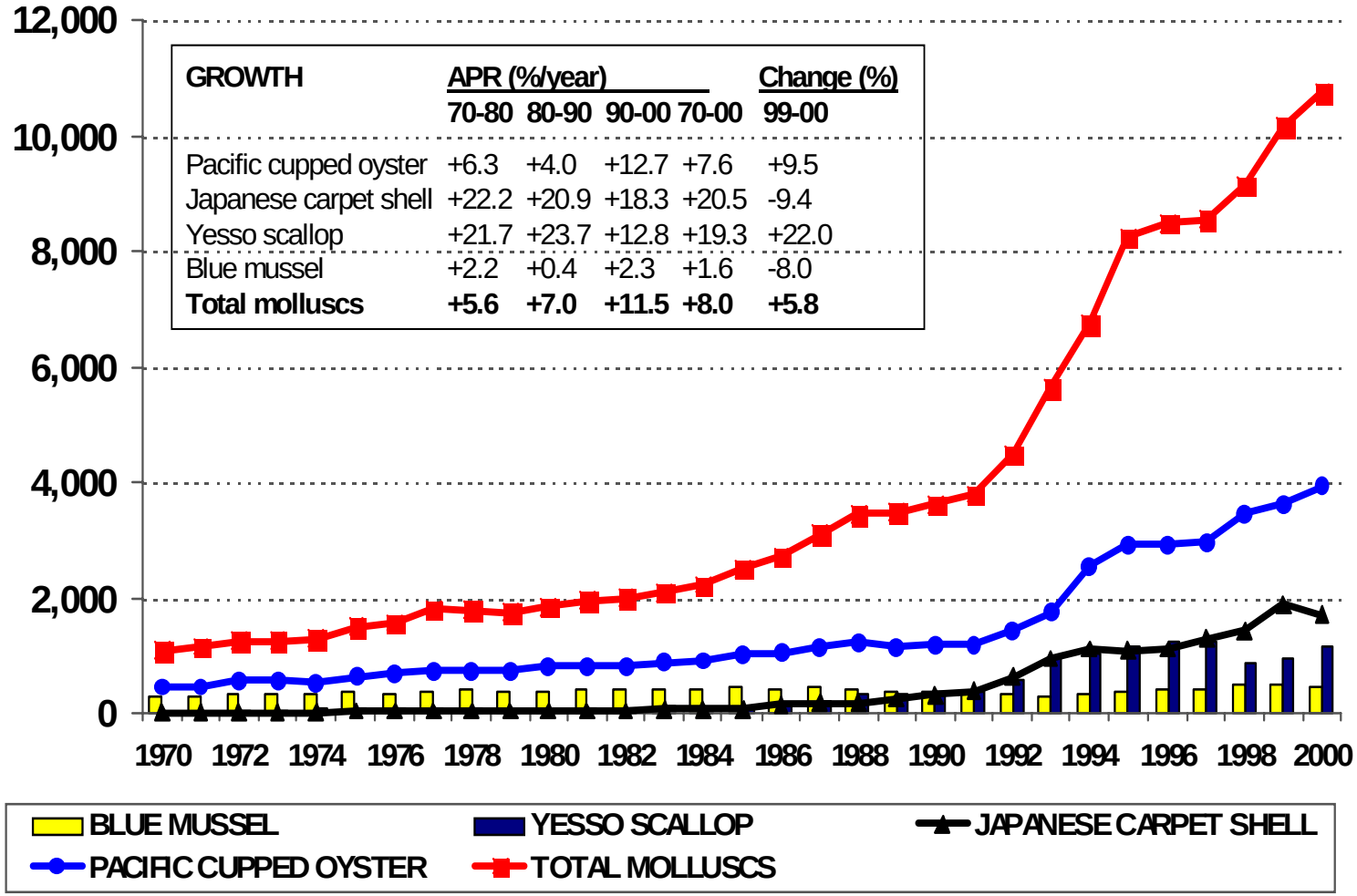
# Production Trends

- In 2002, the world **aquaculture** production of molluscs was estimated at **11.7 million tonnes** valued at **US$ 10.5 B** (FAO, 2002)
  - it represents **29.6%** contribution to the global aquaculture production, up by 6.1% from 2000.
- Top five cultivated mollusc species
  - Pacific oyster, *Crassostrea gigas*
  - Japanese carpet shell/Manila clam, *Ruditapes philippinarum*
  - Yesso scallop, *Patinopecten yessoensis*
  - Blue mussel, *Mytilus edulis*
  - Blood cockle, *Anadara granosa*

  - a total of 42 mollusc species contributes to the production.
- Production continuously increases
- Contribution to **capture fisheries** only **7.9% (= 7.4 million tonnes**) of world's total production



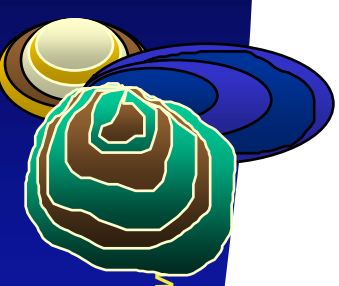
## Mollusc aquaculture production
## (Total production and main species)




| GROWTH | APR (%/year) | | | | Change (%) |
|---|---|---|---|---|---|
| | 70-80 | 80-90 | 90-00 | 70-00 | 99-00 |
| Pacific cupped oyster | +6.3 | +4.0 | +12.7 | +7.6 | +9.5 |
| Japanese carpet shell | +22.2 | +20.9 | +18.3 | +20.5 | -9.4 |
| Yesso scallop | +21.7 | +23.7 | +12.8 | +19.3 | +22.0 |
| Blue mussel | +2.2 | +0.4 | +2.3 | +1.6 | -8.0 |
| **Total molluscs** | **+5.6** | **+7.0** | **+11.5** | **+8.0** | **+5.8** |

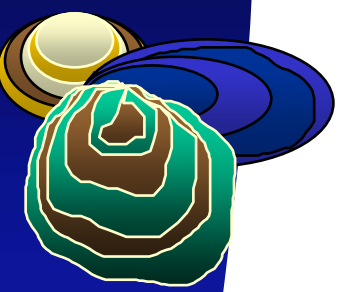
**Slide courtesy of R Subasinghe (FAO)**

# Interest in mollusc culture



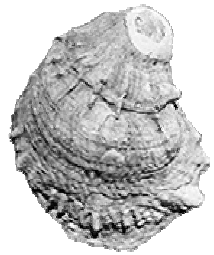
- **Positive impact – no chemical pollution commonly associated with other types of aquaculture because molluscs are sensitive, susceptible to many pollutants and thus require pristine environment for optimum growth**
- **Natural filter-feeding process of bivalves improves water quality; good sentinels of environmental quality**
- **Offers good employment alternative in lieu of, e.g., shrimp farming, and illegal operations such as cyanide and dynamite fishing**
- **Industry has enormous trade potential**
- **Contributes to food availability**
- **Source of growth in aquaculture production**
- **Important source of income for developing nations**
- **Includes high-value species such as the multi-billion dollar pearl oyster, scallops, abalones, and other important species such as edible oysters, mussels, clams, for both food and secondary products.**

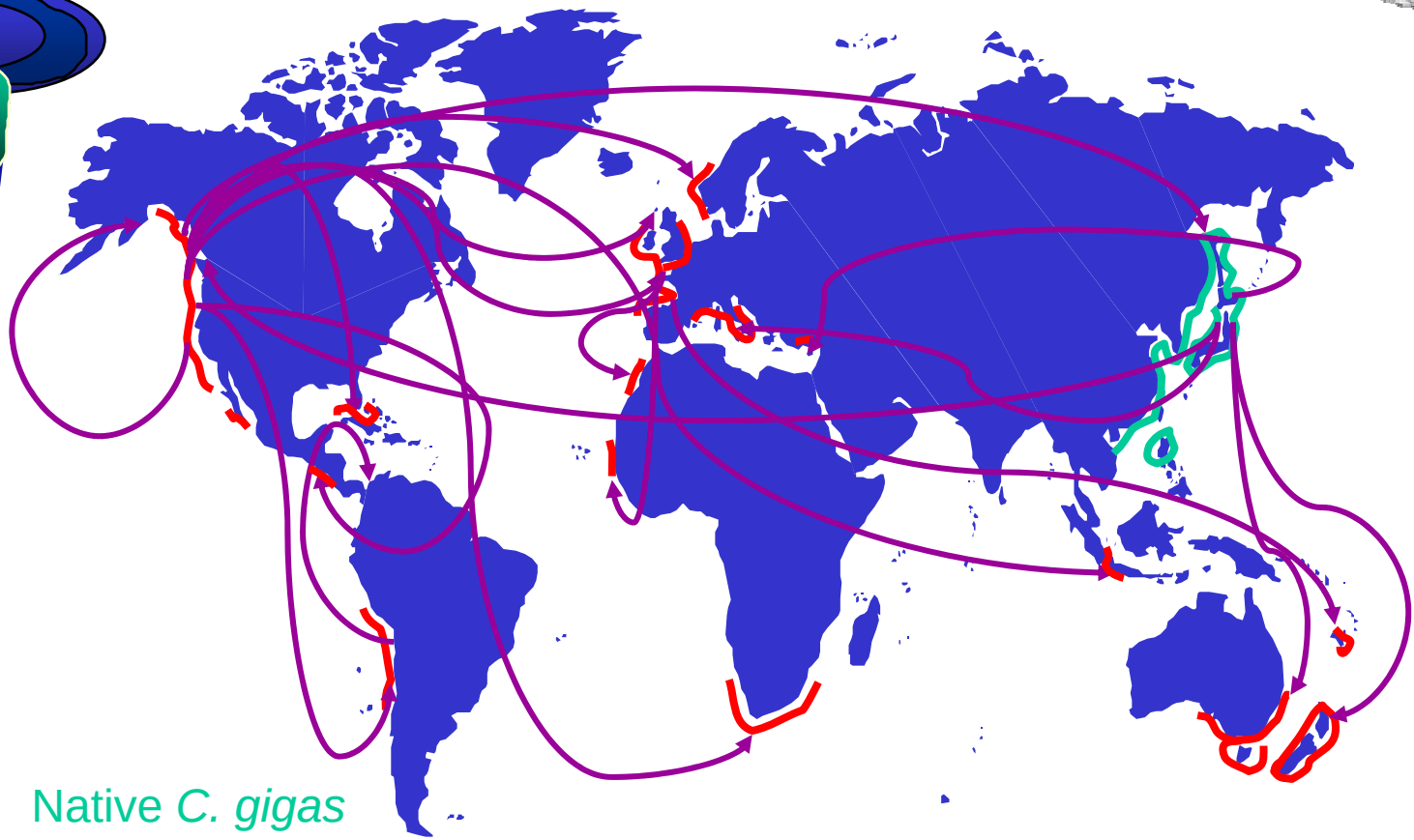
# Transfers and introductions: a baseline of mollusc aquaculture



- In many countries, mollusc aquaculture, is traditionally based on wild stocks which frequently do not fulfil market demand
  - Because of over-fishing of the resource and environmental disorders
  - Because of poor market value of the products
  - Because of disease impact on the stocks
- Species diversification for aquaculture as well as hatchery production to enhance natural seed collection is putting increased pressure for international movements and transfers of live molluscs

# Recorded transfers of *C. gigas*





Native *C. gigas*
Introduced *C. gigas*

(FAO DIAS)

# Impacts of *C. gigas* transfers

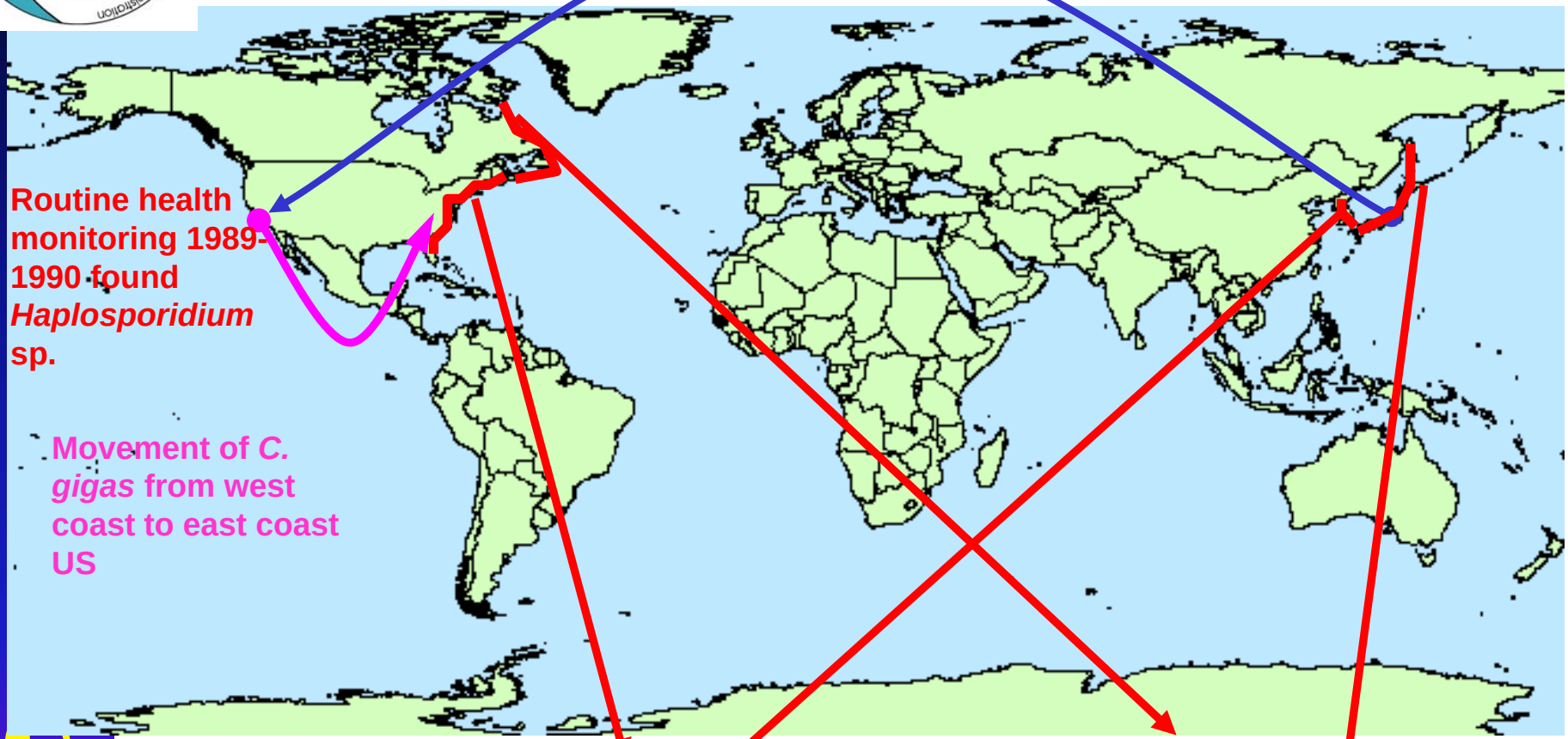
**Pacific oysters were introduced into west coast of the USA from Matsushima Bay in Japan, infected with low levels of *Haplosporidium* sp. identical to *H. nelsoni* (MSX) which causes high mortalities of Eastern oyster (*C. virginica*).**

- **A highly specific and sensitive DNA probe for *H. nelsoni* can also detect *Haplosporidium* sp. in *C. gigas* of western US and Japan (Burreson and Stokes 2000).**
- **In 2002, *H. nelsoni* was detected in Japan using the same probe (Kamaishi and Yoshinaga 2002).**
- **Lesson: it appears that *H. nelsoni* does not cause serious disease in Pacific oysters; *H. nelsoni* is now speculated to have been introduced into the Pacific US by apparently healthy but infected *C. gigas*. Infected *C. gigas* were introduced onto the east coast of the US where the parasite shifted its virulence into a new host, infecting Eastern oysters and causing mass mortalities.**
- ***H.nelsoni* has also been reported from Korea in 1971 at that under the name of *Minchinia* sp. (Kern 1976)**
- ***H. nelsoni* has been reported from Pacific oyster in France (Renault *et al*. 2000) and may have been introduced with P. oyster imports to replace *Ostrea edulis* devastated by *Marteilia refringens* and *Bonamia ostrea*.**
- **Canada reported for the first time *H. nelsoni* infection in 2002.**

# Origin of of *H. nelsoni* (MSX disease)

*C.gigas* importation from Japan to west coast of US since 1902 to 1980

*In-situ* hybridization of samples from Korea (1971), Japan (1993) and California samples gave positive reaction = *H. nelsoni*



Routine health monitoring 1989-1990 found *Haplosporidium* sp.

Movement of *C. gigas* from west coast to east coast US

MSX in East Coast US since 1957

*Minchinia* sp. in Korea in 1971

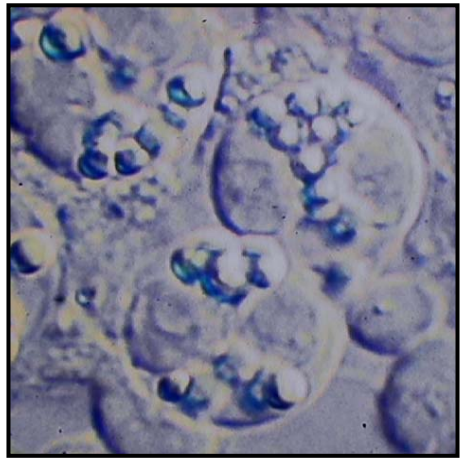
MSX in Canada in 2002

MSX confirmed in Japan in 2002

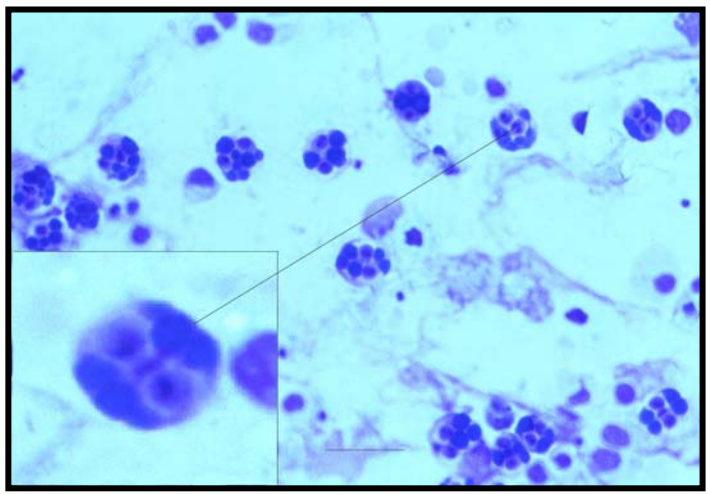
*H. nelsoni* does not cause disease in *C. gigas*; *H. nelsoni* was introduced to the US through healthy *C. gigas* which was introduced to East Coast US, where *H. nelsoni* shifted virulence to a new host, *C. virginica* and caused mass mortality.

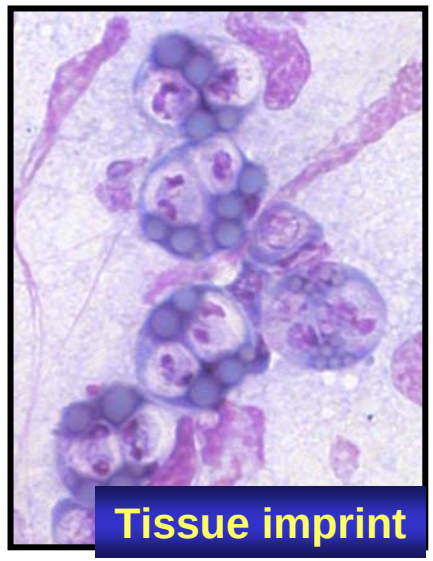
# Impacts of Molluscan Diseases

↑***Marteilia sydneyi*** **causes >90% mortalities among farmed Sydney rock oysters (*Saccostrea commercialis*), with losses of about 40% of total production, in eastern Australia**



Spores (x2) within sporonts





Tissue imprint

Photo courtesy of R Adlard, Australia

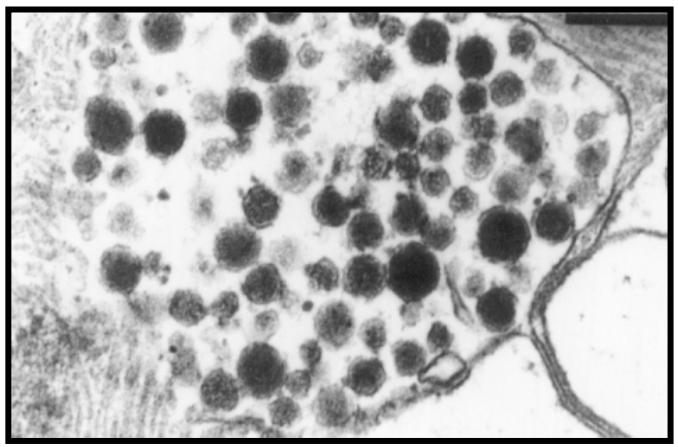
# Impacts of Molluscan Diseases

**Mass mortalities of scallops (*Chlamys farreri*) in North China in 1998 caused an estimated loss of US$ .18 B (Wang *et al*. 2000)**


Photo courtesy of Wang Chongming, China

# Impacts of Molluscan Diseases

- **Mass mortalities of abalone (*Haliotis diversicolor*) in China**
- **Perhaps similar to the abalone die-off in Taiwan in 2003 with losses estimated at US$ 11.5 M**



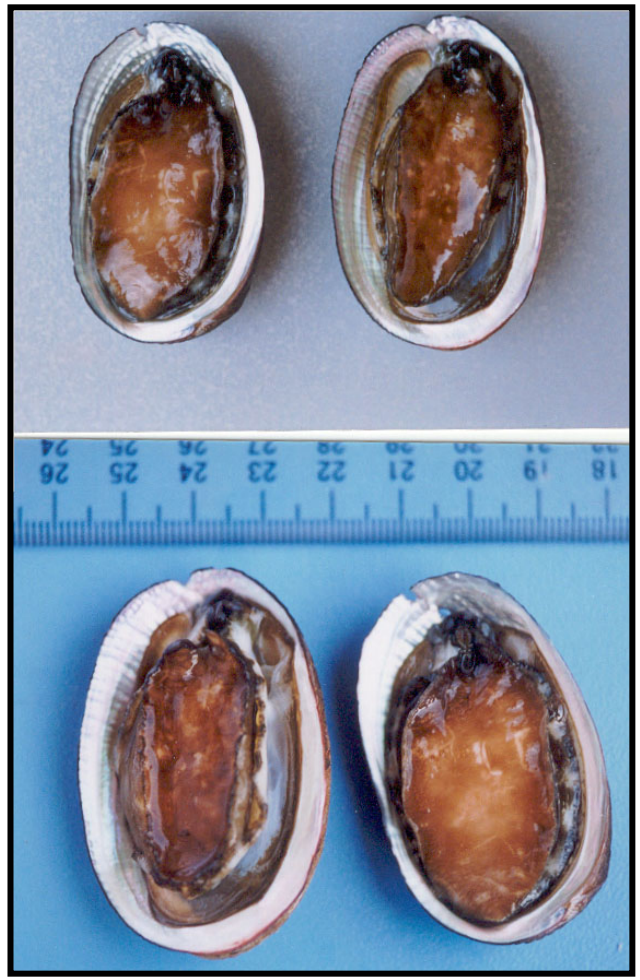
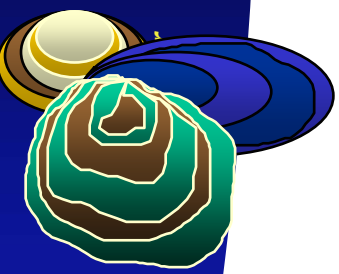
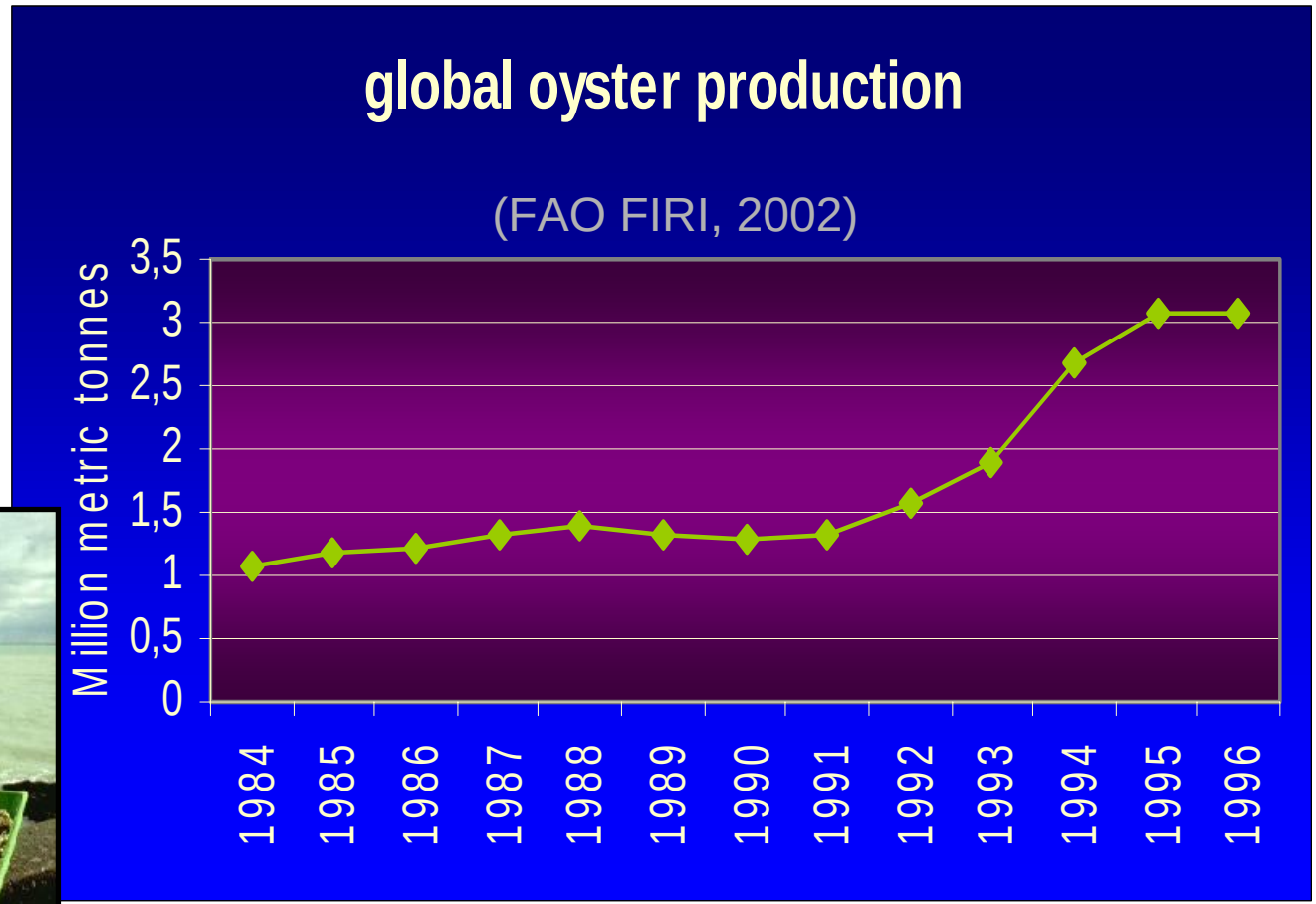


Photo courtesy of Dr. Wang, China

# Increasing trend in edible oyster production



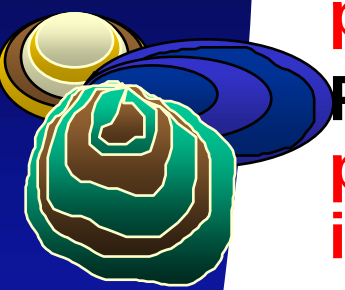


# Impacts of Molluscan Diseases

- **Akoya pearl oyster (*Pinctada fucata martensii*) mortalities in Japan, 1994**
- **Losses (mortalities and decreased quality of pearls produced) exceeded 30 M Japanese yen (= US$ 276 M) (Miyazaki *et al*. 1999)**

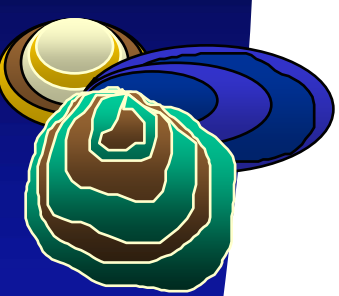
Photo courtesy of K Ogawa, Japan

# Molluscan Pathogens of Concern to ASEAN



- Of the **35 pathogens** listed by OIE, **11 are pathogens of molluscs**
- Fit the criteria of being of **socio-economic** and/or **public health importance** and **significant** in the **international trade** of aquatic animals and aquatic animal products
- Most of these pathogens **have not been reported in ASEAN**, some of them are **known to occur** in neighbouring **Korea, Japan, Australia, New Zealand**
- **Absence of report** does **NOT** necessarily mean **absence of pathogen** unless a **surveillance program** is in place to support **freedom** from pathogen occurrence

# Molluscan Pathogens of Concern to ASEAN

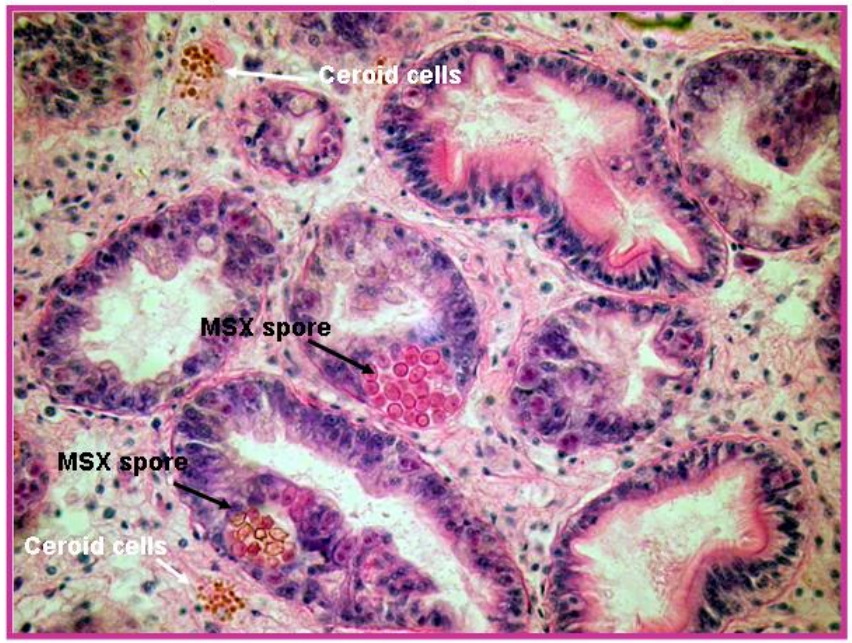


- **Some groups of molluscs are particulalry susceptible to some groups of pathogens**:
  - **Scallops: non-bacterial prokaryotes (rickettsias, chlamydias, mycoplasma)**
  - **Abalones: rickettsias, coccidians, *Perkinsus***
  - **Clams: bacteria, rickettsia, *Perkinsus*, neoplasia, other protozoans**
  - **Mussels: protozoans**
  - **Oysters: everything, including human pathogens**

# Molluscan Pathogens of Concern to ASEAN

- **Disease: Haplosporidiosis**
- **Pathogen: *Haplosporidium nelsoni***
- **Hosts: *C. gigas*, *C. virginica***
- **Distribution: Japan, Korea, USA, Canada, France**

MSX Spore in 2002 Maryland Fall Survey



# Molluscan Pathogens of Concern to ASEAN

- Disease: Perkinsosis
- Pathogen: *Perkinsus olseni*
- Hosts: *Ostrea* spp., *Crassostrea rivularis*
- Distribution: Pacific, Asia, Southeastern Europe
- Moved from Asia to Europe?

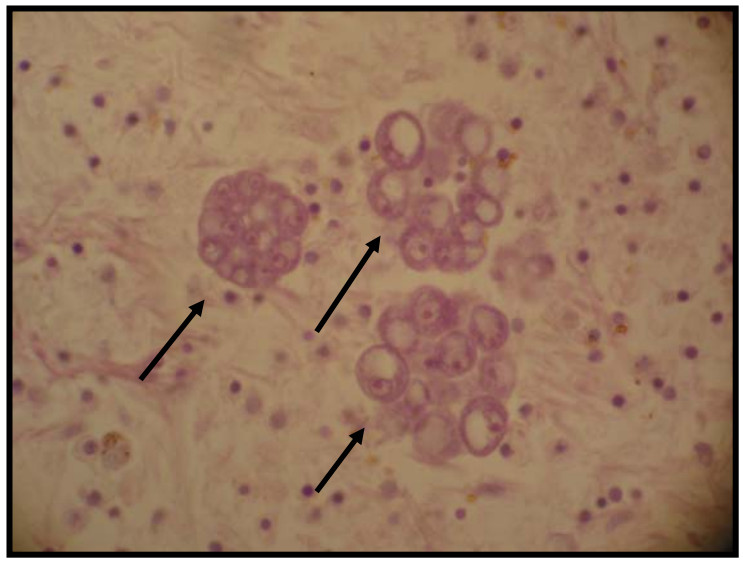
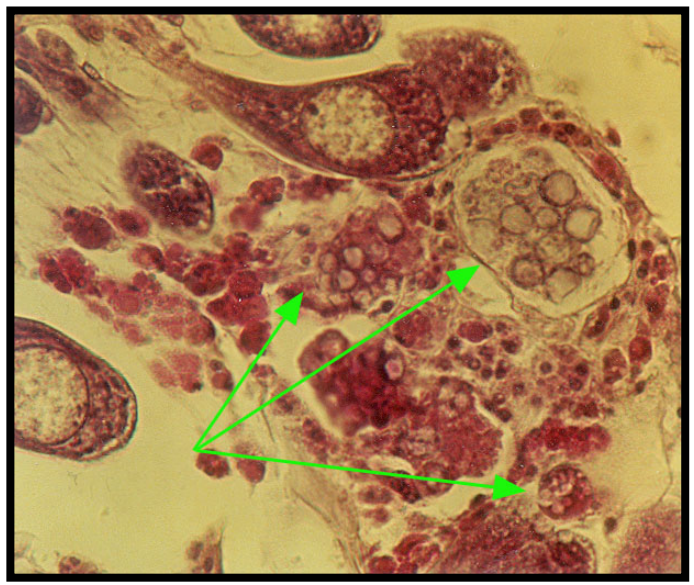



Photo courtesy of B Lester, Australia

# Molluscan Pathogens of Concern to ASEAN

- **Disease: Perkinsosis**
- **Pathogen: *Perkinsus* *sp.* (possibly *P. atlanticus*)**
- **Hosts: *Ruditapes phillipinarum***
- **Distribution: Japan, China, Korea**



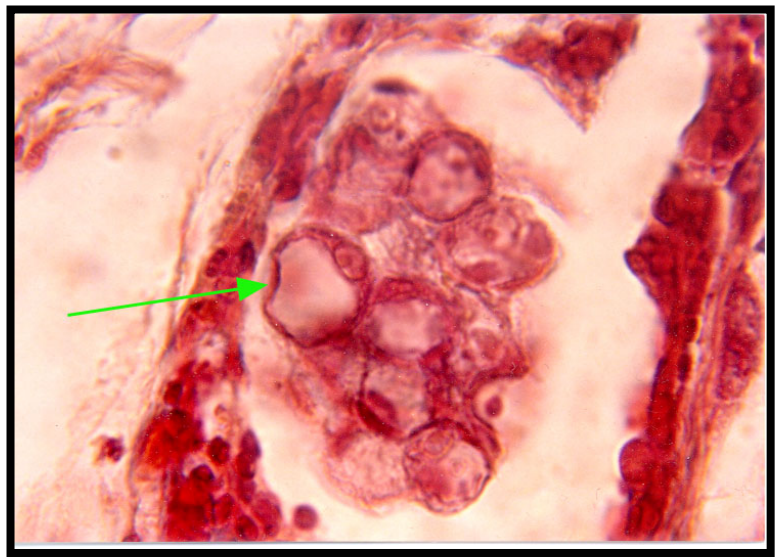
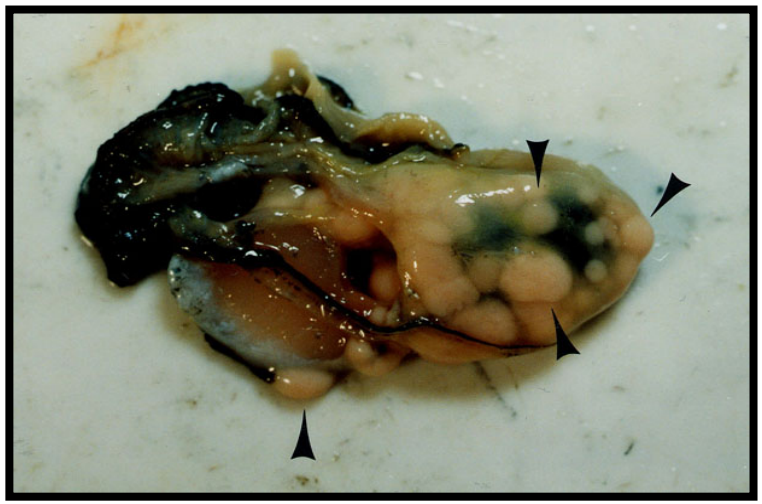


Photo courtesy of A Choi, Korea RO

# Molluscan Pathogens of Concern to ASEAN

- **Disease: Ovarian parasite**
- **Pathogen: *Marteilioides chungmuensis***
- **Hosts: *C. gigas***
- **Distribution: Japan, Korea, China, Australia, west coast US**

**Parasites infect the cytoplasm of oocytes**



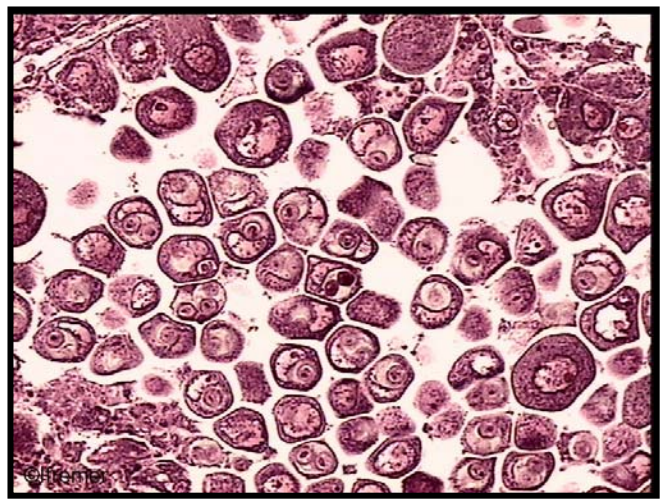
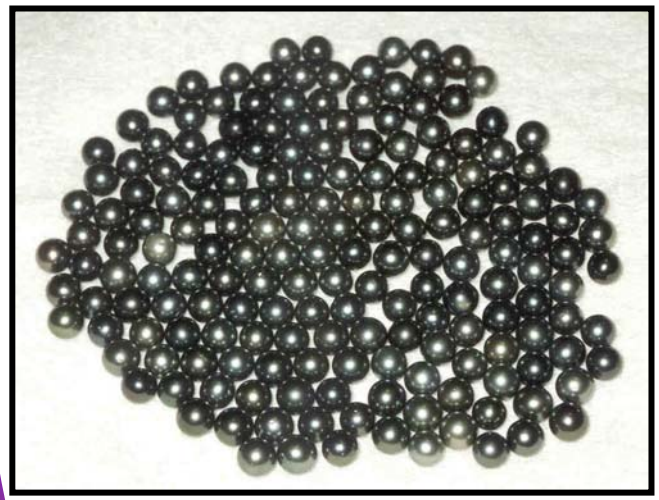


**Photo courtesy of N Itoh, Japan**

# Molluscan Pathogens of Concern to ASEAN

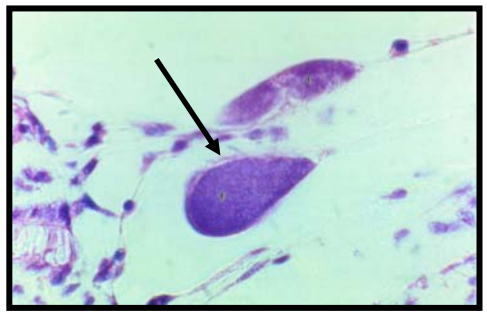
- **Pearl Oysters**
  - **Mass mortalities in Japan, still undiagnosed**
  - **Reported mortalities in Philippines, Indonesia, Cooks Island**
  - **On-going and/or proposed translocation from Japan to Vietnam**

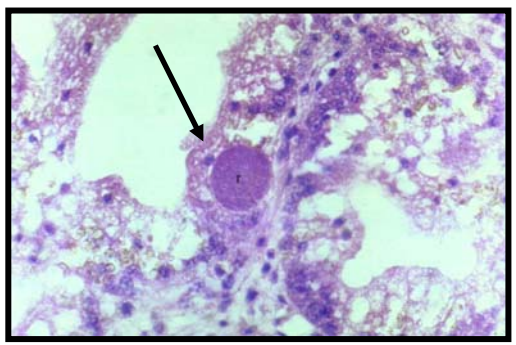


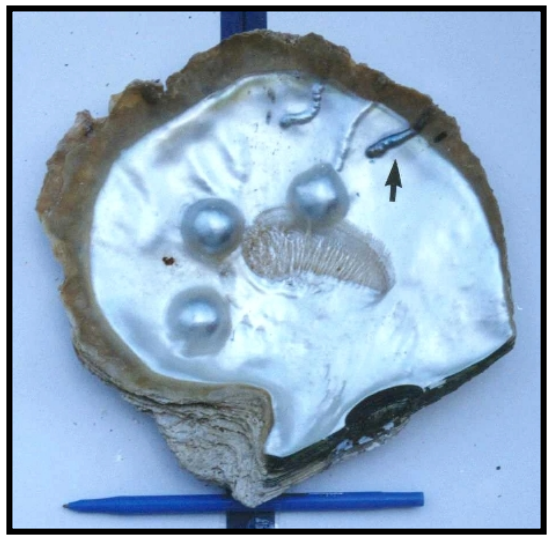
# Molluscan Pathogens of Concern to ASEAN

## Pearl Oysters

- *Polydora* infection (mud-worm)
- Rickettsia-like organisms
- Shell damage due to boring sponge
- Fouling organisms
- Pearl blisters

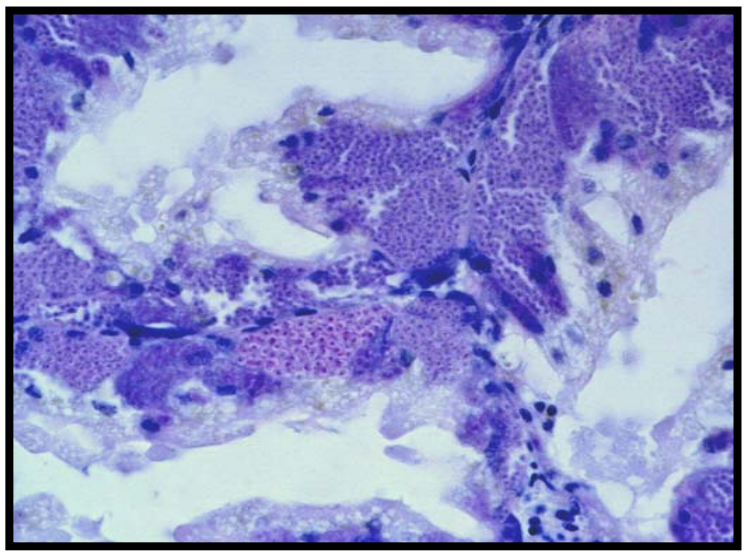






# Molluscan Pathogens of Concern to ASEAN

- **Pearl Oysters**
  - **Viruses: Papovavirus, Parvovirus, Aquabirnavirus**
  - ***Haplosporidium* sp. (in Australia)**
  - **Other parasites gregarines, turbellarians, ancistracomid ciliates**



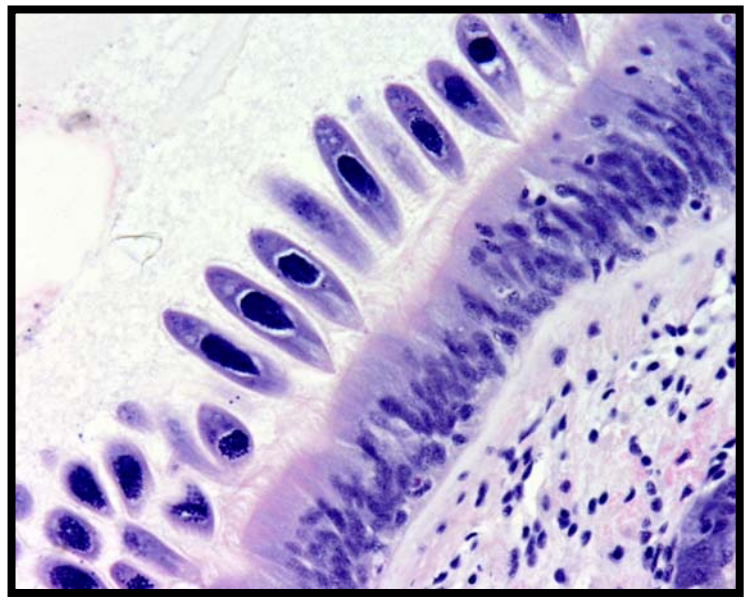


**Photo courtesy of B Jones, Australia**

# Molluscan Pathogens of Concern to ASEAN

- **Abalone**
  - **Mass mortalities in China, Taiwan (possibly virus)**
  - **Amyotrophia (virus) in Japanese black abalone**
  - **Pustule disease of abalone (opportunistic bacteria, usually of *Vibrio* spp.)**
  - **Hemic neoplasia**
  - **Coccidian infection**

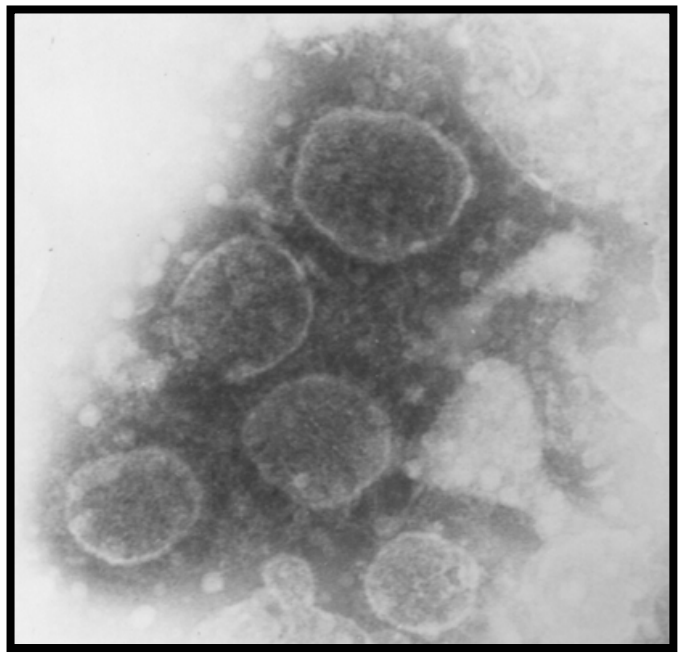
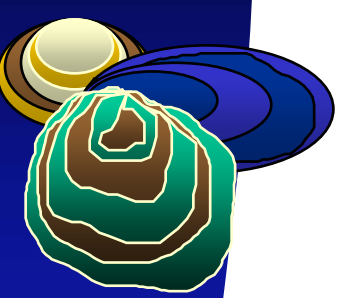


Photo courtesy of B Diggles, New Zealand and W Chongming, China

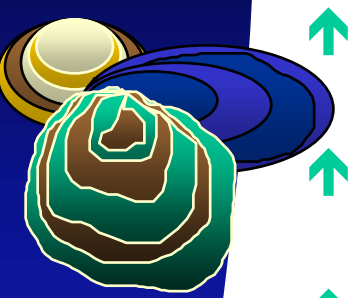
# Factors responsible for rapid spread of a disease (in case of WSSV):



- Translocation of infected broodstock & PL
- Agent has high virulence with wide range of potential hosts and vectors
- Vertical transmission
- Latent period
- Absence of detection methods
- Lack or poor understanding of disease process

Source: P. Walker, CSIRO

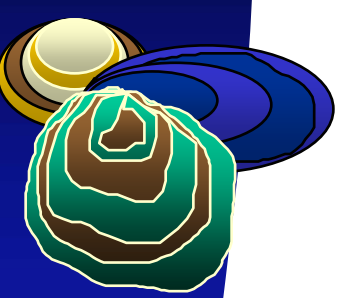
# Possible Causes for a Disease to Occur for the First Time in a Country



- Import health requirements inadequate or non-existent
- Import requirements good but ineffectively enforced (or ignored)
- Unreliable disease surveillance/diagnostics in exporting country
- Route of entry not previously recognised or sufficiently controlled
- Slow awareness of emerging disease in exporting country (KHV)
- Aetiological agent not previously known to be virulent
- Emergence of pathogen from local wild host (marine species)

**Source: B. Hill, DAA V, 2002, Brisbane, Australia**

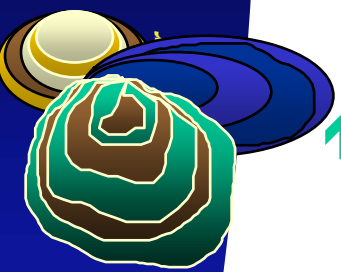
# Molluscan diseases and problems with international movement



- Molluscs are often traded live
- After translocation they are laid in seawater to recover until needed
- It is difficult to determine whether an individual is dead or alive; fouling organisms on the shell also pose a threat
- No cells lines are available
- No vaccines are available
- Disease epidemiology is poorly understood
- Large numbers of very small animals may be involved
- Impossible to apply treatment

**Source: Mike Hine, Phase I Molluscan Health, 1999**

# Molluscan Health Management in Asia-Pacific



- Europe, North America, Australia, New Zealand have pioneered support programmes and infrastructures for molluscan health based on historical experience with significant diseases
- Health infrastructure and expert support for crustaceans and finfish are significantly in place, those for molluscs are lacking
- NACA and FAO initiated an Asia-Pacific Molluscan Health Program (1999)
  - Conceptualized by M Hine (New Zealand), S McGladdery (Canada), F Berthe (France), RP Subasinghe (FAO) and MB Reantaso (NACA)
  - In response to recommendations of FAO TCP on Safe Transboundary Movement of Live Aquatic Animals
  - Shortage of information and knowledge about molluscan diseases in Asia
  - Absence of expertise, facilities and infrastructure for molluscan health
  - The need to establish base-line expertise

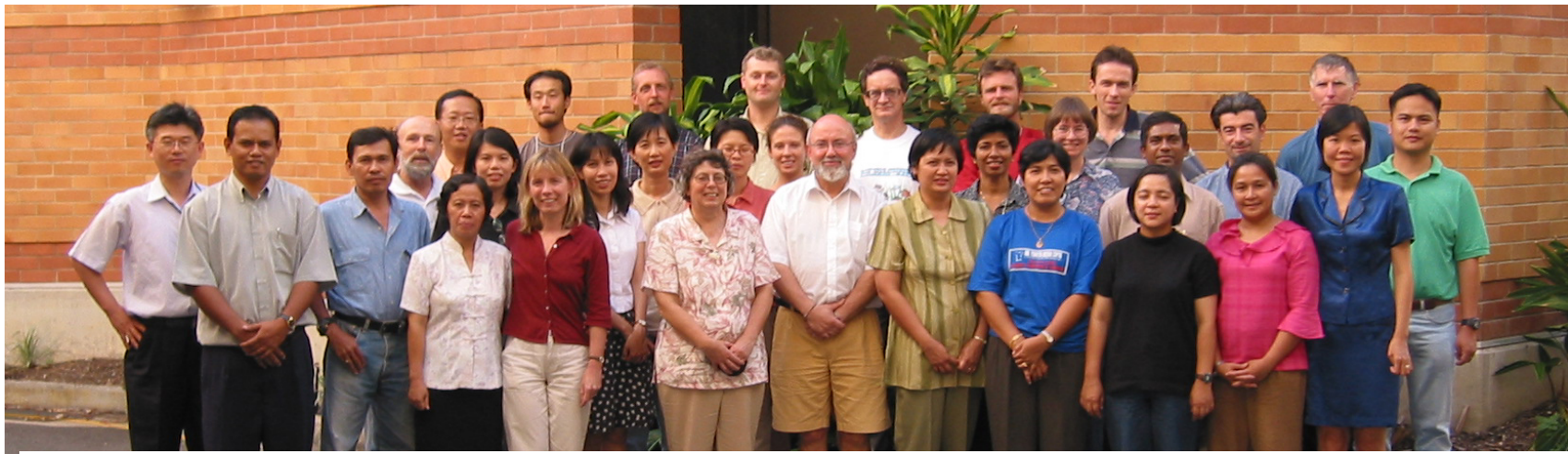
# Molluscan Health Management in Asia-Pacific

- **Phase I**: Baseline Training, 29 Nov-3 Dec 1999, SEAFDEC-AQD, Tigbauan, Iloilo, Philippines
- **Total Participants**: 17 from 10 countries; Trainees (14); Resource Experts (4)


Canada, France, Indonesia, Japan, Korea, Malaysia, New Zealand, Philippines, Thailand, Vietnam

# Molluscan Health Management in Asia-Pacific

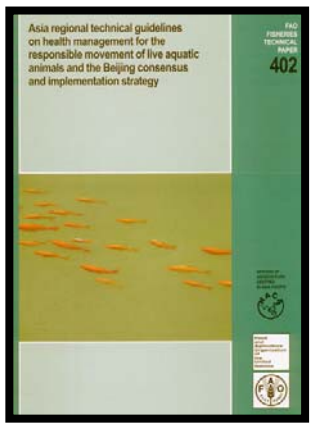
- **Phase II**: Follow-up Training, Evaluation of Results from Country-Specific Surveys, 29 November-3 December 2002, University of Queensland, Brisbane, Australia
- **Total Participants**: 31 from 15 countries; Trainees (20); Resource Experts (11)



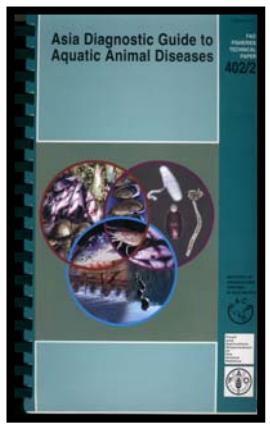
Australia, China, Canada, France, Indonesia, Italy, Japan, Korea RO, Malaysia, New Zealand, Philippines, Sri Lanka, Thailand, Vietnam, USA

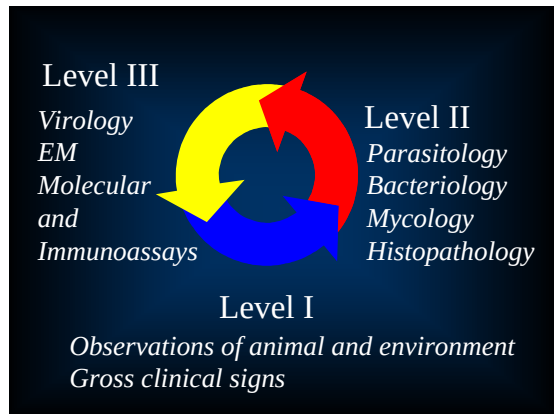
# The Way Forward

- **Efforts are in place to address issues pertaining to support program for molluscan health - these should be proactively supported and continued**
  - **Responsible movement (FAO/NACA TCP on Health)**
  - **National Strategies on Health**



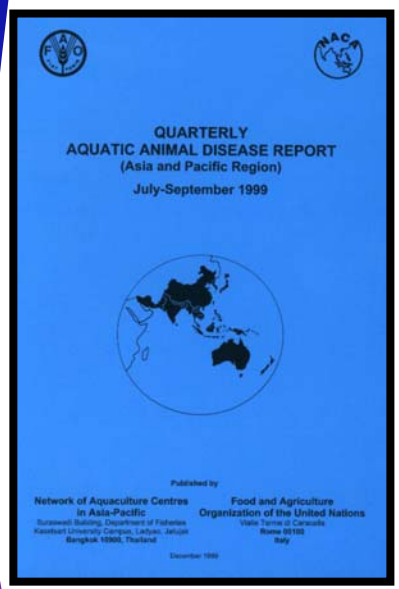


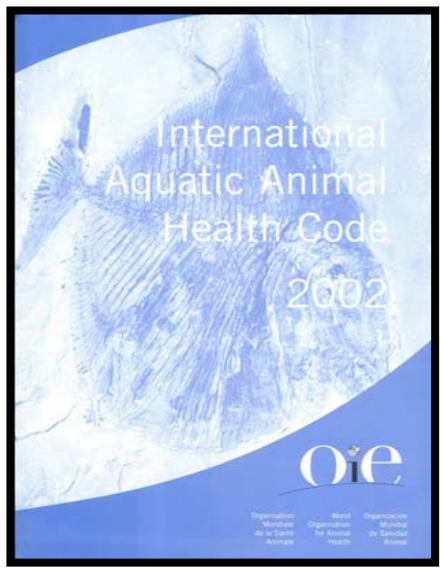


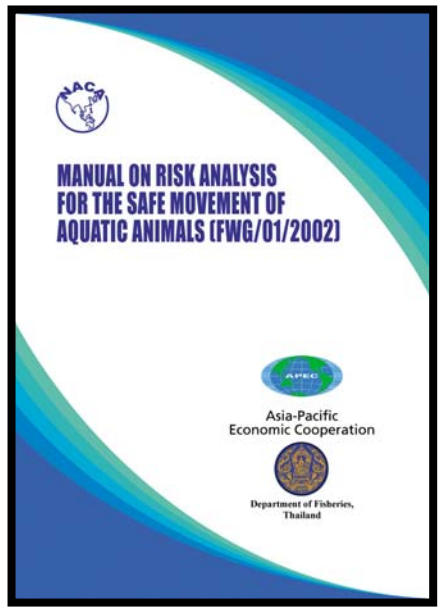



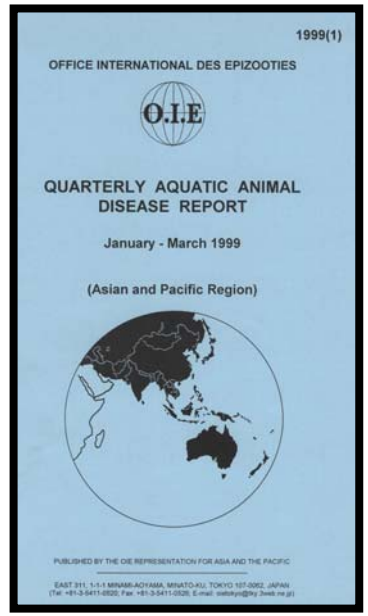
# The Way Forward

- Surveillance and reporting (QAAD with OIE, NACA/FAO)
- Risk analysis (APEC/NACA/FAO)



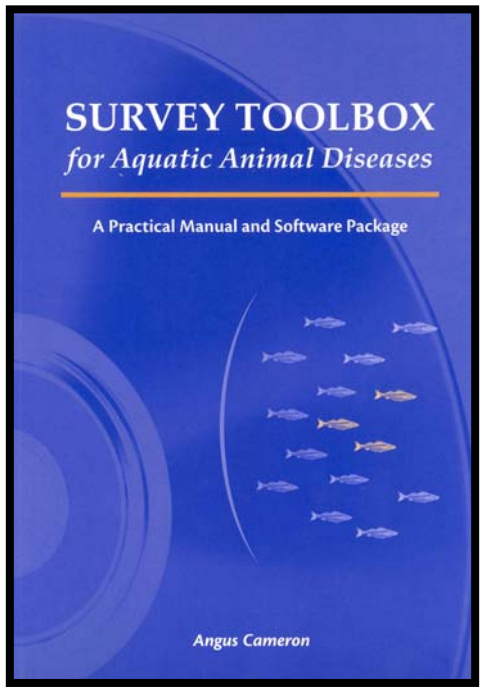



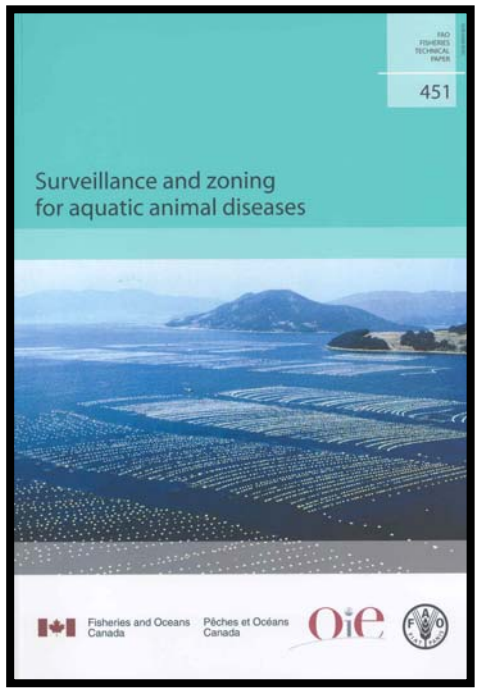



# The Way Forward

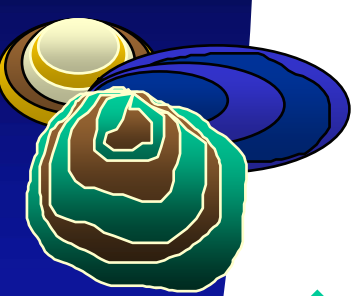
- ↑ Surveillance Toolbox (ACIAR)
- ↑ Surveillance and zoning (FAO/DFO-Canada/OIE)




- ↑ Asia-Pacific Molluscan Health Program (FAO/NACA)

# The Way Forward



- **Research** will form a significant part of addressing pathogen invasions
- Assessments through **systematic surveys** to better understand **disease epidemiology** are necessary
- **Systematic collection of information** necessary to support effective policies for prevention and control
  - Difficult to make **sound and informed policy decisions** based on **qualitative and anecdotal data**
- **Sharing of information** is critical, particularly with respect to **literature** available in **several languages** (e.g. Chinese, Korean, Japanese)

# The Way Forward

- **Inventory of diseases – national and regional databases**
- **Mechanism for easy access and sharing of information and resources**
- **Depository of histological specimens**
- **Focus on hatchery diseases, with intensification hatcheries could be a high risk segment but specific control measures can be established**
- **Practical application of risk analysis**
- **Economic estimates of impacts and management cost**
- **Public and government awareness and education and outreach activities**

# Terimah kasih

**Acknowledgements:**

**MD DNR, US Dept of State, NACA**

**PM Hine & B Diggles (New Zealand), SE McGladdery (Canada), R Adlard, R Lester, B Jones & P Walker (Australia), K Ogawa, N Itoh (Japan), A Choi & DL Choi (Korea), W Chongming (China), Wang (Taiwan PC), A Lovatelli & R Subasinghe (FAO), K Greenhawk & S Tyler (Oxford), B Hill (UK)**