



Network of Aquaculture Centres in Asia-Pacific

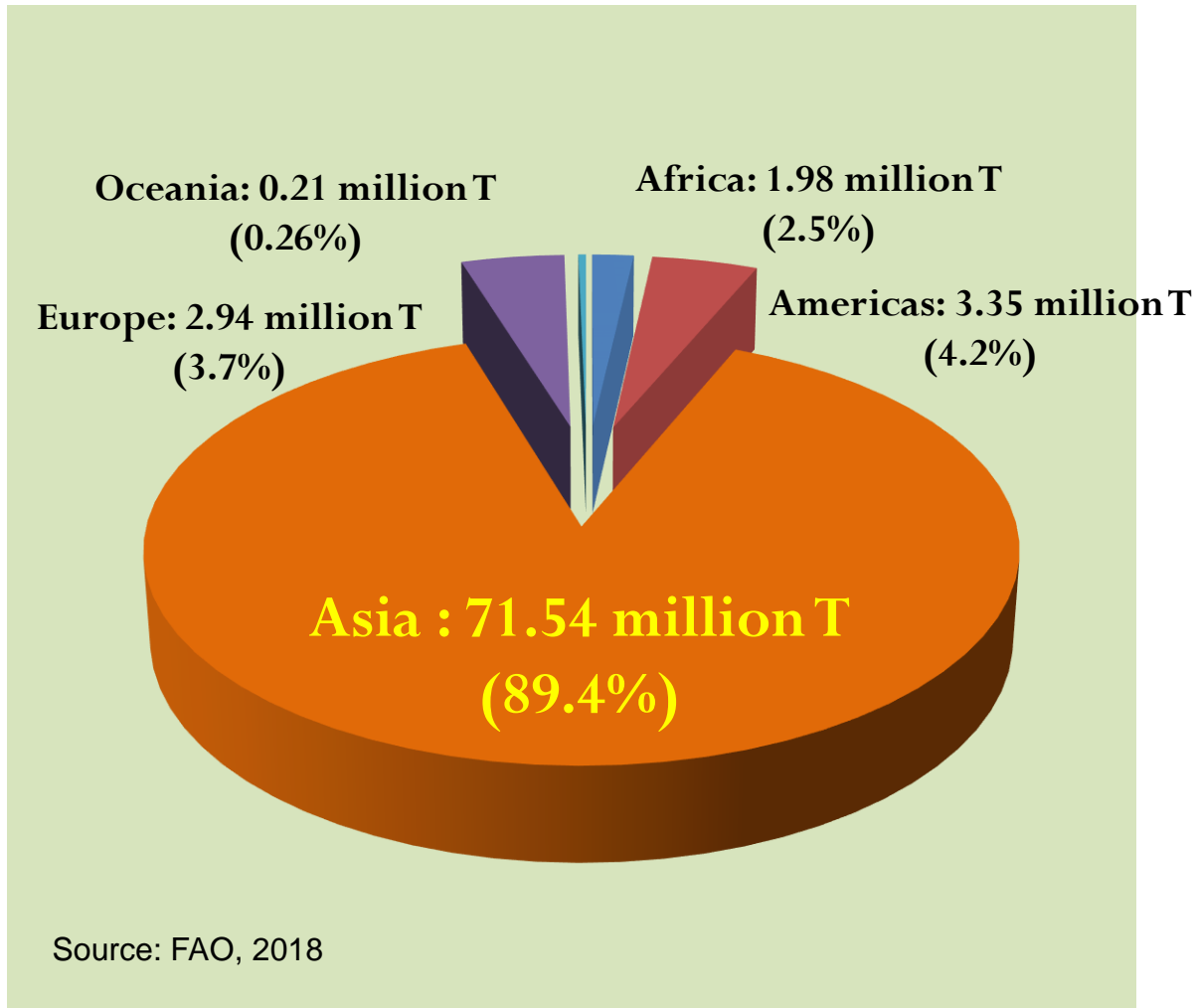
# Transboundary Aquatic Animal Diseases: History and Impacts in ASEAN Aquaculture

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# Asia-Pacific Accounts for about 90% of Global Aquaculture Production



## Top Aquaculture Producers in the World (2016)

Rank	Country	Production (x1000 T)	Percentage
1	China	49,244	61.5
2	India	5,700	7.1
3	Indonesia	4,950	6.2
4	Viet Nam	3,625	4.5
5	Bangladesh	2,204	2.8
6	Egypt	1,371	1.7
7	Norway	1,326	1.7
8	Myanmar	1,017	1.3
9	Chile	1,035	1.3
10	Thailand	963	1.2

Source: FAO, 2018

## ASEAN Aquaculture Production (2016)

Rank	Country	Production (x1000 T)	Percentage (World Production)
1	Indonesia	4,950	6.2
2	Viet Nam	3,625	4.5
3	Myanmar	1,017	1.3
4	Thailand	963	1.2
5	Philippines	796	1.0
6	Malaysia	408	0.5
7	Cambodia	172	0.2
8	Lao PDR	110	0.1
9	Singapore	6	-
10	Brunei Darrusalam	1	-

Source: FAO, 2018

# Asia-Pacific

- **Aquaculture:**
  - **Significant food production sector;**
  - **Provides many livelihood opportunities, especially for many small-scale farming communities which are common in the region;**
  - **Contributes to food security, nutrition and poverty alleviation;**

Km  
0 500 1000 1500 2000  
Miles  
0 500 1000

# Fish Consumption:

- Has been on the rise: Asia accounts for nearly 70% of global consumption.



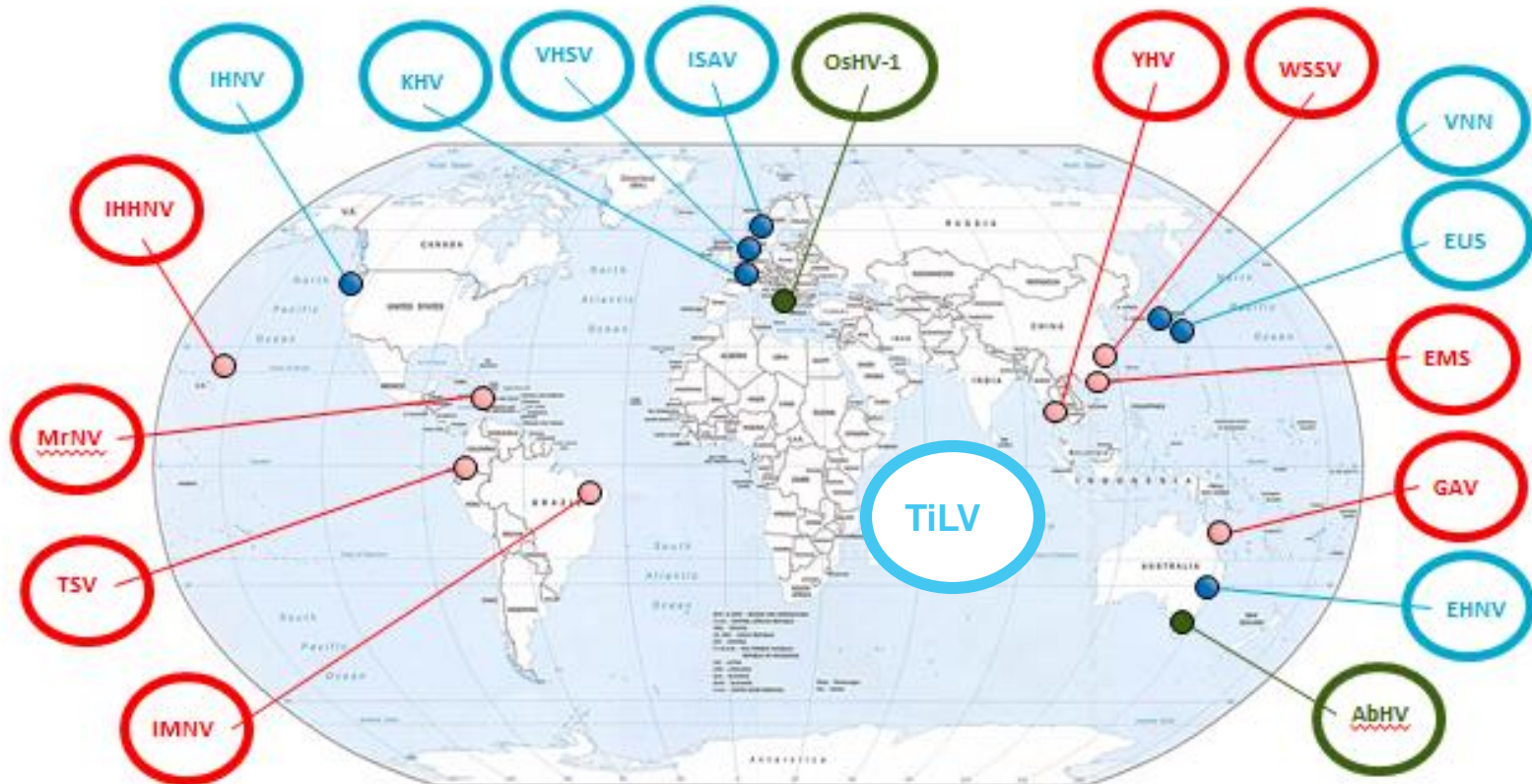
# Aquaculture has developed rapidly in the region

- Previous and recent disease events in fish and shrimp farming have indicated that **preparedness and response measures are still lacking;**
- Contributed significantly to the **spread of diseases** across large areas of the countries involved.

# Trans-boundary Aquatic Animal Diseases



- Several trans-boundary aquatic animal diseases have swept the region over the past 30 years which have caused massive economic and social losses



# Trans-boundary Aquatic Animal Diseases



- Spread of these trans-boundary diseases clearly demonstrates the **vulnerability** of the aquaculture industry to disease emergence, where impacts have been aggravated by the **lack of effective preparedness and response** whenever diseases emerge.

# Emergence and Spread of serious Trans-boundary Aquatic Animal Diseases (TAADs)

- **Reasons**

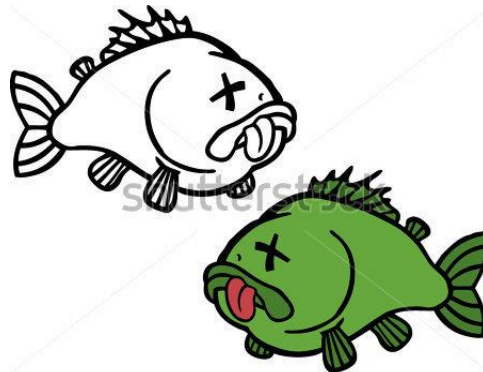
- Intensive aquaculture practices;
- International trade of live aquatic animals (e.g. seeds and brood).



# Emergence and Spread of serious Trans-boundary Aquatic Animal Diseases (TAADs)

- **Economic impact:**

- Direct losses close to US\$ 6 billion annually
- No estimates on indirect losses

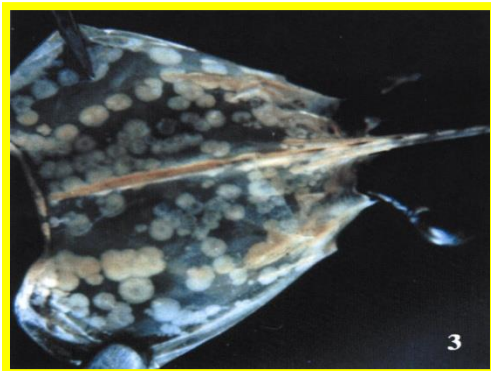


www.shutterstock.com · 45287938



# Emergence and Spread of serious Trans-boundary Aquatic Animal Diseases (TAADs)

- Serious trans-boundary aquatic animal diseases in Asia Pacific over the past 30 years:
  - Infection with *Aphanomyces invadans* (EUS), **Koi herpesvirus disease (KHV)** and Viral Nervous Necrosis (VNN) in fishes
  - **Infection with White Spot Syndrome Virus (WSD)**, Infection with Taura Syndrome Virus (TS), **Infection with Infectious Myonecrosis Virus (IMN)** and **Acute Hepatopancreatic Necrosis Disease (AHPND)** in marine shrimps
  - Infection with *Macrobrachium rosenbergii* Nodavirus (WTD) in freshwater prawn



# Koi Herpesvirus Disease (KHV)

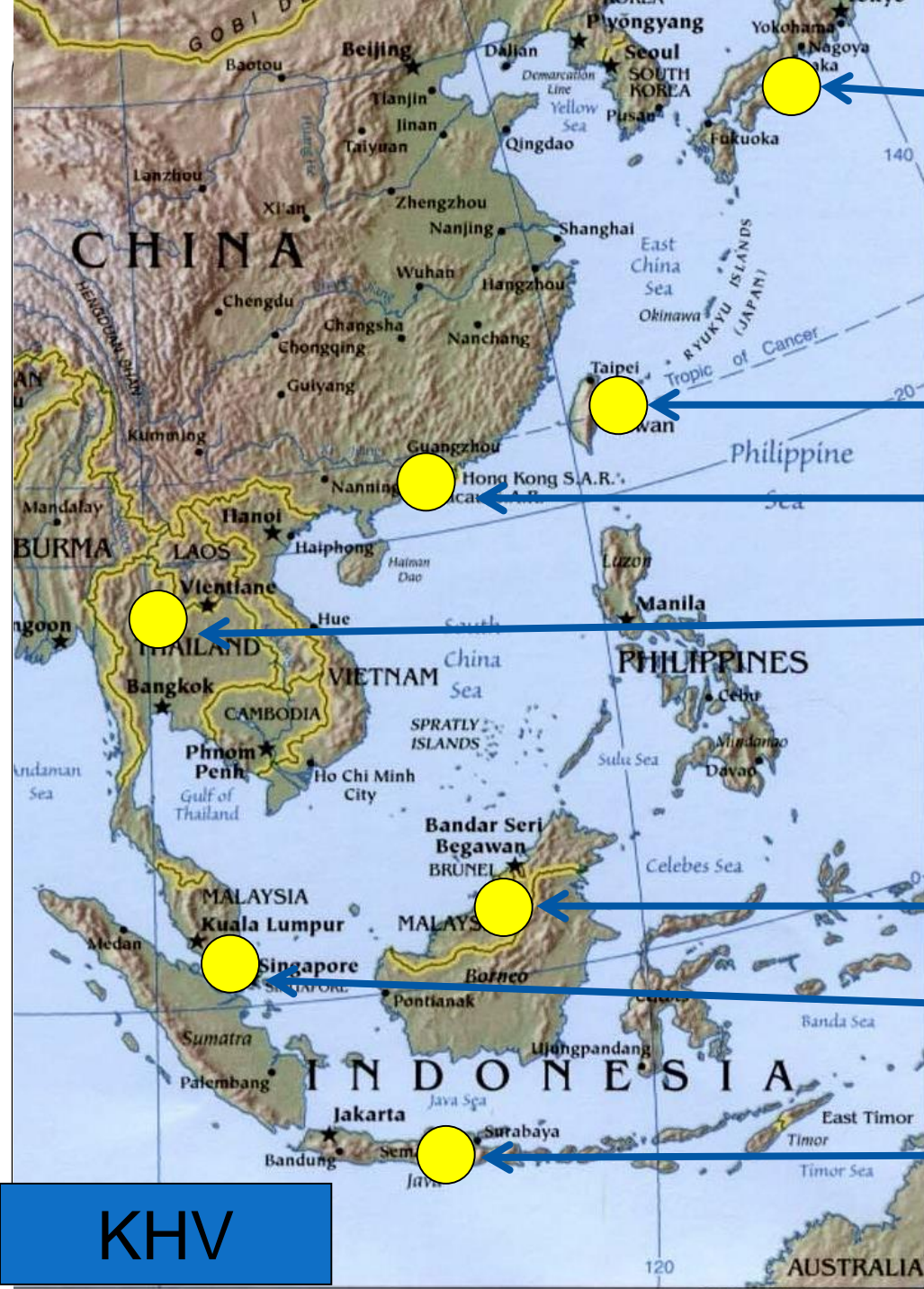
- Can cause mass mortalities (koi carp and common carp), with many dead and moribund fish floating at the surface;
- disorientation and erratic swimming behaviour (sometimes hyperactivity);
- fish coming to the surface and gasping;
- fish separated from the shoal.



# Koi Herpesvirus Disease (KHV)

- Severe gill lesions which exhibit as gill mottling with red and white patches;
- overproduction or underproduction of mucous on the skin and gills
- enlargement and surface haemorrhages of the kidney and liver
- Other external signs:
  - bleeding gills
  - sunken eyes
  - pale patches or blisters on the skin





2003

2002-2004

2001

2004-2005

2001? Koi originating from Malaysia found positive; source not confirmed

2005

2002

**KHV**

Lio-Po, 2011

# Impacts

- Koi carps are highly traded ornamental fish (live form); mass mortalities due to KHV has significantly affected production;
- The disease can be transmitted to and infect common carp; popularly cultured food fish in the region;
- KHV has affected the trading of koi carps, especially from countries reported to be affected by the disease (indirect losses);
- The aquarium fish trade, especially of koi carp, most likely played a significant role in the transboundary movement of the virus.



# Impacts

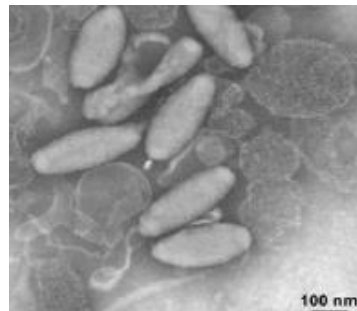
**Japan:** loss of \$2.5 million was reported during the first year of outbreak

**Indonesia:** \$0.5 million loss was reported within 3 months since the outbreak was reported (2002); and as of December 2003, losses amounted to US\$15 million.



# Infection with White Spot Syndrome Virus (WSD)

- WSD is, by far, the most devastating disease of farmed shrimp;
- Infects all cultured shrimps and other crustaceans including wild populations.
- has incurred heavy losses among cultured penaeid shrimps in Asia that almost crippled the shrimp industry in countries where outbreaks were reported.



# White Spot Disease (WSSV)

1993



China



Japan



Taiwan

2000



Philippines

2002



Iran

Between 1994 to 1999



Thailand



Malaysia



India



Sri Lanka



Indonesia



Vietnam



Cambodia



Brunei



Myanmar



WSD

Scale 1:48,000,000

WGS 1984 UTM Zone 48N  
Pseudo-Cylindrical Equal-Area Projection

Boundary representation is not necessarily authoritative.

80

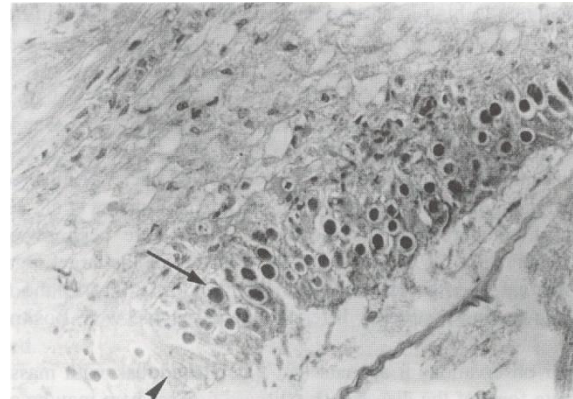
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120

AUSTRALIA

# Infection with White Spot Syndrome Virus (WSD)

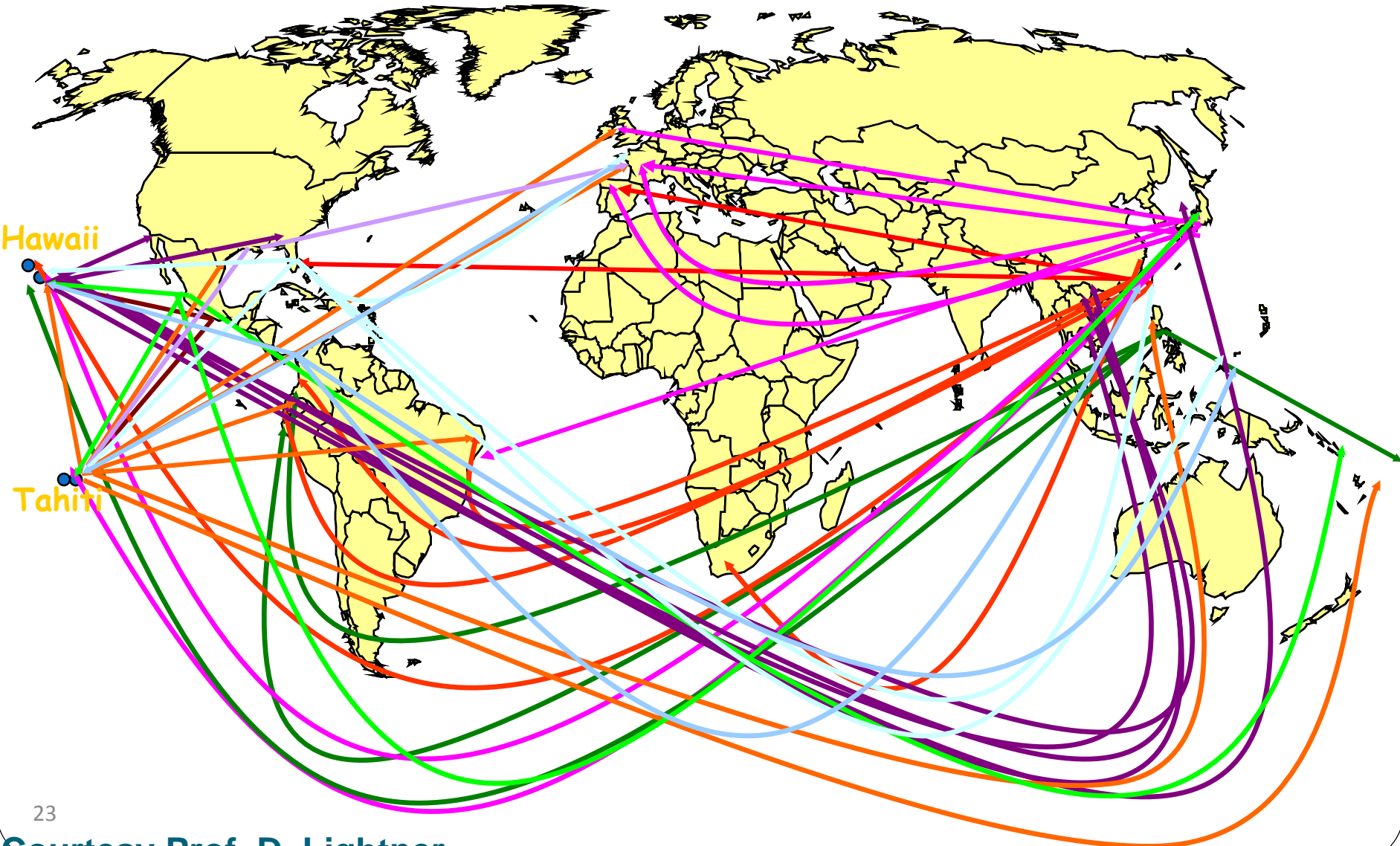
- Infected shrimps:
  - presence of distinct white cuticular spots is a typical sign of the disease;
  - moribund shrimp display red discoloration and have loose cuticle;
  - affected shrimps manifest surface swimming and gathering at pond dikes with broken antennae.



# Infection with White Spot Syndrome Virus (WSD)

- Spread of the disease happened during the peak of the *P. monodon* culture in Asia;
- PL's and broodstock (live) are highly traded between countries; especially from China, Taiwan, Indonesia and Thailand;
- One of the reasons for the collapse of the *P. monodon* industry in some key producing countries (e.g. Taiwan, Indonesia, Thailand);
- Still the most important disease problem in the culture of other Penaeids (esp. *P. vannamei*)

# Global transfers of live shrimp



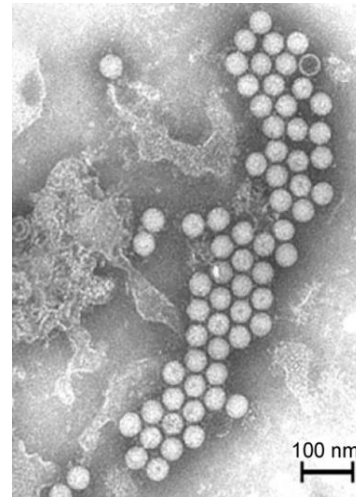
# Impacts

- **After the first outbreak in 1992, it reduced the production over 70% resulting in a production loss of over US\$ 2 billion in China in three years;**
- **In Thailand, the shrimp industry incurred losses of US\$1.6 billion in 1994;**
- **In 1997, losses due to WSD were estimated at US\$600 million in Thailand, and at over US\$2 billion throughout Asia;**
- **In 1992 due to the WSD, shrimp production in Indonesia dropped resulting to production losses of roughly US\$ 1 billion through ten years;**
- **Total losses due to WSD is estimated at around US\$13 billion.**

Source: Flegel, 1998; Lio-Po and Leñaño, 2016; Bir et al, 2017

# Infection with Infectious Myonecrosis Virus (IMN)

- Considered as the current threat in *P. vannamei* culture in the region;
- first outbreak in Asia-Pacific was reported in East Java (Situbondo District), Indonesia in May 2006. It was contained in this area until 2008.



# Infection with Infectious Myonecrosis Virus (IMN)

- Shrimps in acute phase of the disease exhibit white necrotic areas in striated (skeletal) muscles, especially in the distal abdominal segment and the tail fan.
- The necrotic muscles can become reddened in some affected shrimps;
- Severely affected shrimps become moribund;



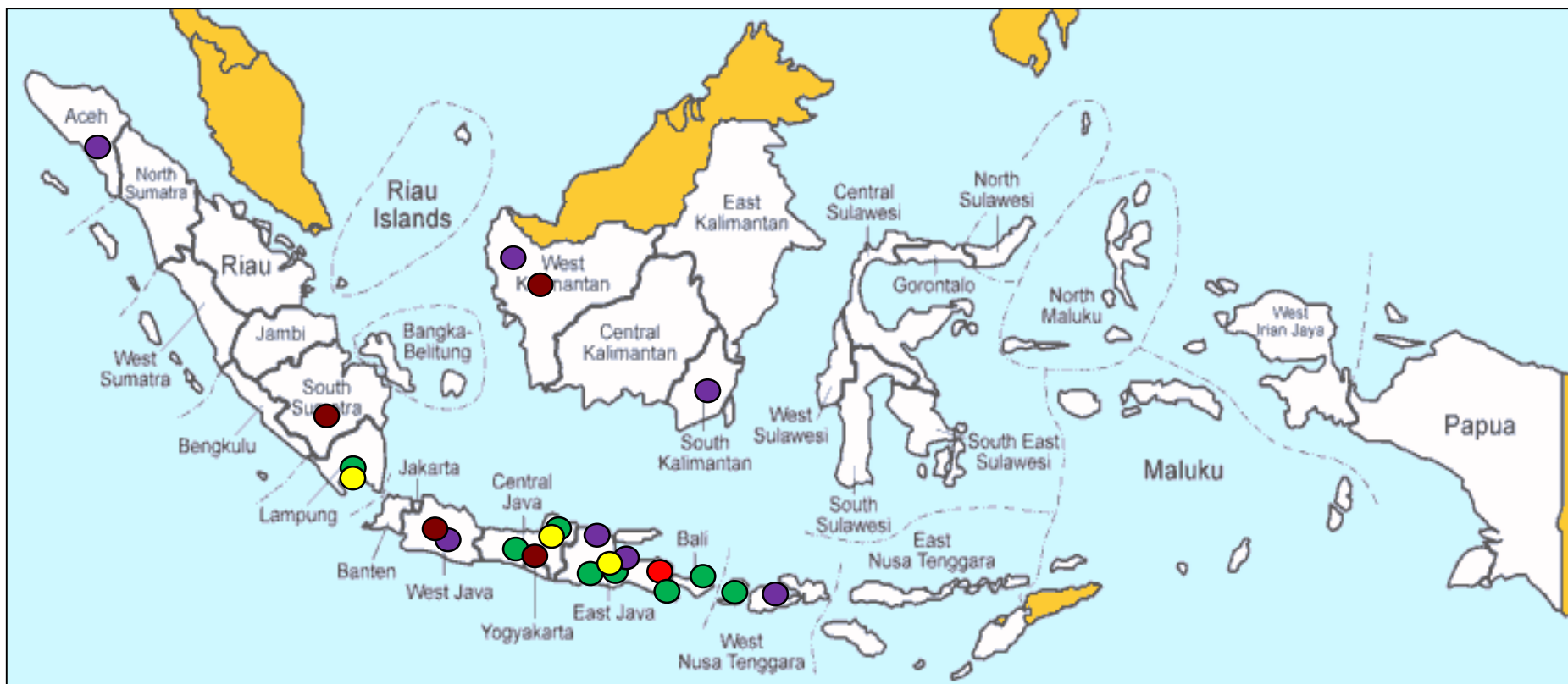
<http://www.aquatec.vn/blog/brazil-study-beta-glucans-improve-survival-of-immv-infected-white-shrimp-835/?hl=en>



<https://shrimpdiseases.wordpress.com/imm/>

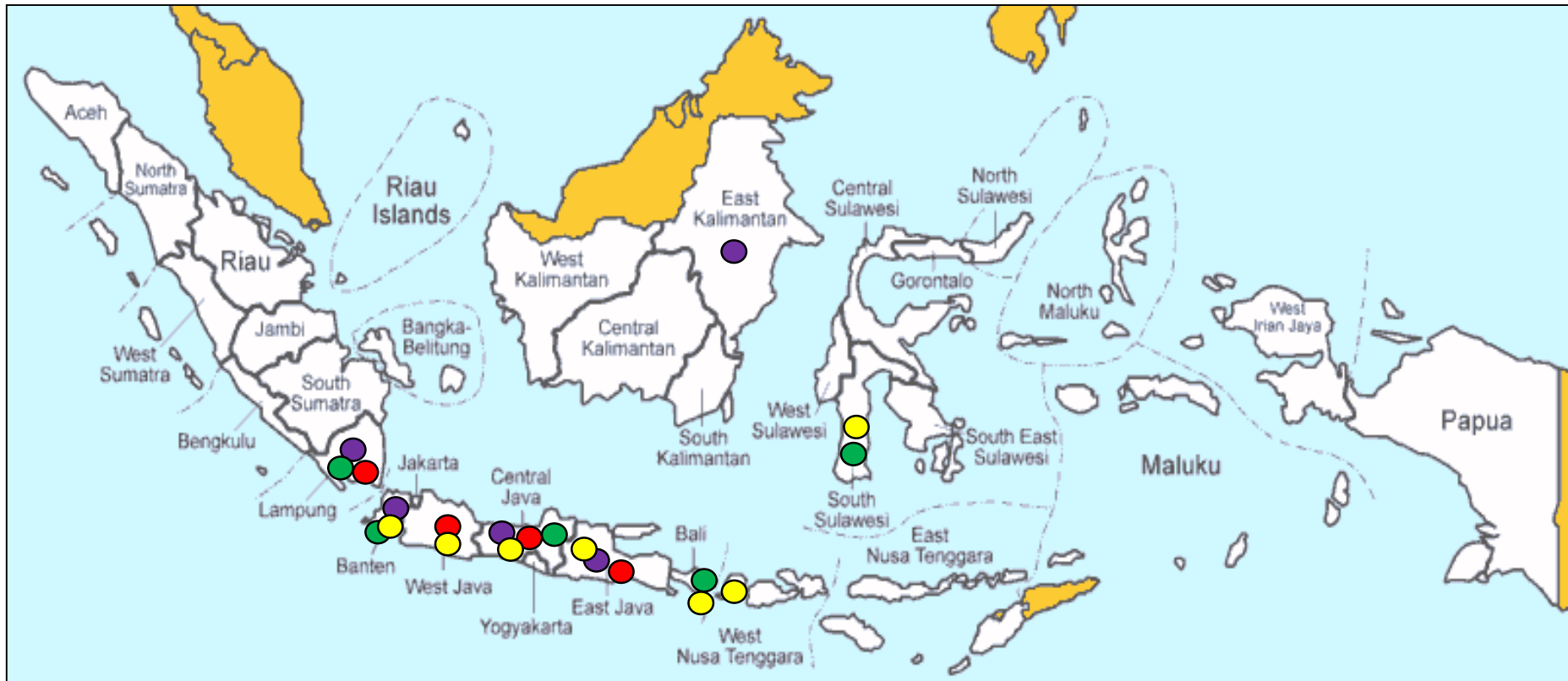


## Spread of IMNV in Indonesia (2006-2012)




- Initially reported in Situbondo District, East Java in **May 2006** and was contained in this area until **2008**.
- **2009:** more districts of East Java (Situ, Banyuwangi, Blitar and Malang); Bali (Jembrana); Lampung (Pesawaran and South Lampung Dist.), West Nusa Tenggara (East Lombok) and Central Java (Jepara, Blora, Kendal and Rembang)
- **2010:** more districts of East Java (Bangil, Pasuran and Lamongan); West Nusa Tenggara (West Sumbawa); West Java; Aceh; West Kalimantan; South Kalimantan.
- **2011:** reported in Lampung, Central Java (Jepara) and East Java (Banyuwangi).
- **2012:** reported in West Kalimantan, South Sumatra, West Java and Yogyakarta

# Spread of IMNV in Indonesia (2013-2017)




- **2013:** reported in East Kalimantan, East Java, Central Java, Banten and Lampung
- **2014:** reported in East Java, Central Java, West Java and Lampung
- **2016:** reported in Banten, South Sulawesi, Central Java, Lampung and Bali
- **2017:** reported in East Java, Central Java, West Java, South Sulawesi, Banten, Bali and NTB Island

# Infectious Myonecrosis (IMN)



## DISEASE ADVISORY

### Infectious Myonecrosis (IMN): Status and Threat

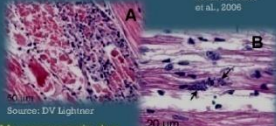


**Infectious myonecrosis (IMN)** is a viral disease caused by infectious myonecrosis virus (IMNV), a putative totivirus. IMNV particles are icosahedral in shape and 40 nm in diameter.

#### Host Range

- Pacific white shrimp, *Penaeus vannamei* (principal host),
- Tiger prawn, *P. monodon* and blue shrimp, *P. stylirostris* (experimental infection).

#### Histopathology



Source: DV Lightner

Myonecrosis due to IMNV infection in *P. vannamei*, H&E stain:


A) Coagulative necrosis of skeletal muscle by haemocytic infiltration and fibrosis, in contrast to normal skeletal muscle which can be observed at the upper right corner.

B) Perinuclear pale basophilic to dark basophilic inclusion bodies (arrows) observed in striated muscle cells.

#### Disease Signs

**Farm Level:**

- Large numbers of sick animals and significant mortalities in pond-reared *P. vannamei* (juveniles and adults);
- Losses due to mortality range from 40 to 70 %.



Source: DV Lightner

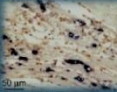
#### Clinical:

- Presence of focal to extensive white necrotic areas in striated (skeletal) muscles, especially in the distal abdominal segment and tail fan, which can become necrotic and reddened in some affected shrimp.
- These signs may have sudden onset following stresses (e.g. capture by cast net, feeding, sudden change in temperature or salinity).

#### Diagnostic Methods

- Definitive diagnosis by histology (acute and chronic phases);
- Molecular detection of IMNV by *in-situ* hybridisation, nested RT-PCR and real time RT-PCR;
- RT-PCR recommended for targeted surveillance. Diagnostic kits are commercially available (e.g. GeneReach Biotechnology Corporation, <http://genereach.com/about1.htm>).

#### In-situ hybridisation of skeletal muscle tissue using a digoxigenin-labelled IMNV probe. A black precipitate is present in areas where the probe has hybridised with the target virus.




Source: DV Lightner

## Infectious Myonecrosis (IMN)

#### Presence in the Asia-Pacific

- Originally reported from north-eastern Brazil, the first outbreak in Asia-Pacific was reported in East Java (Situbondo District), Indonesia in May 2006. It was contained in this area until 2008.
- In 2009, however, more districts in East Java were affected including Situ, Banyuwangi, Blitar and Malang, as well as some districts in the provinces of Bali, Lampung, West Nusa Tenggara and Central Java.
- Based on Quarterly Aquatic Animal Disease (QAAD) reports submitted to NACA, the following Indonesian provinces are now affected by IMNV:
  - East Java
  - Bali
  - Lampung
  - Central Java (Jepara, Blora, Kendal and Rembang)
  - West Kalimantan (Bengkayang)
  - West Nusa Tenggara (West Sumbawa)



Source: DV Lightner

#### What to do when there is (suspected) Outbreak?

- Report immediately to Competent Authorities in respective countries, and to regional and international organizations involved in aquatic animal health: NACA ([www.enaca.org](http://www.enaca.org)); World Organisation for Animal Health (OIE, [www.oie.int](http://www.oie.int)); Food and Agriculture Organization of the United Nations (FAO; [www.fao.org](http://www.fao.org))
- Collect tissue samples with guidance from Fish Health experts, for submission to accredited national or regional laboratories:
  - Best tissue samples for IMNV detection include striated (skeletal) muscle, connective tissues, haemocytes, and lymphoid organ,
  - For non-lethal testing (can be used for surveillance), haemolymph or excised pleopods may be collected.

#### Prevention and Control

- Better husbandry practices and use of specific pathogen free (SPF) broodstock have been proven to be the most successful methods to prevent infection;
- There are no reported control measures for IMNV.

#### Current Threat

- With the current spread of the disease to other provinces in Indonesia, there is a high threat of spreading the disease to neighboring *P. vannamei*-producing countries;
- P. vannamei* is now the most popularly cultured shrimp species in many Asian countries, including Malaysia, Thailand, the Philippines, Vietnam and China among others;
- Increased awareness and preparedness on IMN disease and outbreak are needed in these countries.

#### Key References

AGDAFF-NACA (2007). Infectious myonecrosis. Aquatic Animal Diseases Significant to Asia-Pacific Region: Identification Field Guide, Australian Government of Agriculture, Fisheries and Forestry, Canberra, Australia.

OIE (2010). Chapter 2.2.3 – Infectious myonecrosis. Manual of Diagnostic Tests for Aquatic Animals 2010. World Organisation for Animal Health, Paris, France.

Poulos, B.T., Tang, K.F.J., Pantolo, C.R., Bonami, J.R., Lightner, D.V. (2006). Purification and characterization of infectious myonecrosis virus of penaeid shrimp. J. Gen. Virol. 87: 987-996.

Saengtham, S., Riewwanya, K., Briggs, M., Rival, T.W. (2007). Outbreaks of infectious myonecrosis virus (IMNV) in Indonesia confirmed by genome sequencing and use of an alternative RT-PCR detection method. Aquaculture, 228: 32-38.

© Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand. December 2010

# Infection with Infectious Myonecrosis Virus (IMN)

- Outbreak was reported in India:
  - 2016 (3<sup>rd</sup> quarter)
  - 2017 (2<sup>nd</sup> quarter)

## JOURNAL OF FISH DISEASES

ORIGINAL ARTICLE

Studies on the occurrence of infectious myonecrosis virus in pond-reared *Litopenaeus vannamei* (Boone, 1931) in India

A S Sahul Hameed ✉, S Abdul Majeed, S Vimal, N Madan, T Rajkumar, S Santhoshkumar, S Sivakumar

First published: 20 June 2017 | <https://doi.org/10.1111/jfd.12655> | Cited by: 1

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## Abstract

Whiteleg shrimp, *Litopenaeus vannamei*, with clinical sign of muscle opaqueness with reddish colour at the distal abdominal segments were observed in farms located in West Bengal State, India. The mortality of shrimp in all disease outbreak ponds ranged from 20% to 50%, and mortality increased gradually. The RT-PCR assay of these samples using primer sets specific to infectious myonecrosis virus (IMNV) revealed its presence in the disease outbreak ponds. The IMNV infection was reproduced in healthy shrimp by intramuscular injection to satisfy River's postulates. The virus caused mortality in intramuscularly challenged shrimp, but failed to cause mortality by oral route. Tissue distribution of IMNV in infected shrimp by RT-PCR assay revealed the presence of this virus in haemolymph, gill, hepatopancreas and muscle. This study confirms that the disease outbreak which occurred in the shrimp farms located at Purba Medinipur District, West Bengal, India, was due to IMNV.



# Impacts

- High production losses in affected shrimps: mortalities can be instantaneously high and continue for several days (40-70%)



<http://www.kanyafarm.com/articles/42104028/>



<http://fis.com/fis/worldnews/worldnews.asp?l=e&id=54421&ndb=1>



<https://en.engormix.com/aquaculture/articles/southern-brown-shrimp-susceptible-to-immv-t34718.htm>

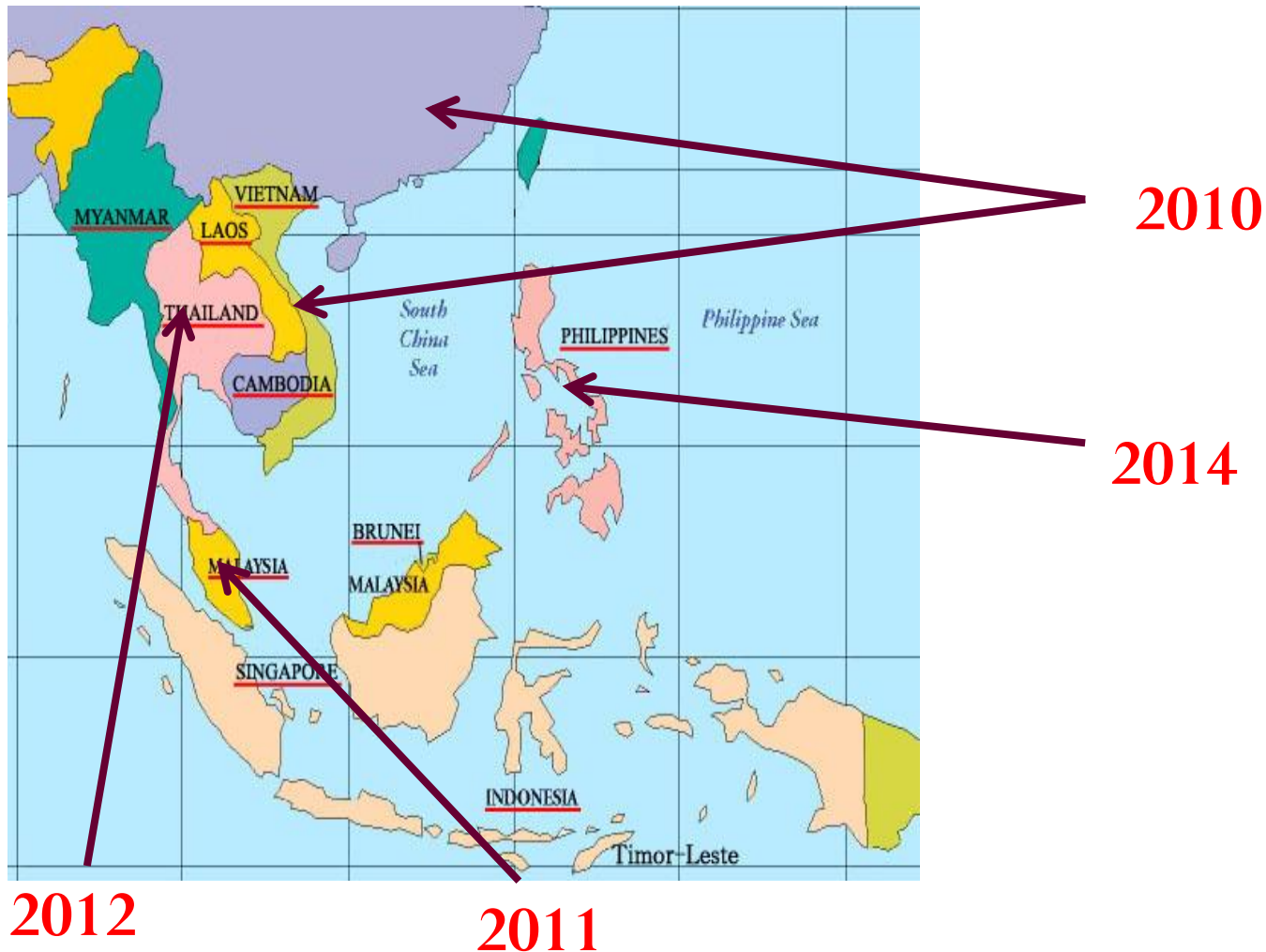


# Acute Hepatopancreatic Necrosis Disease (AHPND)

- Recent shrimp disease problem that has swept the region;
- Affects both cultured *P. monodon* and *P. vannamei*;



# Acute Hepatopancreatic Necrosis Disease (AHPND)



# Acute Hepatopancreatic Necrosis Disease (AHPND)

- Spread was attributed to trading of live PLs and non-SPF broodstock;
- Trading/movement of live polychaetes as natural food for shrimp broodstock (live polychaetes was found to harbor AHPND *Vibrio parahaemolyticus*)
- Early warning and information dissemination significantly prevented the further spread of the disease to other shrimp-producing countries in the region

# Impacts

AHPND/EMS

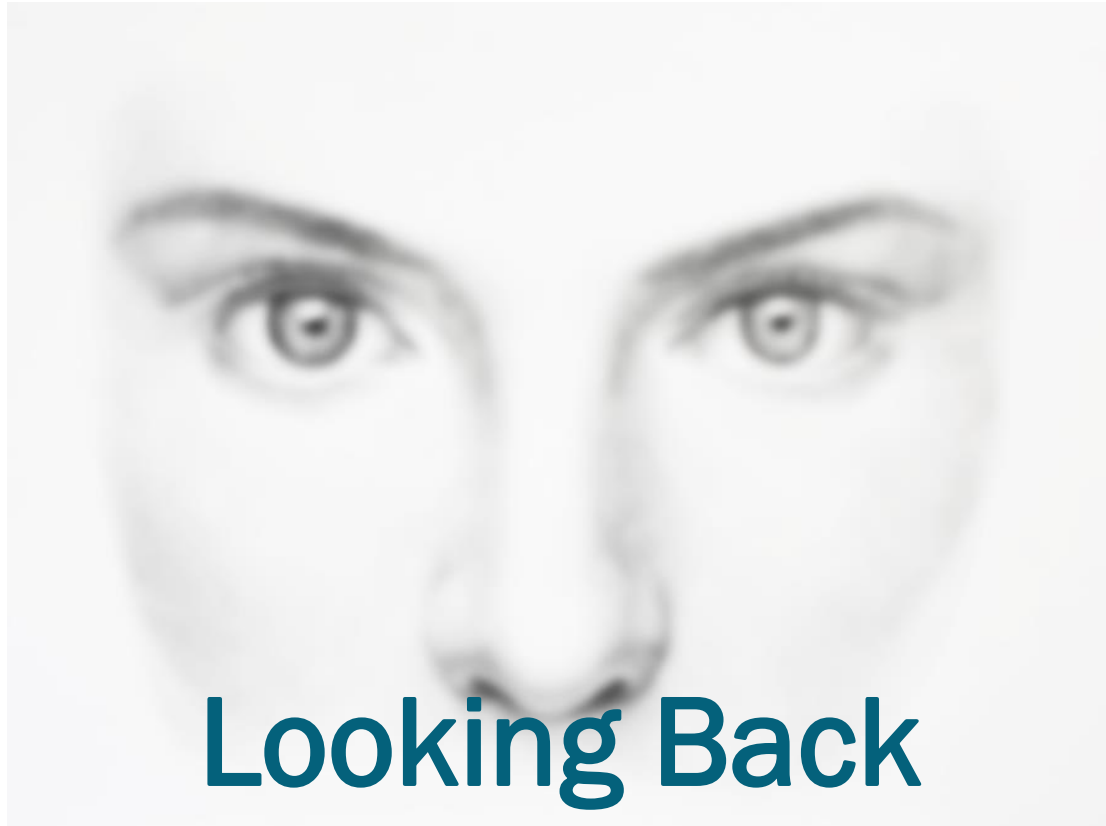
**2016: loss of more than  
US\$5 billion, based on  
the value of lost tonnage**

**In Vietnam alone,  
losses were  
calculated at more  
than US\$10 million**



**With the several aquatic animal disease emergencies that swept the region.....**

**Are we prepared enough for the next one???**



**Looking Back**

# Infection with *Aphanomyces invadans* (Epizootic Ulcerative Syndrome)

- First reported in Singapore in 1977(?), and Malaysia in 1979.
- It then rapidly spread to other ASEAN countries including Thailand (1981), Cambodia (1981), PDR and Vietnam (1982), Myanmar (1984), Philippines (1985), and Indonesia (1985).
- Most AMCs were not prepared on such emergency epizootic, especially with the very rapid spread of the disease;
- This is coupled with the time taken to single out the main pathogen involved, which is responsible for the wide and rapid spread of infection.



**MESS**

# Koi Herpesvirus Disease (KHV)

- After the experience with EUS and then with WSD, the first reported outbreak of KHV in the region (2001-2002) alerted koi and common-carpet producing countries;
- Significant achievements, however, were made by some countries in prevention of further spread and/or indicating the disease (e.g. ...)
- Despite some efforts (and preventive measures and biosecurity) by ... countries prevented the ... spread of the disease. ... not spared.



**PANIC**

# Acute Hepatopancreatic Necrosis Disease (AHPND)

- After the experience and response to previous important diseases (EUS, WSD, KHV), and despite the modern diagnostic tools available, the detection of shrimp diseases, the coming of AHPND again surprised the shrimp industry of the region;
- Efforts to identify the pathogen, prevent and control the disease were not coordinated well; however, emergency actions through international and regional organizations (FAO, OIE, etc.) including wider dissemination of information and advisories prompted several shrimp-producing countries to apply strict biosecurity measures (e.g. Indonesia)



**CHAOS**

# New/Emerging Diseases

Is there improvement so far??

# Tilapia Lake Virus (TiLV)

- First reported in the region by Thailand (early 2017) and Chinese Taipei (mid-2017); followed by Malaysia, India and the Philippines (3<sup>rd</sup> quarter 2017);
- Pathogen identified and diagnostic method available when the disease is confirmed in the region;
- Active surveillance took place in key tilapia-producing countries like China, Indonesia and Vietnam;
- Local publication reported the presence of the disease in Indonesia (early 2018);
- Some countries banned the importation of tilapia from countries affected by the disease;

# Tilapia Lake Virus (TiLV)

- Listing of TiLV in QAAD to monitor prevalence of the disease in AP region
- Emergency regional consultation undertaken under a few months after the first report of the disease in the region;
- Intensive training of diagnostics was undertaken more than a year after the first report of the disease.

Better  
Preparedness  
and  
Response



# New/Emerging Diseases

**New Threats are COMING!!!**



# New Aquatic Animal Diseases already listed in QAAD

- Hepatopancreatic microsporidiosis caused by *Enterocytozoon hepatopenaei* (EHP)
- Viral Covert Mortality Disease of shrimps
- *Spiroplasma eriocheiris* infection in crayfish and freshwater prawn
- Iridovirus in crayfish

To be considered for listing:

- Shrimp haemocyte iridovirus (SHIV)

# New/Emerging Diseases

**New Threats are COMING!!!**

**There is a strong need for harmonized emergency preparedness and response in the ASEAN region for better management of important and emerging transboundary aquatic animal diseases.**



# Few last words....

- Outbreaks of damaging aquatic animal diseases are **likely to continue** – potential consequences are likely to increase with the expansion (intensification) of aquaculture systems, trading/movement of aquatic animals, and introduction of new species for culture;
- Aquatic animal disease, once introduced into the country/area, is often very **hard to eradicate**;
- Risks associated with emerging and transboundary diseases are **shared** – shared water bodies and epidemiological links through trade (especially live movement);
- **Collaborative approach** is necessary for effective aquatic animal health management, disease surveillance programme, and for effective emergency preparedness and response system.



Thank you....



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