Current Disease Trends in Aquaculture

Regional Perspective

Eduardo M. Leaño
Network of Aquaculture Centres in Asia-Pacific
Bangkok, Thailand
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;
- With a very long history in Asia (thought to have originated from China)
Asia-Pacific

- Fish Consumption:
  - Has been on the rise: Asia-Pacific accounts for nearly 70% of global consumption;
  - Per caput:
    - Asia-Pacific = 43 kg/year
    - Global = 23 kg/year
Asia-Pacific

- Top aquaculture producer in the world;
- In 2010, almost 90% of world aquaculture production.

Source: FAO, 2012

**Pie Chart**

- **Asia-Pacific**: 53,301,157 T (89.0%)
- **Europe**: 2,523,179 T (4.2%)
- **Americas**: 2,576,428 T (4.3%)
- **Africa**: 1,288,320 T (%2.2)
- **Oceania**: 183,516 T (0.3%)
# Asia-Pacific

Top aquaculture (aquatic animals) producers in the world in 2008 (FAO, 2010)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Production (T)</th>
<th>Value (US$1000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>China</td>
<td>32,735,994</td>
<td>50,638,540</td>
</tr>
<tr>
<td>2</td>
<td>India</td>
<td>3,478,690</td>
<td>5,043,749</td>
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<tr>
<td>3</td>
<td>Vietnam</td>
<td>2,461,700</td>
<td>4,599,850</td>
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<tr>
<td>4</td>
<td>Indonesia</td>
<td>1,690,121</td>
<td>2,813,673</td>
</tr>
<tr>
<td>5</td>
<td>Thailand</td>
<td>1,374,024</td>
<td>2,202,075</td>
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<tr>
<td>6</td>
<td>Bangladesh</td>
<td>1,005,542</td>
<td>1,766,182</td>
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<tr>
<td>7</td>
<td>Norway</td>
<td>843,730</td>
<td>3,119,011</td>
</tr>
<tr>
<td>8</td>
<td>Chile</td>
<td>843,142</td>
<td>4,502,789</td>
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<tr>
<td>9</td>
<td>Philippines</td>
<td>741,142</td>
<td>1,576,141</td>
</tr>
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<td>10</td>
<td>Japan</td>
<td>732,374</td>
<td>3,104,346</td>
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Asia-Pacific

Top aquaculture (aquatic animals) producers in the world in 2008 (FAO, 2010)

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<tbody>
<tr>
<td>11</td>
<td>Egypt</td>
<td>693,815</td>
<td>1,251,119</td>
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<td>12</td>
<td>Myanmar</td>
<td>674,776</td>
<td>817,218</td>
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<tr>
<td>13</td>
<td>USA</td>
<td>500,114</td>
<td>936,922</td>
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<tr>
<td>14</td>
<td>Korea, Rep. of</td>
<td>473,794</td>
<td>1,287,039</td>
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<td>15</td>
<td>Taiwan</td>
<td>323,982</td>
<td>1,068,795</td>
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<td>16</td>
<td>Brazil</td>
<td>290,186</td>
<td>608,329</td>
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<tr>
<td>17</td>
<td>Spain</td>
<td>249,062</td>
<td>517,771</td>
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<td>18</td>
<td>Malaysia</td>
<td>243,081</td>
<td>564,327</td>
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<tr>
<td>19</td>
<td>France</td>
<td>237,833</td>
<td>814,023</td>
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<tr>
<td>20</td>
<td>Italy</td>
<td>181,369</td>
<td>810,375</td>
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</table>
Aquaculture production in the Asia-Pacific region (2010).
Asia-Pacific

- **Species:**
  - **Finfishes** \((\text{Vol} = 49\%; \text{Val} = 55\%)\)
  - **Aquatic plants** \((\text{Vol} = 22\%; \text{Val} = 8\%)\)
  - **Molluscs** \((\text{Vol} = 19\%; \text{Val} = 12\%)\)
  - **Crustaceans** \((\text{Vol} = 7\%; \text{Val} = 24\%)\)

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*DeSilva, 2010*
Asia-Pacific

- **Finfishes**
  - Mainly freshwater fishes: 60% of total aquatic animal production (56% total value)
  - Marine fishes: 32% total production (31% value)
  - Brackishwater fishes: 8% total production (4% value)
Top 10 finfish species that are produced around the world (2008). Source: FAO, 2010

<table>
<thead>
<tr>
<th>Rank</th>
<th>Species</th>
<th>Production (T)</th>
<th>Value (x1000 US$)</th>
</tr>
</thead>
</table>
| 1    | Silver carp  
(\textit{Hypophthalmichthys molitrix}) | 3,782,281      | 4,766,195         |
| 2    | Grass carp  
(\textit{Ctenopharyngodon idellus}) | 3,775,267      | 4,797,279         |
| 3    | Common carp  
(\textit{Cyprinus carpio}) | 2,987,433      | 3,696,415         |
| 4    | Nile tilapia  
(\textit{Oreochromis niloticus}) | 2,334,432      | 3,208,561         |
| 5    | Bighead carp  
(\textit{Hypophthalmichthys nobilis}) | 2,321,513      | 2,975,412         |
Top 10 finfish species that are produced around the world (2008). Source: FAO, 2010

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</thead>
<tbody>
<tr>
<td>6</td>
<td>Catla (Catla catla)</td>
<td>2,281,838</td>
<td>3,303,124</td>
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<td>7</td>
<td>Crucian carp (Ctenopharyngodon idellus)</td>
<td>1,975,337</td>
<td>2,135,857</td>
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<tr>
<td>8</td>
<td>Atlantic salmon (Salmo salar)</td>
<td>1,456,721</td>
<td>7,204,152</td>
</tr>
<tr>
<td>9</td>
<td>Pangasius catfish (Pangansius/Pangasianodon spp.)</td>
<td>1,388,546</td>
<td>2,009,081</td>
</tr>
<tr>
<td>10</td>
<td>Rohu (Labeo rohita)</td>
<td>1,159,454</td>
<td>1,334,193</td>
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</tbody>
</table>
Pacific white shrimp
(*Penaeus vannamei*)
Vol. = 2,259,183 T
Val. = ~9 Billion US$

Manila Clam
(*Ruditapes philippinarum*)
Vol. = 3,141,851 T
Val. = ~3 Billion US$
Super performers of the Decade

- 3 species achieved most **outstanding** growth
  - Catla (20 % per year)
  - Whiteleg shrimp (99 % per year)
  - Pangas catfishes (29% per year)
Asia-Pacific

- Most are small-scale: farmer-owned/leased, managed and operated.
  - **Indonesia**
    - Freshwater ponds: 0.14 ha
  - **Thailand**
    - Coastal pond: 0.8 ha
    - Freshwater pond: 0.28 ha
  - **Vietnam catfish culture**
    - >55% under 4 ha
    - But production per ha very high, average 350-400 t/ha/crop

_Fw Ponds (517,266) Bw Ponds (182,713)_

DeSilva, 2010
Culture systems: Ponds
Culture Systems: Cages
Culture Systems:

Tanks
Culture Systems:

Integrated System (Rice-Fish)
Aquaculture

- Beset by many problems: environmental, technical (supply of seeds, feed cost, etc.), food safety issues and **diseases**.

- **Disease outbreaks** are one of the serious causes of economic loss in many aquaculture operations around the region.
Aquaculture trends

- Increasing intensification
  - more disease outbreaks and disease emergencies
- Continued diversification of species
  - Increased risk of introduction and spread of pathogens (Trans-boundary pathogens)
- Continued diversification of farming systems
  - Potential for spread of pathogens to wider geographical areas
- Economic and social cost of disease is enormous (e.g. One billion $ annual loss in China)
Serious aquatic animal diseases in the Asia-Pacific

- **Crustaceans**
  - White spot disease (WSD)
  - White tail disease (MrNV)
  - Infectious myonecrosis (IMN)

- Acute hepatopancreatic necrosis syndrome (AHPNS)
Crustacean diseases: WSD

- Most devastating disease of farmed shrimps;
- Infects all cultured shrimps;
- Reported in almost all shrimp-producing countries in the region.
Crustacean diseases: MrNV

- First reported in Thailand in 1987;
- Subsequently in Taiwan, China, India and Vietnam
- Reported in Australia in 2008;
Crustacean diseases: 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.
Spread of IMNV in Indonesia (2006-2011)

- **2006**: 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).
- **2007**: 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 (Banyuangi).
Spread of IMNV in Indonesia (2012)
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 areicosahedral 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).

**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%.

**Clinical:**
- Presence of focal to extensive white necrotic areas in adductor (sternal) muscles, especially in the distal abdominal segment and tail fan, which can become necrotic and reddened in some affected shrimp.
- These signs may leave sudden death following stressors (e.g., capture by cast net, feeding, sudden change in temperature or salinity).

**Histopathology**
- Myonecrosis due to IMNV infection in P. vannamei, H&E stain.
  - A coagulative necrosis of skeletal muscle by haemocytic infiltration and fibrin, in contrast to normal skeletal muscle which can be observed at the upper right corner.
  - Injection sites are dark basophilic inclusion bodies (arrows) observed in skeletal muscle cells.

**Diagnostic Methods**
- Tentative diagnosis by histology (acute and chronic phases).
- Molecular detection of IMNV by in-situ hybridisation, nested RT-PCR, and real time RT-PCR.

**Presence in the Asia-Pacific**

- Originally reported from north-eastern Brazil, the first outbreak in Asia-Pacific was reported in East Java (Bubuto District), Indonesia in May 2005. It was contained in this area until 2008.
- In 2009, however, more districts in East Java were affected including Situ, Banyuwangi, Bima and Malang, as well as some districts in the provinces of Bali, Lampung, West Nusa Tenggara and Central Java.

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

- Collect tissue samples with guidance from Fish Health experts, for submission to accredited national or regional laboratories:
  - best tissue samples for IMNV detection include skeletal (subcutaneous) muscle, connective tissues, haemocysts, and lymphoid organ.
  - For non-invasive testing (can be used for surveillance), haemolymph or excess 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.

**Available for free download at** www.enaca.org
Crustacean diseases: AHPNS

- unusually heavy shrimp mortality approx. within the first 35 days of culture

- This very imprecise case definition that has led to confusion in diagnosis

- Many possible causes including diseases of well-known pathogens like WSSV & YHV

Source: T Flegel
AHPNS histopathology

- Sloughing of HP cells
- Lack of E-cell mitosis
- Lack of B, F & R cells
- Enlarged HP nuclei
- Hemocytic infiltration
- 2° bacterial infection

Source: T. Flegel
Causative agent:

**Vibrio parahaemolyticus**
History of outbreaks

- First seen in China in latter part of 2009 (officially reported in 2010) and then in Vietnam in 2010

- Next reported from Malaysia in 2011

- Reported from Thailand (eastern Gulf of Thailand) in 2012
History of outbreaks

- May 2013: Mexico
NACA Regional Response to EMS/AHPNS
Recognizing the problem

- Alerting NACA Regional Advisory Group, OIE and FAO to the emerging threat of EMS in Mekong Delta of Vietnam in April 2011
- NACA AG discussed the issue in AGM 10 in Nov 2011
Alerting CA’s

- Formal NACA circular to CA’s of all member governments in May 2012
- Development and wide dissemination of EMS/AHPNS Disease advisory in May 2012
DISEASE ADVISORY

Early Mortality Syndrome (EMS)/Acute Hepatopancreatic Necrosis Syndrome (AHPNS): An emerging threat in the Asian shrimp industry

Eduardo M. Lealio and C.V. Mohan
NACA, Bangkok, Thailand

The Asia-Pacific region, being the top producer of aquaculture products in the world, is continuously beset by emerging aquatic animal disease problems causing high mortalities and economic losses among small farmers as well as commercial producers. Over the last couple of decades, several diseases (e.g. luminous vibriosis, white spot syndrome, yellowhead disease, Taura syndrome) have caused significant devastation in the shrimp aquaculture of the region, causing the collapse of some industries (e.g. Penaeus monodon). Recently, a new/emerging disease known as early mortality syndrome (EMS) in shrimp (also termed acute hepatopancreatic necrosis syndrome or AHPNS) has been reported to cause significant losses among shrimp farmers in China (2009), Vietnam (2010) and Malaysia (2011). It was also reported to affect shrimp in the eastern Gulf of Thailand (Flegel, 2012).

The disease affects both P. monodon and P. vannamei and is characterized by mass mortalities (reaching up to 100% in some cases) during the first 20-30 days of culture (post-stocking in grow-out ponds). Clinical signs observed include slow growth, corkscrew swimming, loose shells, as well as pale coloration. Affected shrimp also consistently show an abnormal hepatopancreas (shrunken, small, swollen or discoloured). The primary pathogen (considering the disease is infectious) has not been identified, while the presence of some microbes including Vibrio, microsporidians and nematode has been observed in some samples. Lightner et al. (2012) described the pathological and etiological details of this disease. Histological examination showed that the effects of EMS in both P. monodon and P. vannamei appear to be limited to the hepatopancreas (HP) and show the following pathology:

1) Lack of mitotic activity in generative E cells of the HP;
2) Dysfunction of central hepatopancreatic B, F and R cells;
3) Prominent karyomegaly and massive sloughing of central HP tubule epithelial cells;
4) Terminal stages including massive intertubular hemocytic aggregation followed by secondary bacterial infections.

Similar histopathological results were obtained by Prachumwat et al. (2012) on Thai samples of P. vannamei collected from Chanthaburi and Rayong provinces in 2011 and early 2012 (Figure 1). The progressive dysfunction of the HP results from lesions that reflect degeneration and dysfunction of the tubule epithelial cells that progress from proximal to distal ends of HP tubules. This degenerative pathology of HP is highly suggestive of a toxic etiology, but anecdotal information suggests that disease spread patterns may be consistent with an infectious agent.

In China, the occurrence of EMS in 2009 was initially ignored by most farmers. But in 2011, outbreaks became more serious especially in farms with culture history of more than 5 years and those closer to the sea using very saline water of 20 (Pakporn, 2012). Shrimp farming in Hainan, Guangdong, Fujian and Guangxi suffered during the first half of 2011 with almost 80% losses.

Summary:
The emerging disease early mortality syndrome (EMS) has caused huge losses among shrimp farmers in China, Vietnam, Malaysia and Thailand. Affecting both P. monodon and P. vannamei, EMS is characterized by mass mortalities during the first 30 days of culture. Clinical signs include slow growth, corkscrew swimming and pale coloration. Affected shrimp consistently show abnormal hepatopancreases. No causative pathogen has been found for EMS. Its spread points to the need for increased awareness and cooperative reporting.

Serious Losses
In China, the occurrence of EMS in 2009 was initially ignored by most farmers. However, in 2011, outbreaks became more serious especially in farms with a culture history of more than 5 years and those closer to the sea using very saline water of 20 (Pakporn, 2012). Shrimp farming in Hainan, Guangdong, Fujian and Guangxi suffered during the first half of 2011 with almost 80% losses.

Global Aquaculture Advocate;
July/August 2012
Convening of Emergency Regional Consultation

Convening of Asia Pacific emergency regional consultation (9-10 August 2012), Bangkok with support from DAFF, Australia

- 17 global shrimp experts
- 40 national delegates representing CA and lead research institutions
- 10 regional/international institutions; national universities
- 8 private sector representatives
Technical Report on AHPNS

- Technical report preparation and wider dissemination
  - Latest updates and review of status
  - Case definition at animal and pond level
  - R&D directions
  - Recommendations for national and regional levels
Disease Card

- Development and dissemination of AHPNS Disease Card
  - To harmonize research effort
  - To provide information to support disease surveillance
  - To support outbreak investigations
Prior to identification of the causative agent
• Asia Regional Advisory Group on Aquatic Animal Health (AG): decided and agreed to include AHPNS in QAAD Reporting under the non-OIE list of diseases for crustaceans;

• Purpose: gain more information about AHPNS within the region.
<table>
<thead>
<tr>
<th>Item</th>
<th>Disease status</th>
<th>Level of diagnosis</th>
<th>Epidemiological comment numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISEASES PREVAILING IN THE REGION</td>
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<tr>
<td>FINFISH DISEASES</td>
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<tr>
<td>OIE-listed diseases</td>
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</tr>
<tr>
<td>1. Epizootic haematopoetic necrosis</td>
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<tr>
<td>2. Infectious haematopoetic necrosis</td>
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<td>3. Spring viruria of carp (SVC)</td>
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<td>4. Viral haemorrhagic septicaemia (VHS)</td>
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<td>5. Epizootic ulcerative syndrome (EUS)</td>
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<td>6. Red seabream iridoviral disease (RSID)</td>
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<td>7. Koi herpesvirus disease (KHV)</td>
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<td>Non OIE-listed diseases</td>
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<td>8. Grouper iridoviral disease</td>
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<td>9. Viral encephalopathy and retinopathy</td>
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<td>10. Enteric septicemia of catfish</td>
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<tr>
<td>1. Infection with Bonamia exigua</td>
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<td>2. Infection with Perkinsia osleri</td>
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<td>3. Infection with abalone herpesvirus</td>
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<td>5. Infection with M. chunghensean¢</td>
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<td>6. Acute viral necrosis in scallops</td>
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<td>7. Akoya oyster disease</td>
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<td>CRUSTACEAN DISEASES</td>
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<tr>
<td>OIE-listed diseases</td>
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<tr>
<td>1. Taura syndrome (TS)</td>
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<td>2. White spot disease (WSD)</td>
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<td>3. Yellowhead disease (YHD)</td>
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<td>4. Infectious hypodermal and haematopoetic necrosis (IHHN)</td>
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<td>5. Infectious myonecrosis (IMN)</td>
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<td>6. White spot disease (WSD)</td>
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<td>7. Necrotising hepatopancreatitis (NHP)</td>
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<td>8. Milky haemolymph disease of spiny lobster (Panulirus spp.)</td>
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</table>

Non OIE-listed diseases

8. Milky haemolymph disease of spiny lobster (*Panulirus* spp.)
9. *Monodon* slow growth syndrome
10. Acute hepatopancreatic necrosis syndrome (AHPNS)
Follow-up Disease Advisory

• To address the many circulating false and baseless speculations on the effects and spread of AHPNS in the region.

Acute Hepatopancreatic Necrosis Syndrome (AHPNS): Status Update

Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand

Post-EMS/AHPNS Regional Consultation

Since the Asia Pacific Emergency Regional Consultation on EMS/AHPNS held in August 2012 in Bangkok, Thailand, many news reports have been widely circulated that have led to various baseless speculations and conclusions on the true nature of AHPNS. The disease, as previously reported, has been affecting shrimps in four Asia-Pacific countries (China, Vietnam, Malaysia and Thailand), with the greatest production losses reported in Vietnam. Given the uncertainty regarding the various causes of early mortality, Thai farmers have consulted with experts and government officials and agreed at a national meeting on 28 February 2013 to implement more stringent pond biosecurity and management measures, to focus on post larvae (PL) quality and to stock only PL10 or higher, until the causes are clarified.

To this date, the case definition (both at farm and animal levels) developed by Prof. Donald Lightner is still the sole basis for proper diagnosis of the disease (refer to AHPNS Disease Card; http://www.enaca.org/modules/library/publication.php?publication_id=1060). It was also established in various expert investigations that the disease only affects younger shrimps, usually within the first 35 days after stocking in grow-out ponds. Thus, reports that the disease is also killing broodstock shrimp are baseless, and such reports should not be circulated unless scientific investigations have been done to prove that mortalities were caused by the same disease.

Unconfirmed Outbreaks

NACA has also received several reports on early mortality in shrimps from other countries in the region. These, however, were unconfirmed reports as confirmatory diagnosis (by histopathology) was not performed. In response to this, the Asia Regional Advisory Group on Aquatic Animal Health (AG) has decided to include AHPNS in the list of reportable diseases for QAAD (Quarterly Aquatic Animal Disease) Reporting in Asia-Pacific starting in the first quarter of 2013. This is for the sole purpose of gaining more information about the disease within the region (NACA, 2012. AGM 11: Report of the Meeting; http://www.enaca.org/modules/library/publication.php?tag_id=362&label_type=1&title=advisory-group-on-aquatic-animal-health).

@NACA March 2013
## QAAD Report: 2Q 2013

<table>
<thead>
<tr>
<th>Non OIE-listed diseases (Crustaceans)</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Level of diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute hepatopnacreatic necrosis syndrome (AHPNS)</td>
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<tr>
<td>Australia</td>
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<td>China</td>
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<td>India</td>
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<td>Japan</td>
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<td>Korea, Republic of</td>
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<td>Lao PDR</td>
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<td>Sri Lanka</td>
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<tr>
<td>Thailand</td>
<td>+( )</td>
<td>+( )</td>
<td>+( )</td>
<td>II</td>
</tr>
<tr>
<td>Vietnam* (1Q 2013 report)</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>I,II,III</td>
</tr>
</tbody>
</table>

*** No information available
0000 Never reported
?( ) Suspected but not confirmed in a zone
+( ) Occurrence limited to certain zone

QAAD Report: 2Q 2013

NACA
Serious aquatic animal diseases in the Asia-Pacific

- Finfishes
  - Epizootic ulcerative syndrome (EUS)
  - Koi herpesvirus disease (KHV)

- Viral nervous necrosis (VNN)
- Grouper iridoviral disease (GIV)
Finfish diseases: EUS

- Very common in wild and cultured fish;
- Snakeheads, puntius, catfishes, Indian major carps are among the highly susceptible;
- Caused by *Aphanomyces invadans* (primary pathogen)

2006: Zambezi River system in southern Africa (Andrew et al., 2008. Veterinary Record, 63:629-631)
Finfish diseases: KHV

- First reported in Japan, then spread to many countries in the region;
- Major problem in Indonesia (cage culture in reservoirs);
- First listed in QAAD in 2004; listed in OIE in 2007;
- Can cause mass mortalities among common carp and koi carp.
Finfish diseases: VNN

- Delisted from OIE list in 2006;

- Reported to affect at least 30 marine fish species with great impacts on seabass, groupers, jacks, puffers and flatfishes;

- Common in many countries in the region and other parts of the world;
Finfish diseases: GIV

- Listed in QAAD since 2004;
- Affects all life stages of groupers (from fry to marketable size fish);
- Officially reported from Hong Kong, Republic of Korea, Indonesia, Vietnam, Singapore and Taiwan.
Other important/emerging diseases:

*Streptococcus agalactiae* infection in Tilapia (China, Indonesia, Thailand, Malaysia, Bangladesh, Hong Kong, Korea, Philippines, Singapore, Vietnam)

Enteric septicaemia of catfish, caused by *Edwardsiella ictaluri*
Other important/emerging diseases:

*Nocardia* and *Tenacibaculum maritimum* infections in marine fishes

(Australia, China, Indonesia, Japan, Thailand, Malaysia, Korea, Philippines, Singapore, Vietnam, Taiwan)
Other important/emerging diseases:

- Monodon slow growth syndrome (Thailand)

- Abdominal segment deformity disease (ASDD) (Thailand, Malaysia and Indonesia)

Sakaew et al. 2008
Other important/emerging diseases:

Ganglionueritis in abalone (Australia)

Ranavirus in frogs and some freshwater fishes (Thailand, China and Japan)
Other important/emerging diseases:

- **Finfish**
  - *Edwardsiella tarda* in marine species
  - “BB” or big belly (new *Vibrio* species??)
  - *Streptococcus iniae* in marine and also freshwater species
  - *Francisella* sp. in Tilapia in Indonesia
  - Red spot disease in grass carp (GCRV)
  - Red spot disease in Tilapia??

- **Crustaceans**
  - Loose Shell syndrome in *P. monodon*
  - bamboo shrimp syndrome in *P. vannamei*
Thank you... 

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