Overview of Emerging Disease Issues and New Discoveries

Dr Kelly Bateman

Centre for Environment
Fisheries & Aquaculture
Science

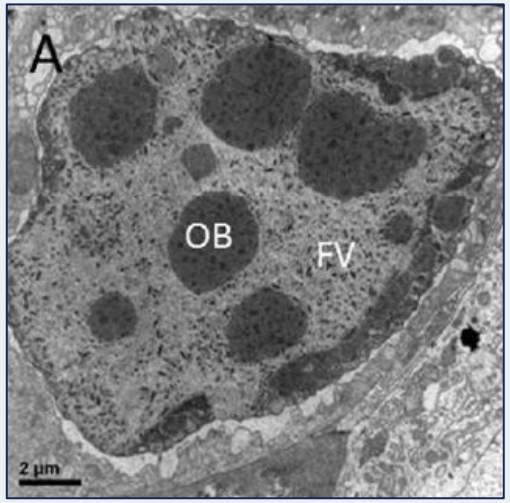
Cefas

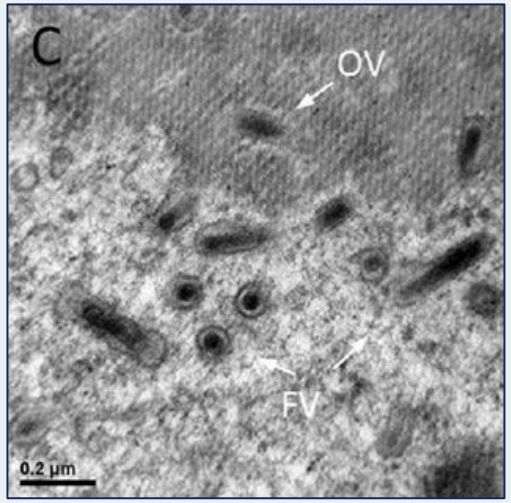
Monodon Baculovirus (MBV) – Penaeus monodon Nudivirus (PmNV)

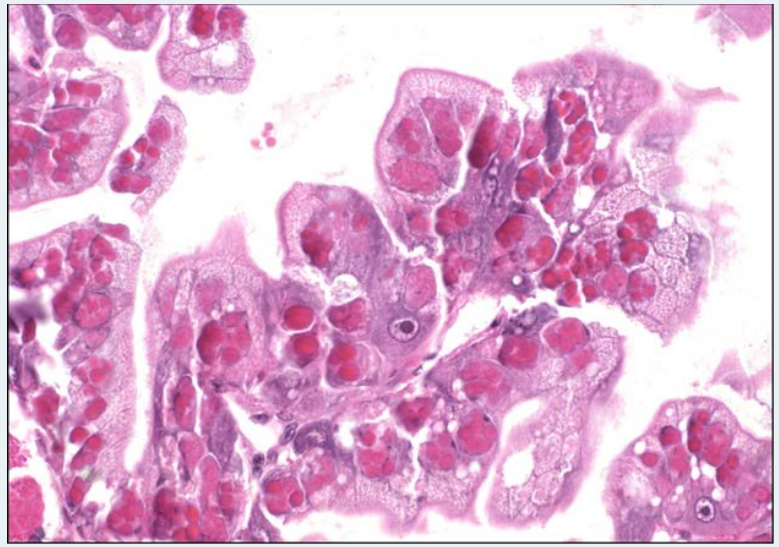
OIE Delisted

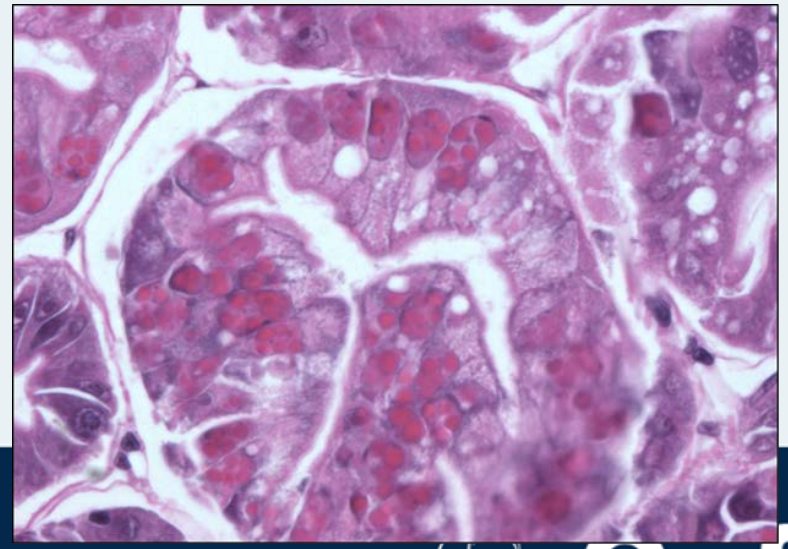
Agent Description

- Initially thought to be Baculovirus
- Family: *Nudiviridae,* Genus: *Gammanudivirus*
- dsDNA, 120 kbp
- Rod-shaped, enveloped particles, 74 x 270 nm, occluded virus
- First reported in Taiwan in 1981, *P. monodon*
- Spherical inclusion bodies within nuclei of hepatopancreatic epithelial cells









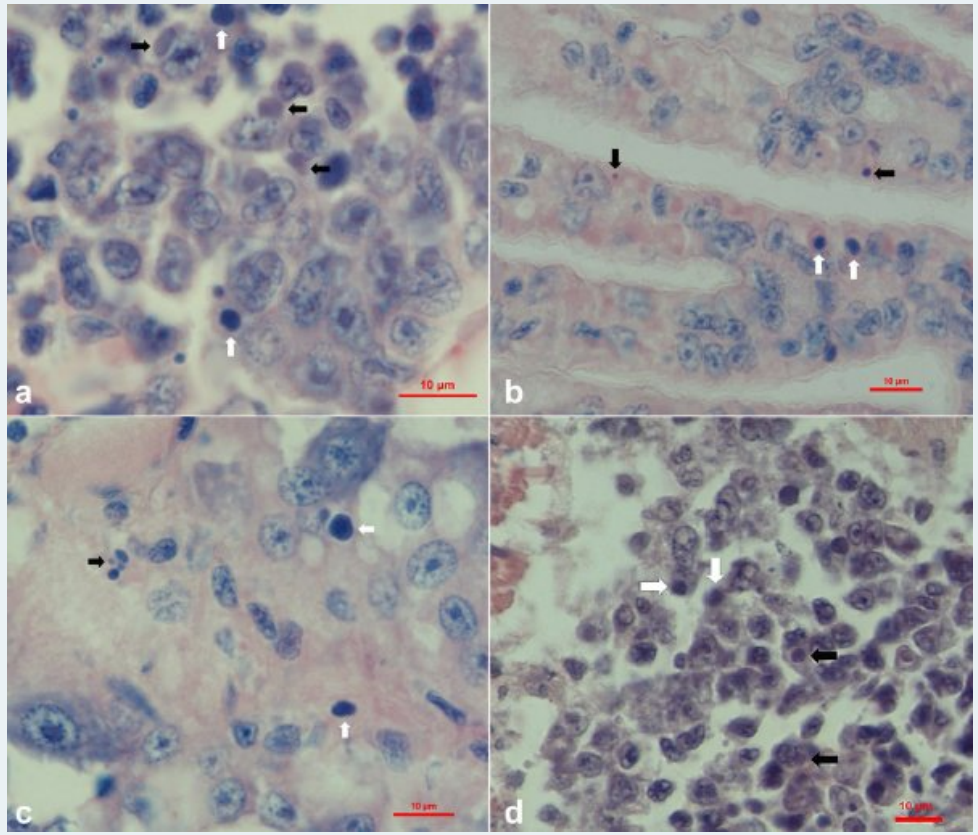
Yang *et al*., 2014, BMC Genomics, 15, 1 - 24

Emerging?

Shrimp Hemocyte Iridescent Virus (SHIV)

Agent Description

- Shrimp Hemocyte Iridescent virus (SHIV)
- Family: *Iridoviridae,* new genus
- 160 – 140 nm, non-enveloped, icosahedral particles
- 140 - 303 kbp genome, dsDNA virus
- Sequence similarity with Cherax quadricarinatus iridescent virus (CqIV)
- Initially described in 2014, massive mortality of *P. vannamei* in China
- Clinical signs: empty stomach and guts, pale hepatopancreas and soft shell
- Histology: pyknosis and basophilic inclusions in haematopoietic tissue and haemocytes
- Susceptible species: *P. vannamei, Fenneropenaeus chinensis and Macrobrachium rosenbergii*



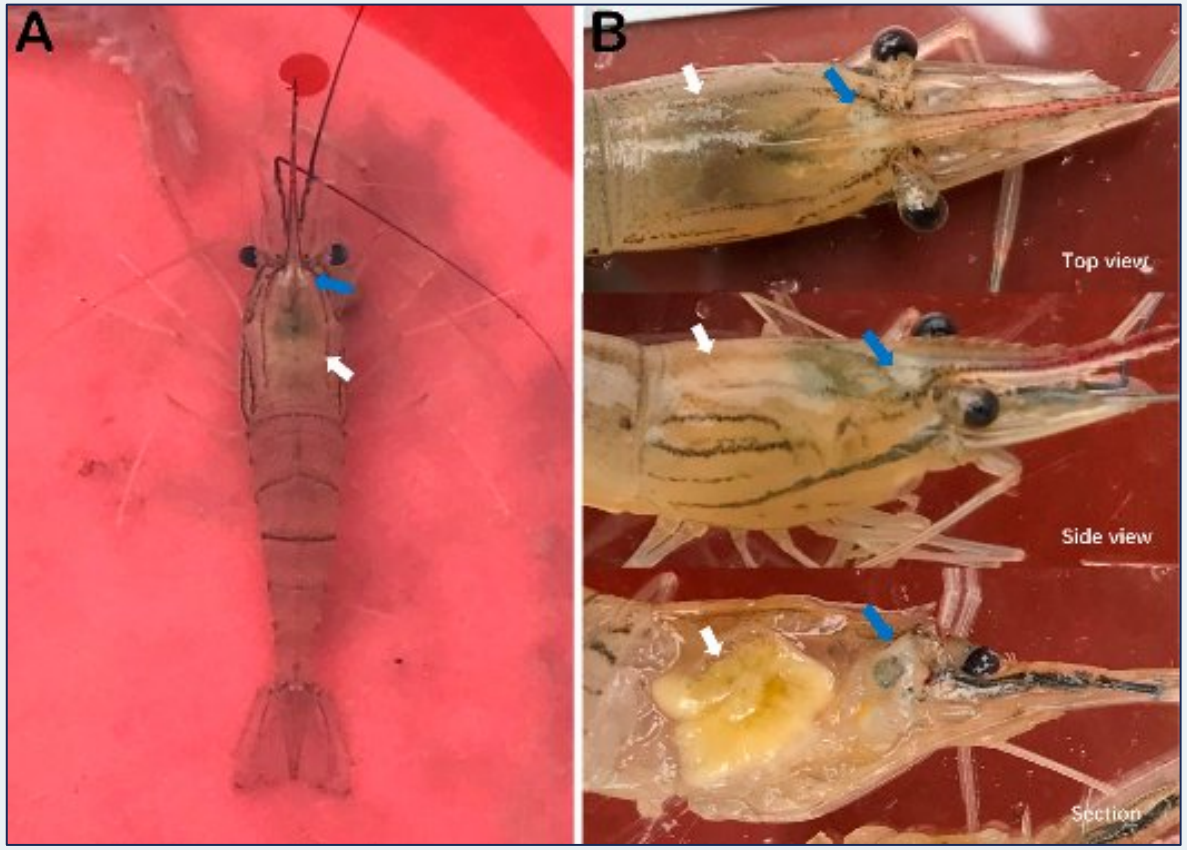
Discussion at OIE

SHIV = Decapod Iridescent Virus 1 (DIV1)

- ICTV suggested renaming – Simian HIV (SHIV)
- Family *Iridoviridae*
- Novel genus *Decapodiridovirus*
- qPCR assay available

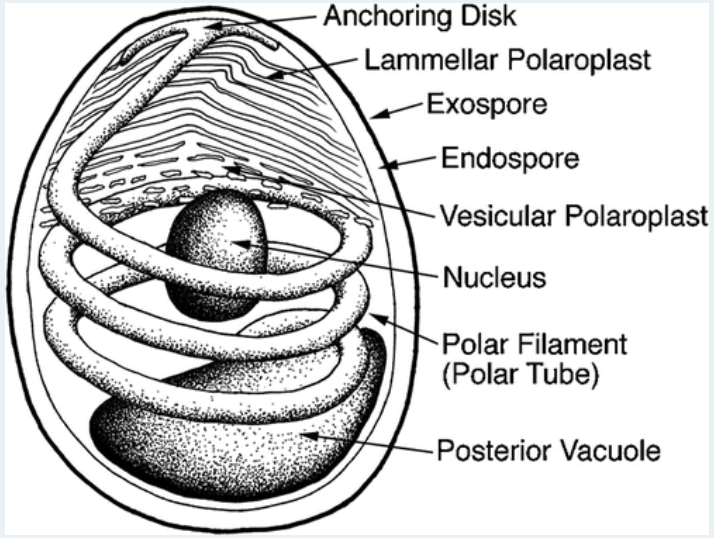
- Currently being reviewed by OIE

- "White head" shown to be main symptom in *M. rosenbergii*
- Cumulative mortality 80%
- Polyculture with *P. vannamei*
- *M. nipponense, Exopalaemon carinicauda* and *Procambarus clarkii* also shown to be susceptible
- Polyculture with different species of crustacea discouraged
- Threat to wild populations unclear

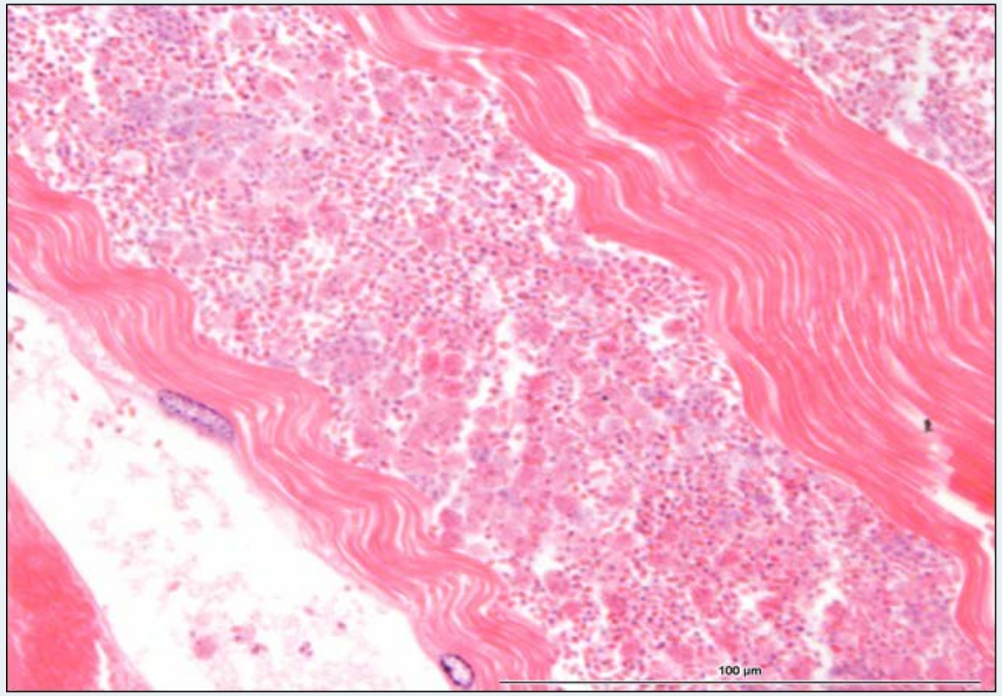


Microsporidia

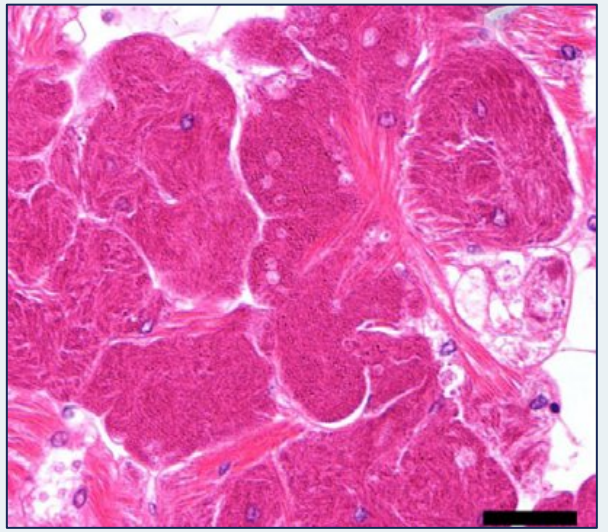
- Diverse phylum of divergent Fungi
- Almost 200 genera described to date, half from aquatic hosts
- Growing (meront) and dividing (sporont) stages, and spores
- Intracellular or (rarely) intranuclear
- Obtain energy directly from the cell (amitochondriate)
- Replace host cell organelles (though mitochondria remain intact in late stages)
- Mild infection to patent disease and death
- Clinical signs in aquatic hosts

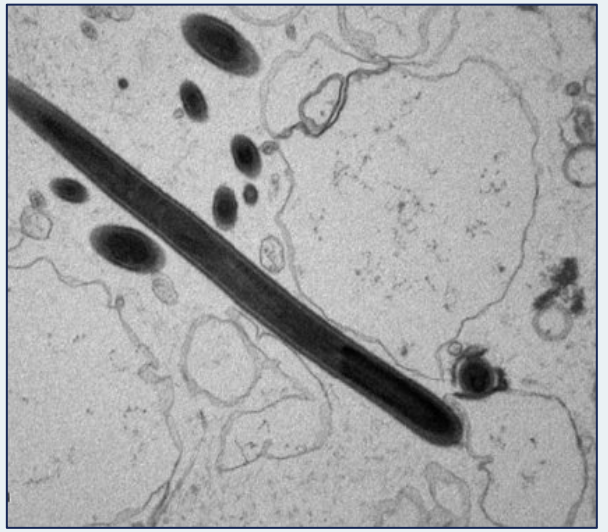


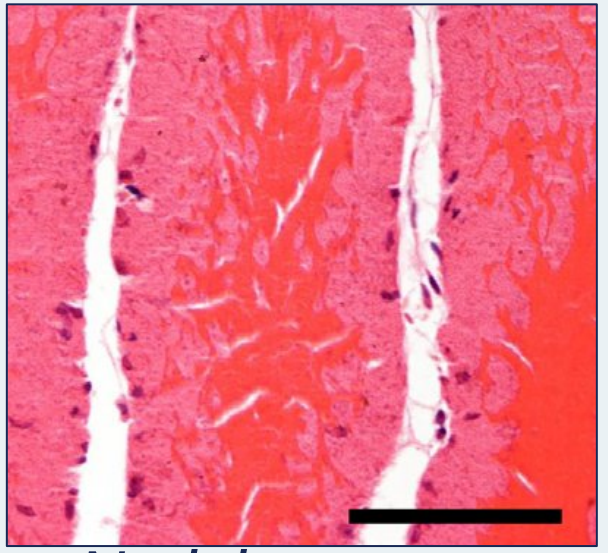
Muscle Infections



Thelohania spp.

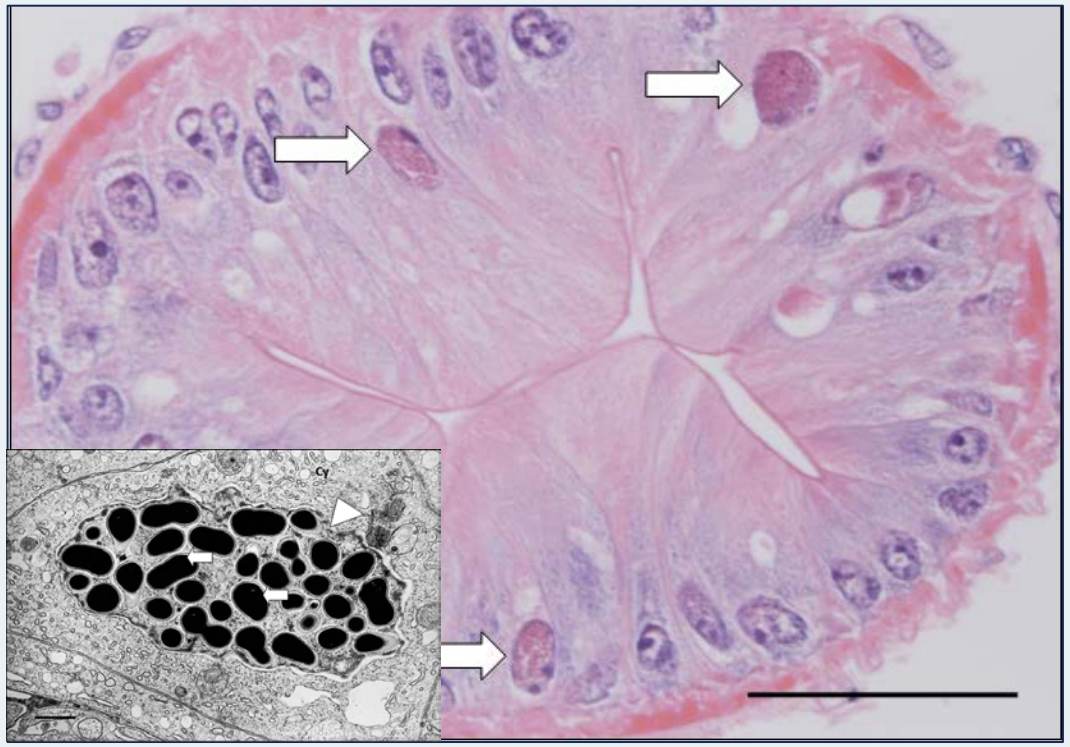




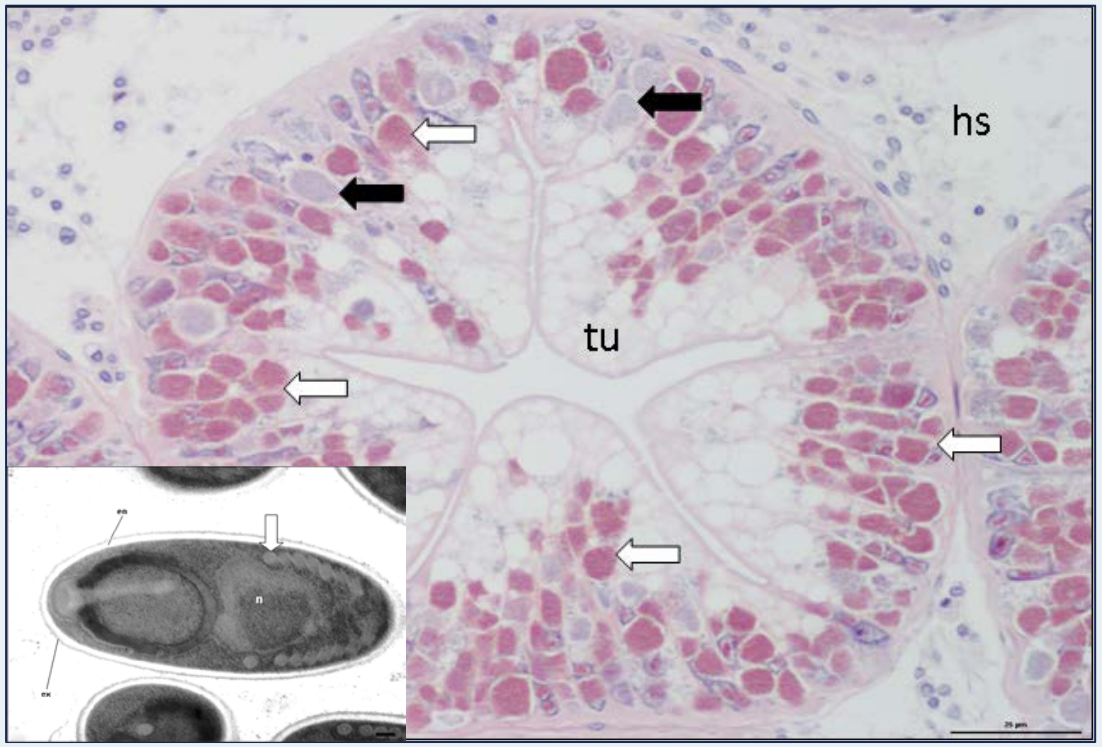


Nadelspora canceri or *Ameson pulvis?*

Hepatopancreas Infections



Enterospora canceri



Hepatospora eriocheir

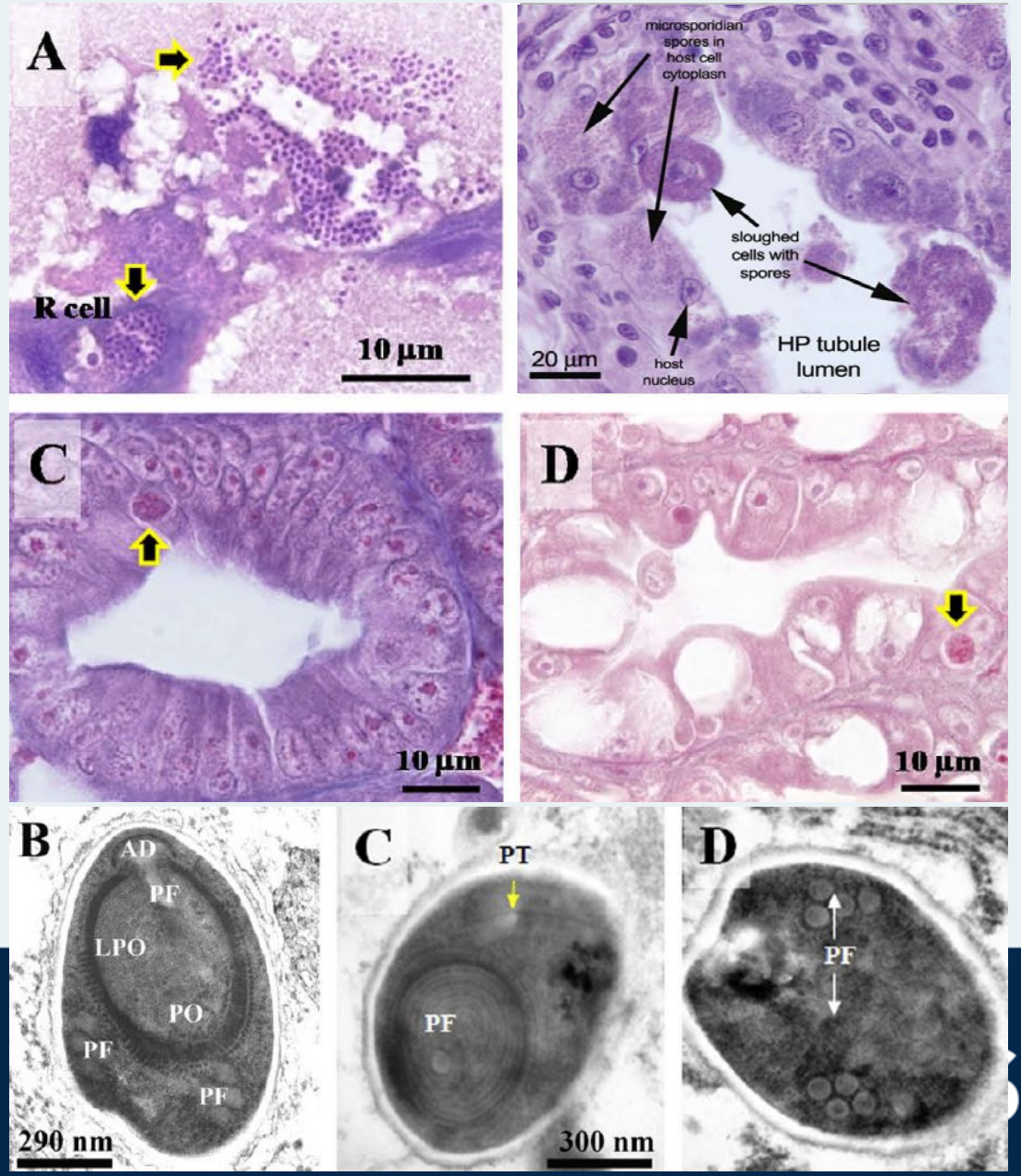
Stentiford *et al*., 2007, Diseases of Aquatic Organisms, 75, 61 – 72
Stentiford *et al*., 2011, Journal of Invertebrate Pathology, 108, 156-166
Bateman *et al*., 2016, Parasitology, 143, 971 – 982

Enterocytozoon hepatopenaei (EHP) – Hepatopancreatic microsporidiosis

OIE?

Agent Description

- Microsporidian parasite
- Microsporidia are obligate, intracellular parasites, fungi
- Spores measure 1 x 0.6 nm, possess polar filament with 4 – 5 coils
- Infects the tubule epithelial cells of hepatopancreas
- Initially described in 2004, *P. monodon* in Thailand
- Clinical signs: infection suspected in shrimp with retarded growth
- Histology: presence of cytoplasmic, basophilic inclusions containing clusters of elliptical to ovoid spores
- Susceptible species: *P. monodon*, *P. vannamei, P. japonicus*

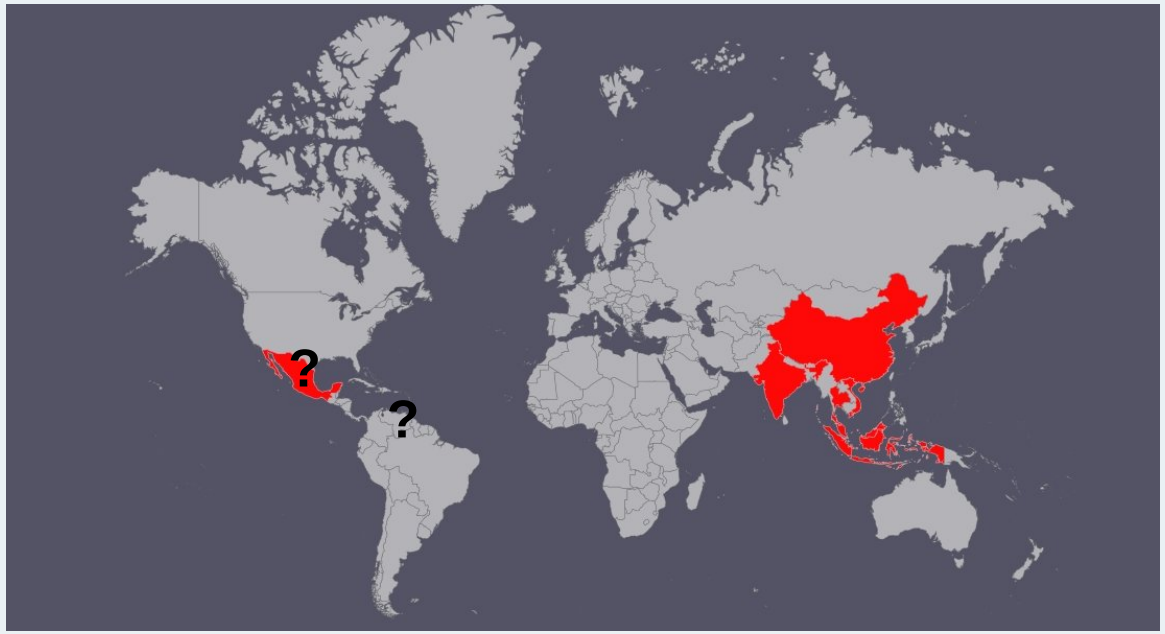


Centre for Environment Fisheries & Aquaculture Science

Tourtip *et al*., 2009, Journal of Invertebrate Pathology, 102, 21 - 29

Enterocytozoon hepatopenaei (EHP) – Hepatopancreatic microsporidiosis

OIE?



Emergence in Americas

Anecdotal evidence of AHPND in illegal imports in Mexico – EHP and AHPND shown together…

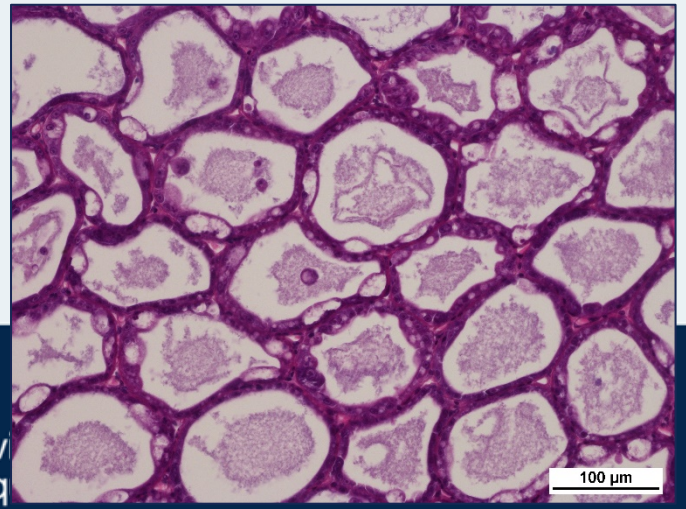
Venezuela - similar but not identical to Asian isolate (99% identity with 18S rRNA, 93% identity with β-tubulin, 91% identity with spore wall protein)

True EHP? Or similar pathogen?

More work is needed…

Sritunyalucksana *et al*., 2015, Aquaculture Asia, 1, 31 - 32
Tang *et al*., 2017, Aquaculture, 480, 17 - 21

White Faeces Syndrome (WFS)



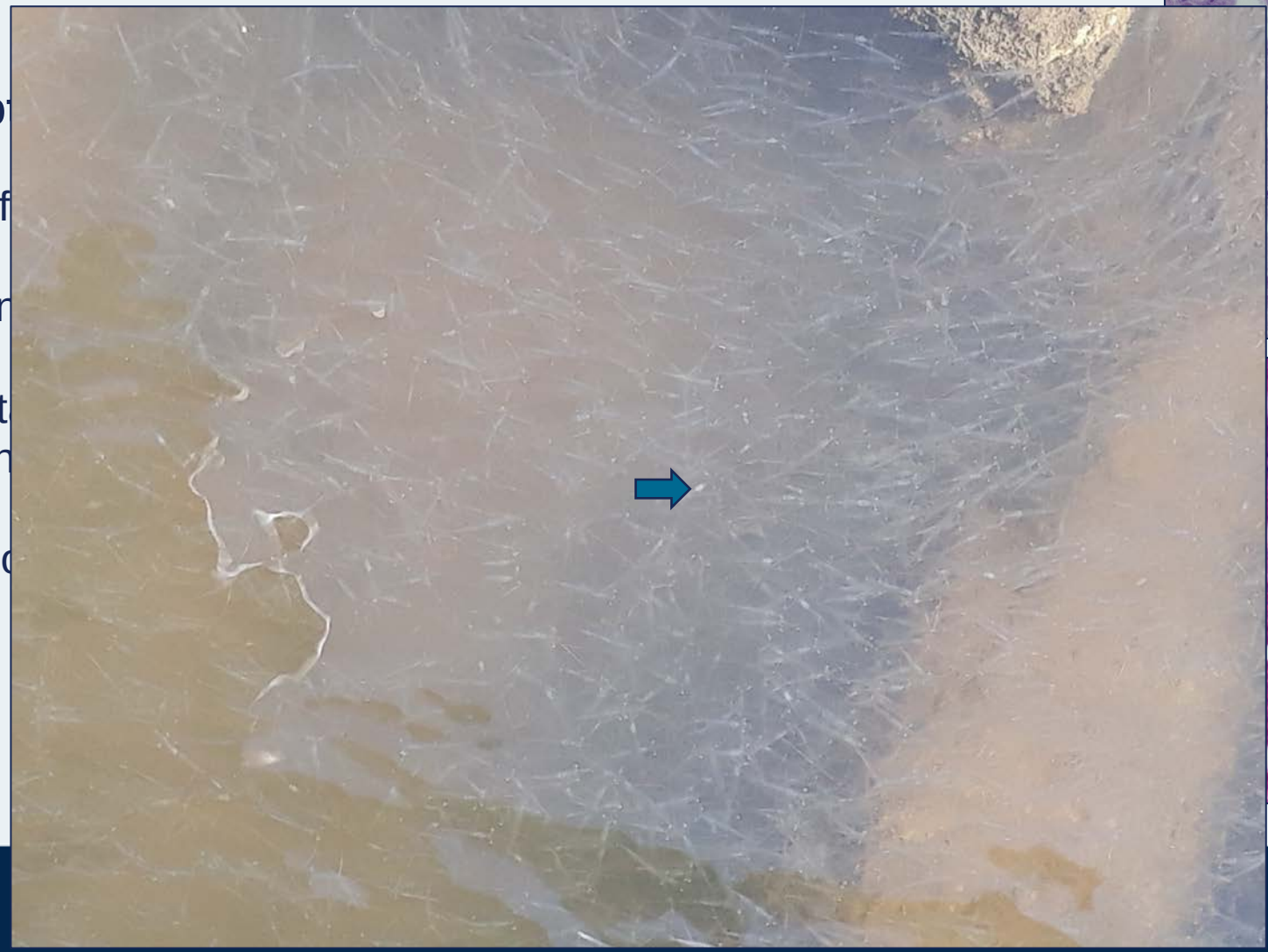
Emergence in Asia

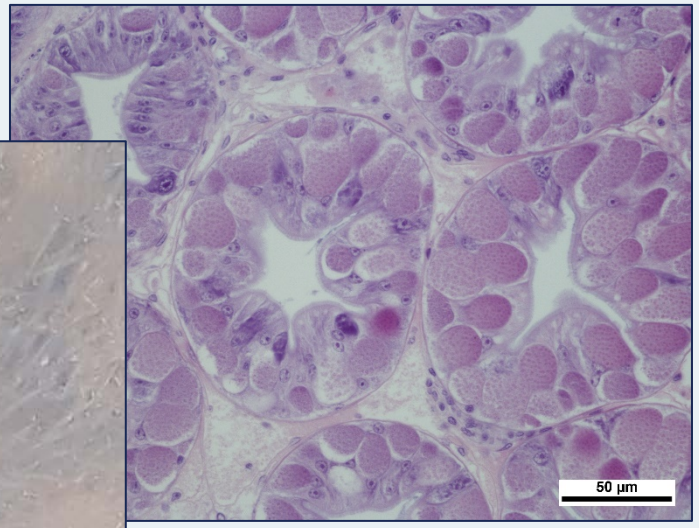
- White faecal strings floating in ponds
- Affects both *L. vannamei* and *P. monodon*
- Microvilli are stripped from HP tubules and gut
- Multiple possible causes reported – AHPND, EHP, Gregarines, Bacteria, Algae…

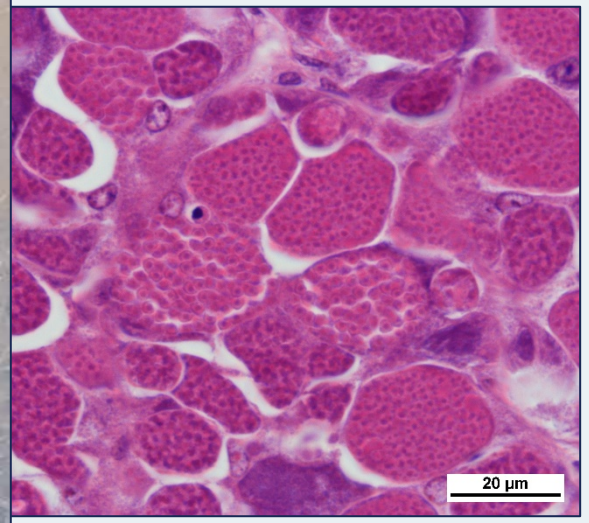
Haplosporidian – Jelly Shrimp (*Acetes sibogae australis*)

Agent Descript

- Gross signs of
- Infection within
- Uninucleate st
  stages followin
- Classification







Microsporidian – Jelly Shrimp

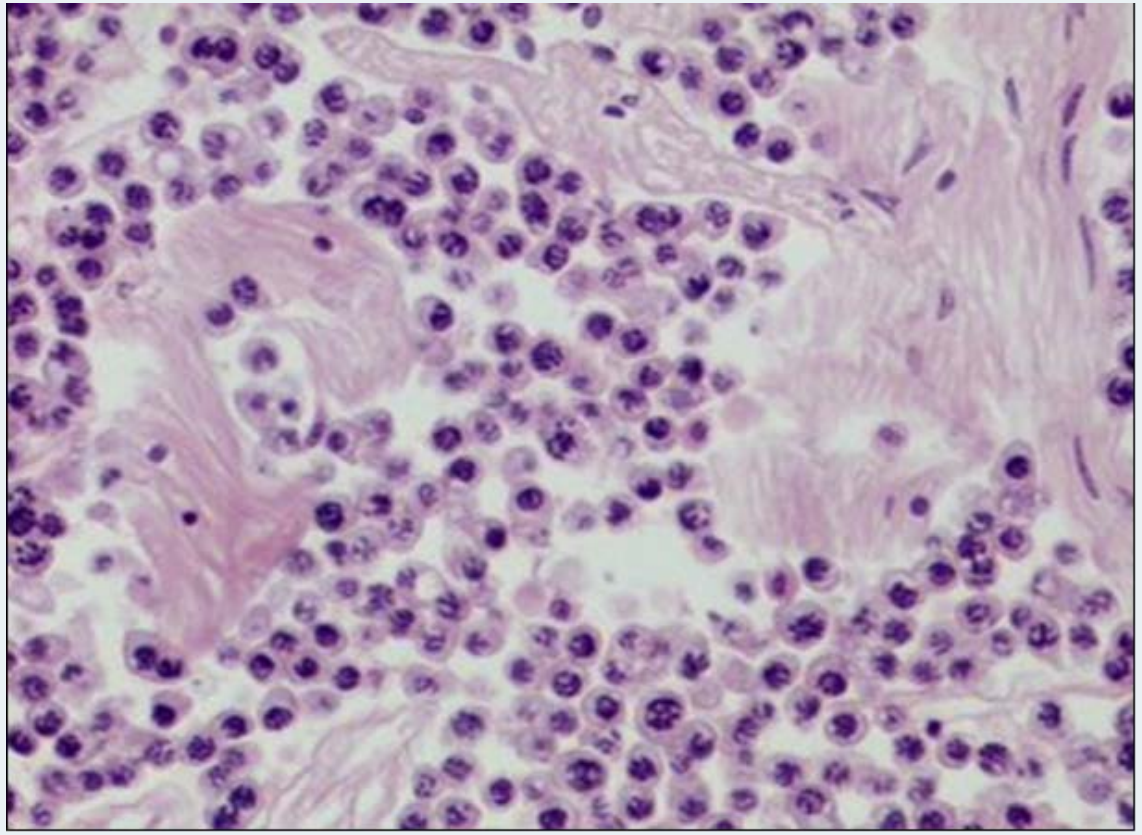
Agent Description

- Co-infection within hepatopancreas tubules
- Develops within the cell nuclei
- Preliminary molecular data suggests similarities with EHP
- Classification ongoing

Hematodinium spp.

Agent Description

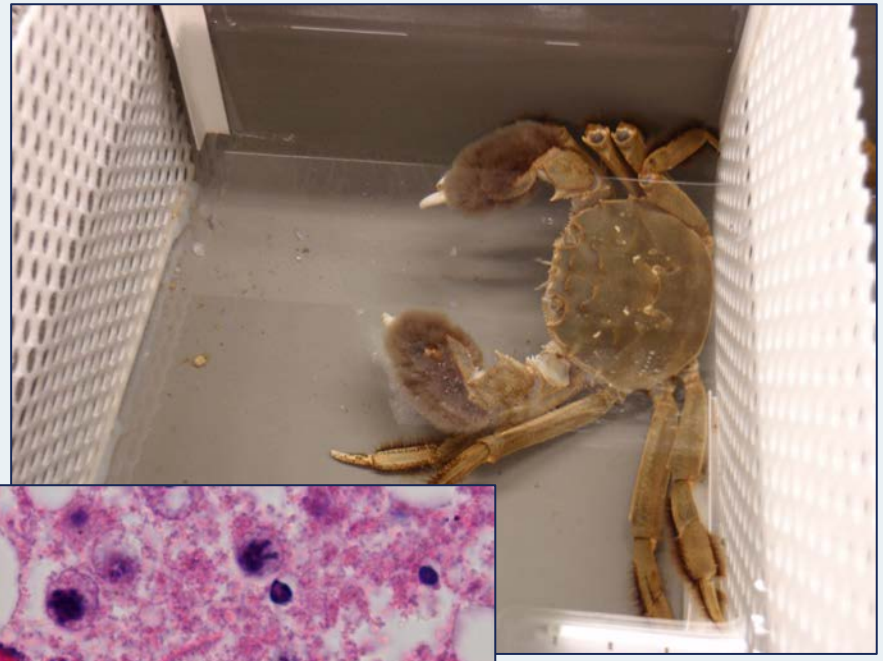
- Parasitic dinoflagellate
- Can cause hyperpigmentation of carapace – “cooked”
- Opaque to cream coloured haemolymph in heavily infected animals
- Commonly found infecting marine crustacea
  - *Nephrops norvegicus*
  - *Cancer pagurus* (Pink Crab Disease (PCD))
  - *Callinectes sapidus, Chionectes sp.* (Bitter crab disease)
  - *Carcinus maenas* – type species

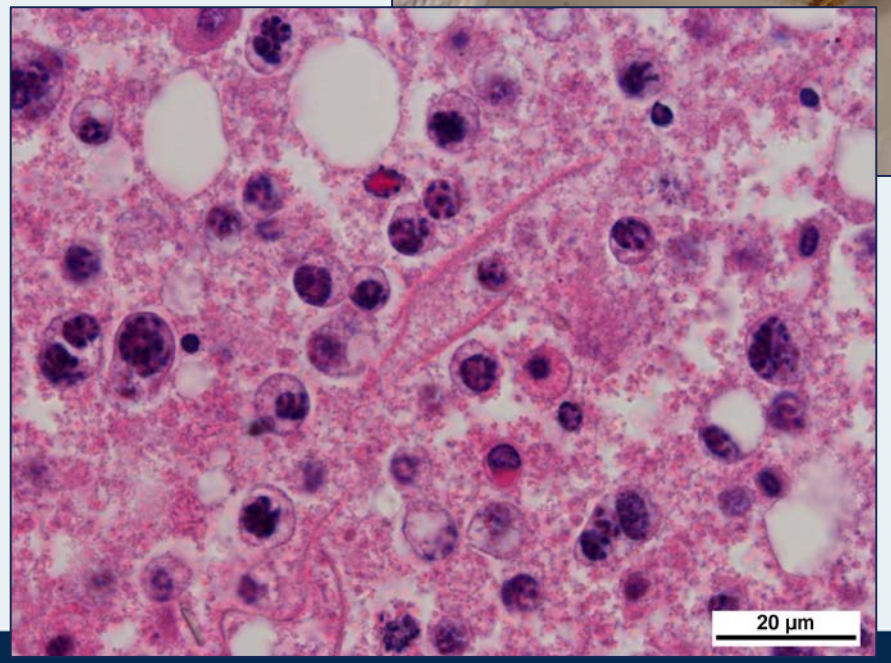


Stentiford & Shields, 2005, Diseases of Aquatic Organisms, 66, 47 - 70
Stentiford *et al*., 2002, Journal of Invertebrate Pathology, 79, 179 -

Hematodinium spp.

- Discovered within Chinese mitten crabs (*Eriocheir sinensis*) within River Thames, London, UK
- Sequencing results pending…

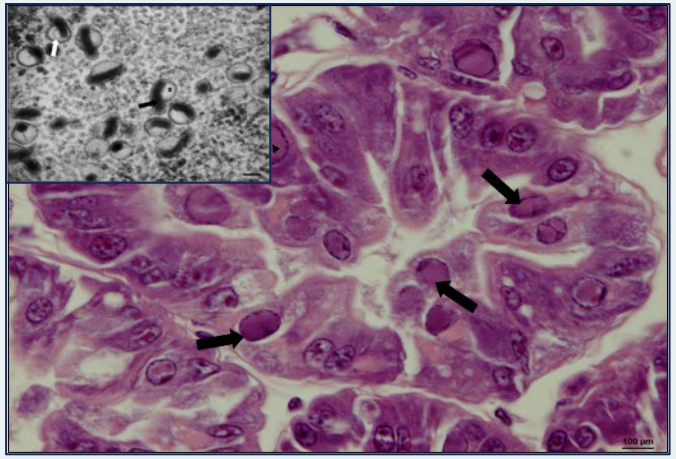




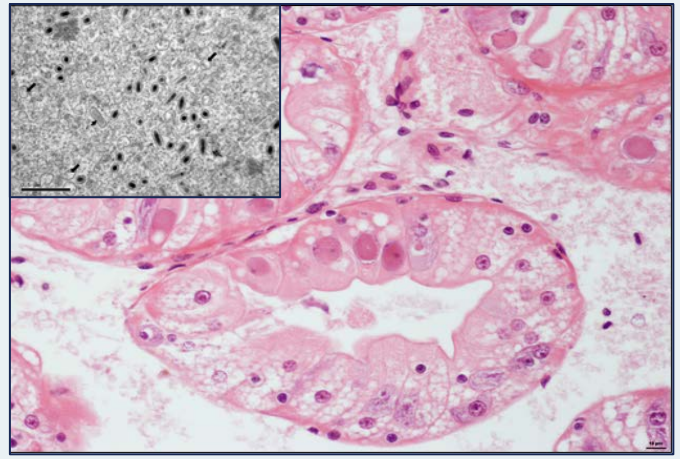
Nudiviridae

Agent Description

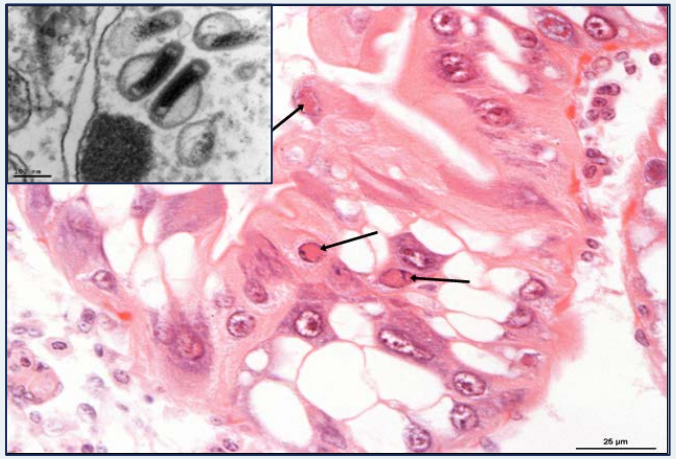
- DNA Virus, Family *Nudiviridae*, Genus *Gammanudivirus*
- Affects hepatopancreatic epithelial cells
- Hypertrophied nuclei with eosinophilic inclusions
- Rod shaped virions, bulbous envelope extension at one end
- Affects most crustacean species
- Classifications needed to confirm each case



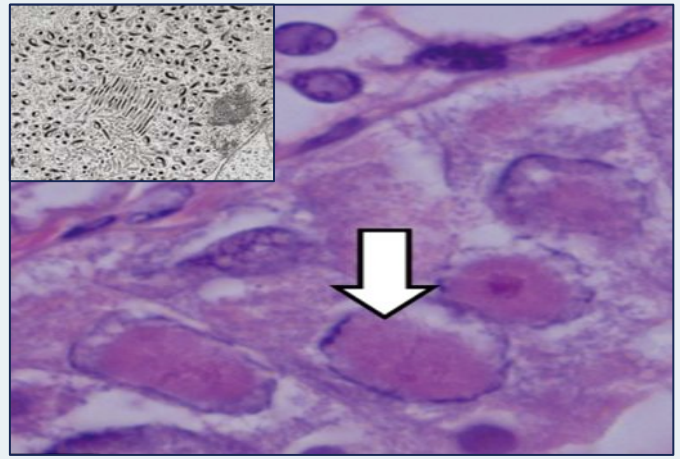
Crangon crangon Nudivirus



Cherax quadricarinatus Nudivirus



Cancer pagurus Nudivirus



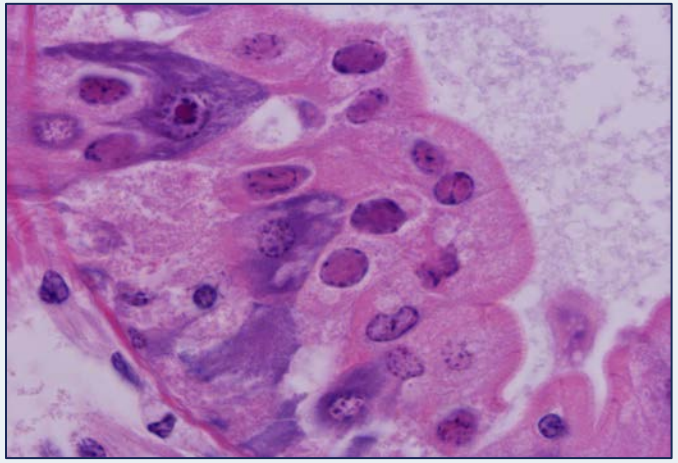
Carcinus maenas Nudivirus

Bateman & Stentiford, 2008, Diseases of Aquatic Organisms, 79, 147 – 151
Stentiford *et al*., 2004, Diseases of Aquatic Organisms, 58, 57 – 68

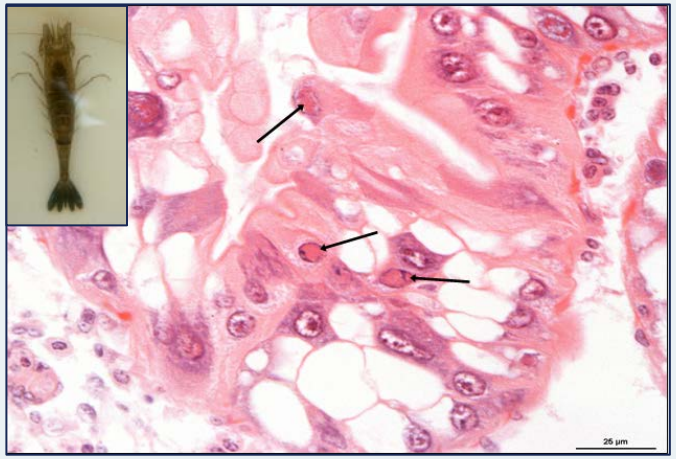
Nudiviridae

Agent Description

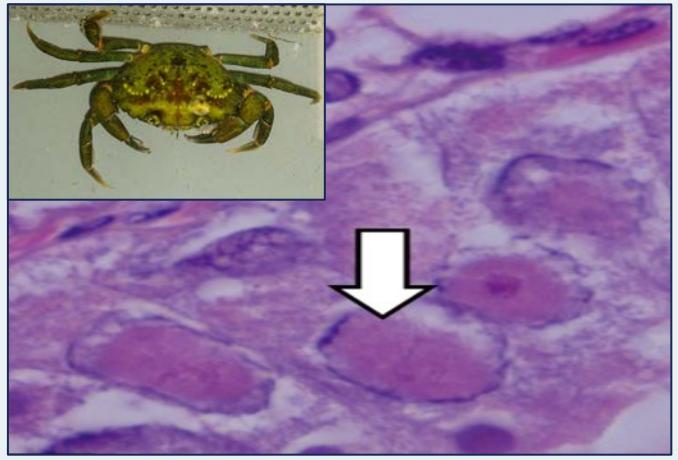
- Full genomes of three more species
- First virus described in clawed lobster
- Publications pending…
- Likely to be plenty more!



Homarus gammarus Nudivirus



Crangon crangon Nudivirus



Carcinus maenas Nudivirus