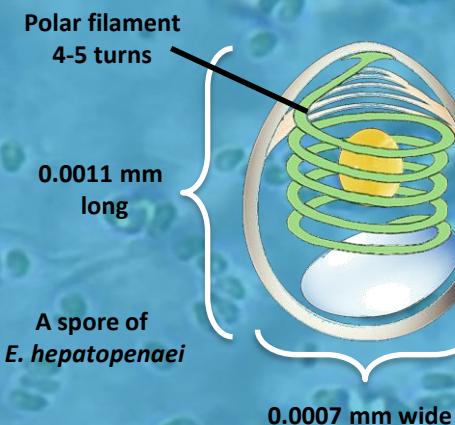


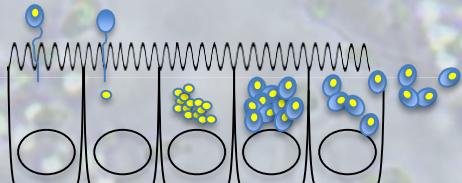
EHP: fact sheet

What is EHP?

EHP or *Enterocytozoon hepatopenaei* is a fungal microsporidian parasite that infects the hepatopancreas (hp) of tiger shrimp (*Penaeus monodon*) and whiteleg shrimp (*P. vannamei*) in Thailand and results in slow growth and, in chronic infections, mortalities. EHP is also known from Brunei, China, India, Indonesia, Malaysia, Philippines, Venezuela and Vietnam.



Inside the hp, a spore activates, releasing its polar filament, injecting the parasite's sporoplasm directly into a cell. Inside, the sporoplasm proliferates. Mature spores then develop which are released back into the gut damaging the cell which then sloughs away, the spores pass out in the faeces.



EHP infects the tubules of the hp causing cells to slough and impacts on the shrimp's ability to digest its diet. If shrimp are unable to digest their diet and repair the damage to lost tissue, the shrimp have a reduced appetite and slow growth.

EHP-infected shrimp may have a thin cuticle, white muscle as a stress response, black spots on their eyestalks, in their muscle tissue and along the hind gut.

Shrimp become infected by ingesting spores from the water, from sediment, from eating EHP-infected live feeds (polychaetes, molluscs, frozen Artemia mass etc) or by cannibalism.

How quickly do EHP infections develop?

- How quickly infections develop will depend on the farm practices in place, the number of water exchanges made, the quality of the feed used etc;
- One of the biggest challenges is the circular movement of water between linked ponds which means a reservoir of infection is retained;
- SPF shrimp become infected within 2 weeks when cohabited with infected shrimp. Shrimp can become infected within one week when fed EHP-infected hp, and, within 15 days when exposed to pond soil. For earth ponds without a toilet where there is no removal of organic material and spores, infections can rise rapidly;
- PL that are PCR negative (-) but have a 20-30% infection in the hp might develop white faeces in 65-79 days. For PL that are PCR positive (+) with a 50-60% in the hp, when transferred to ponds might develop white faeces within 30-44 days. PL that give a strong PCR positive (++) result and have a 40-90% infection in the hp might develop white faeces within 14-20 days. Note: PCR reaction is to nuclear DNA coding for the spore wall; PCR detection of early stage infections are more challenging.

How can I check for EHP?

- Infection can be checked by microscopic examination (at x100 oil immersion) of the hp and the gut of the shrimp;
- Infection can also be confirmed by molecular testing of the hp by PCR. Samples can be submitted live or fixed in ethanol to your local lab;
- Faecal samples from broodstock can also be tested by PCR;
- Regular health assessments are recommended. If there is a large difference in the size of PL, if PL feeding activity is less than expected, the number of lipids in the hp drops, growth and moulting slows, then these are also good indications of infection. The number of swollen tubules may provide an indication of how advanced infections are.

Between grow-out cycles

- Drain ponds, then look at the sludge map and for residual pools of water – move aerators for effective bottom cleaning;
- Using >15 ppm $KMnO_4$ or >40 ppm chlorine to inactivate spores has been suggested (Kallaya, 2018);
- For earth ponds, adding calcium oxide or quick lime at >6 tons hectare to quickly raise the pH from 8 to >11. Ponds must be completely dry, apply quick lime and then plough into the sediment to 10-12 cm depth, then moisten to activate the lime;
- Treatment of water before stocking with 18 g m^3 calcium hypochlorite to remove wild crustaceans.

How do I manage EHP infections?

In broodstock facilities

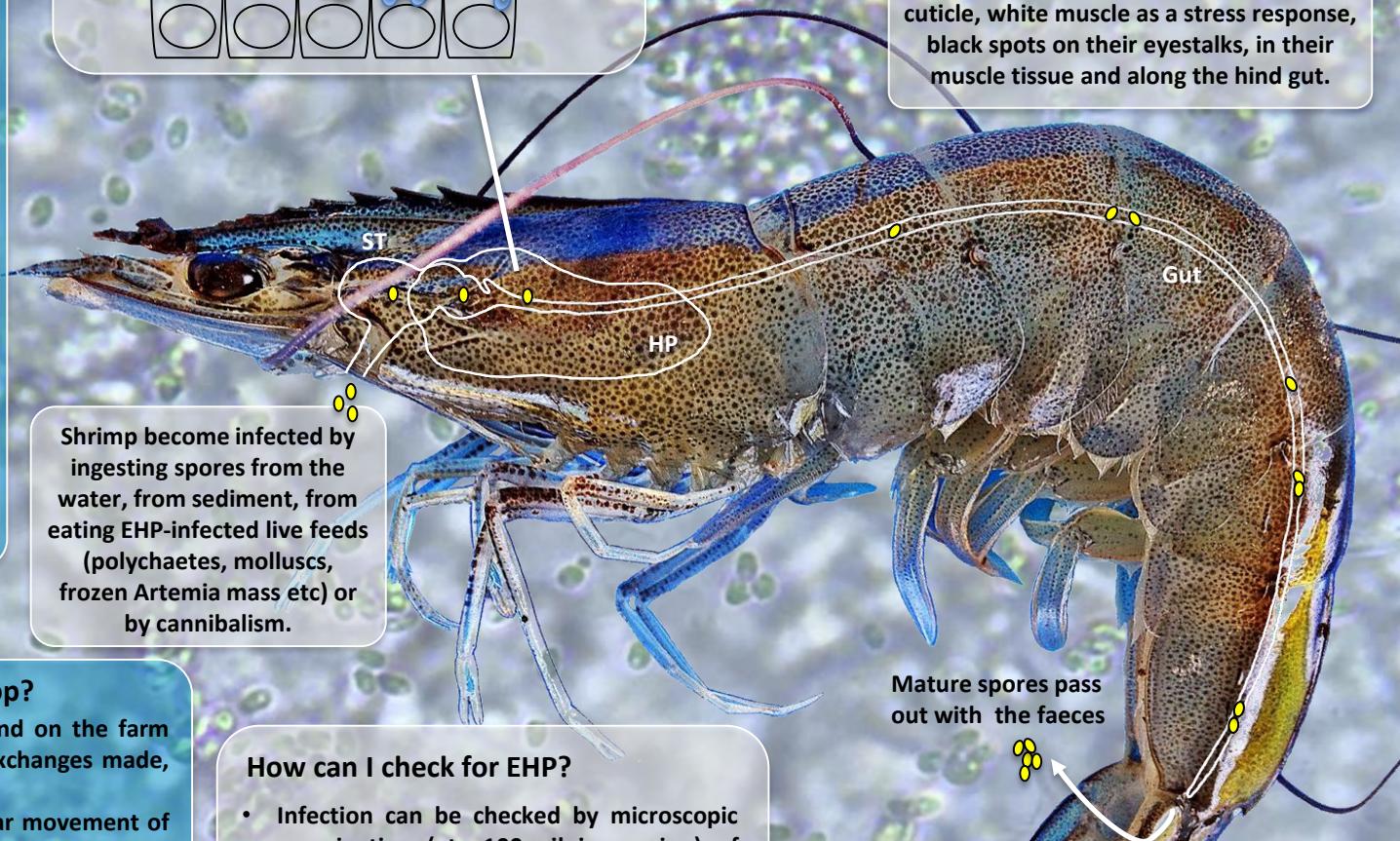
- Use EHP-free tested feeds only (e.g. SPF polychaetes) or use diets that have been frozen (i.e. 2h @ $-20^{\circ}C$ to ensure that spores are destroyed), pasteurised or gamma irradiated;
- Disease checking of animals before their transfer into culture systems - this means only stocking EHP-free animals.

In hatcheries

- Soak tanks and associated pipework in 2.5% sodium hydroxide for 3 h, followed by complete dry out for 7 days. An increase of pH to >9 results in 90% of spores firing (i.e. are unable to infect host cells);
- Practice tight biosecurity;
- Disease check stock before their transfer into culture systems - this means only stocking EHP-free animals;
- Conduct regular screening for EHP - swollen hp tubules may suggest an EHP infection;
- If PL eat less than expected, then check the hp and get a sample tested for EHP;
- Use of high-quality diets to promote shrimp health.

In grow-out ponds

- Ensure effective disinfection of culture systems, pond liners, farm equipment and water;
- The ageing of water may reduce EHP infection;
- Only stock EHP-free animals. Destroy EHP-infected stock;
- Only buy PL from registered hatcheries;
- Keep pond bottoms clean - remove accumulating organic matter that could act as a spore reservoir;
- Move aerators to ensure effective water movement;
- If an infection is detected, give a high protein diet to help the shrimp's digestive capacity and recovery of the hp;
- Do not overfeed shrimp – energy spent in digestion will only weaken the shrimp;
- A wide range of natural products claim to control EHP infections including chitosan, various essential oils, herbal extracts, Spirulina, and, seaweed extracts – their performance needs confirming;
- Poly aluminium chloride is used to coagulate suspended organic material including spores causing suspended material to flocculate and to sediment which can then be removed / pumped away;
- Ensure any new water entering production ponds is treated to prevent re-infection.



Mature spores pass out with the faeces

