NETWORK OF AQUACULTURE CENTRES IN ASIA-PACIFIC

Twenty Fourth Meeting of the Asia Regional Advisory Group on Aquatic Animal Health

REPORT OF THE MEETING

Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand
24-25 November 2025
Prepared by the NACA Secretariat

Preparation of this document:
This report was prepared by the 24th Asia Regional Advisory Group on Aquatic Animal Health (AG) who met virtually in Bangkok, Thailand on 24-25 November 2025.
The AG was established by the Governing Council of the Network of Aquaculture Centres in Asia-Pacific (NACA) in 2001 to provide advice to NACA members in the Asia-Pacific region on aquatic animal health management, through the following activities: (a) evaluate disease trends and emerging threats in the region; (b) identify developments with global aquatic animal disease issues and standards of importance to the region; (c) review and evaluate the Quarterly Aquatic Animal Disease reporting programme and assess the list of diseases of regional concern; (d) provide guidance and leadership on regional strategies to improving management of aquatic animal health including those under the framework of the Asia Regional Technical Guidelines; (e) monitor and evaluate progress on Technical Guidelines implementation; (f) facilitate coordination and communication of progress on regional aquatic animal health programmes; (g) advise in identification and designation of regional aquatic animal health resources, as Regional Resource Experts (RRE), Regional Resource Centres (RRC) and Regional Reference Laboratories (RRL); and (h) identify issues of relevance to the region that require depth review and propose appropriate actions needed. Members of the Advisory Group include invited aquatic animal disease experts in the region, representatives of the World Organisation for Animal Health (WOAH) and the Food and Agricultural Organization of the United Nations (FAO), collaborating regional organisations such as SEAFDEC Aquaculture Department (SEAFDEC AQD) and WOAH-Regional Representation in Asia and the Pacific (WOAH-RRAP), and the private sector.

Reference: NACA 2025. Twenty Fourth Meeting of the Asia Regional Advisory Group on Aquatic Animal Health: Report of the Meeting. Published by the Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand.

ABBREVIATIONS AND ACRONYMS

AAD	Aquatic animal disease
AAHSC	Aquatic Animal Health Standards Commission of the WOAH
AG	Asia Regional Advisory Group on Aquatic Animal Health (NACA)
AGM	Advisory Group Meeting
AHPND	Acute hepatopancreatic necrosis disease
AMR	Antimicrobial resistance
AMU	Antimicrobial use/usage
AP-AquaNet	Asia Pacific Network for Aquatic Animal Health
ARAHIS	ASEAN Regional Animal Health Information System (WOAH)
ARG	Antimicrobial resistance gene
AST	Antimicrobial sensitivity testing
ATMS	Aquaculture transformation monitoring system
BALO	*Bdellovibrio* and related organisms
DAFF	Australia Department of Agriculture, Fisheries and Forestry
DIV1	Infection with Decapod iridescent virus 1
DOF	Department of Fisheries-Thailand
DLD	Department of Livestock Development (Thailand)
ECOFF/ECV	Epidemiological cut-off value
eDNA/eRNA	Environmental DNA/RNA
EHP	Hepatopancreatic microporidiosis caused by *Enterocytozoon hepatopenaei*
EUS	Epizootic ulcerative syndrome (Infection with *Aphanomyces invadans*)
EWM	Early warning module (WOAH)
FAO (HQ)	Food and Agricultural Organization of the United Nations (Headquarters)
GAP/GAqP	Good aquaculture practices
GESI	Gender equality and social inclusion
HEPA	High-efficiency particulate air (filter)
IDRC	International Development Research Center of Canada
IHN	Infection with Infectious haematopoietic necrosis virus
IMNV	Infectious myonecrosis virus
ISKNV	Infectious spleen and kidney necrosis virus
NACA	Network of Aquaculture Centres in Asia-Pacific
NAPs	National Aquaculture Plans
NVI	Norwegian Veterinary Institute
PMP/AB	Progressive management pathway for improving aquaculture biosecurity
PPP	Public Private Partnership
RAOHS	NACA Regional Aquatic Organism Health Strategy
RSIV	Red seabream iridovirus
SBC	Social behavioral change
SEAFDEC-AQD	Southeast Asian Fisheries Development Center, Aquaculture Department
SOP	Standard operating procedures
TCP	Technical Cooperation Programme
TG	Technical Guidelines (Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals)
TiLV	Tilapia lake virus
TPD	Translucent Post-larva Disease
TRBIV	Turbot red body iridovirus
WOAH	World Organisation for Animal Health (Founded as OIE)
WOAH RRAP	WOAH Regional Representation for Asia and the Pacific
WSSV	White spot syndrome virus
YSFRI	Yellow Sea Fisheries Research Institute (PR China)

The 24th Asia Regional Advisory Group on Aquatic Animal Health

Participants of the virtual AGM 24

- **Members and Co-opted members (first and second rows; L to R):**
  Dr. Ingo Ernst (WOAH-AAHSC; Australia); Dr. Andrew Shinn (INVE Aquaculture; Private Sector); Dr. Hirofumi Kugita (WOAH-RRAP, Japan); Dr. Saraya Tavornpanich (NVI, Norway); Ms. Lovelyn Marie Naluaran (SEAFDEC/AQD, Philippines); Dr. Siow Foong Chang (NPB, Singapore); Dr. Diana Chee (NPB); Dr. Liu Hong (P.R. China); Dr. Eduardo Leaño (NACA; Technical Secretary).
- **Observers (third to fifth rows; L-R):**
  Dr. Chyna Suit-B Yong (WOAH-RRAP); Dr. Jacqueline Lusat (WOAH-RRAP); Dr. Shohei Urushizaki (WOAH-RRAP); Dr. David Strand (NVI); Dr. Yuko Hood (Australia); Dr. Chan Dara Khan (Cambodia); Dr. Peter Kar-him Luk (Hong Kong); Dr. Pravata Pradhan (India); Dr. Kua Beng Chu (Malaysia); Dr. May Zun Phyo (Myanmar); Dr. Sonia Somga (Philippines); Dr. Le Hong Phuoc (Vietnam); Dr. Nguyen Thi Thuy (Vietnam)
- **NACA Secretariat (last row; L-R):**
  Dr. Derun Yuan (Environment and Sustainability Programme); Mr. Simon Wilkinson (Information and Networking Programme); Mr. Chokanan Prompichai (Education and Training Programme).
- **Other attendees** (no photo): Dr. Brian Tan (NPB); Dr. Md. Habib Forhad Alam (Bangladesh); Ms. Fathimath Shazra Mueen (Maldives)

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OPENING SESSION

The 24th Meeting of the Asia Regional Advisory Group on Aquatic Animal Health (AGM 24) was convened virtually in Bangkok, Thailand on 245-25 November 2025. Originally attended by only AG members, co-opted members and few observers, the meeting was again participated by NACA member country representatives, as in the last five years. NACA member countries and territories represented include Australia, Bangladesh, Cambodia, Hong Kong SAR, India, Malaysia, Maldives, Myanmar, the Philippines, Thailand, and Vietnam.

The meeting was opened by **Dr. Eduardo Leaño**, Director General and Senior Programme Officer of NACA, and Technical Secretary of the AG.

After a brief self-introduction by all the participants, Chairperson **Dr. Leobert dela Peña** (SEAFDEC AQD; represented by **Ms. Lovelyn Marie Naluaran**) and vice-chairperson **Dr. Andy Shinn** (INVE Aquaculture) took over in the facilitation of the AGM 24 and moved for the adoption of the Provisional Agenda (**Annex A**). The complete list of participants is attached as **Annex B**.

SESSION 1: PROGRESS REPORT FROM NACA'S ASIA REGIONAL AQUATIC ANIMAL HEALTH PROGRAMME

Dr. Eduardo Leaño (Director General and Senior Programme Officer of NACA) presented the progress report of NACA's Asia Regional Aquatic Animal Health Programme since the previous AGM 23 which was held virtually on 14-15 November 2024. Key recommendations during the AGM 23 include the following:

- **Compartmentalization (instead of zoning) should be promoted in aquaculture systems**, as this has already been applied in some countries to identify areas with established biosecurity (sone including quarantine) measures for proper health maintenance of the cultured stocks (whether it is for ornamental or food fish industries).
- As some countries have already established free compartments and use them for international trade, these compartments are not formally declared as disease-free under WOAH standards through self-declaration of freedom. **It is therefore recommended that a formal declaration should be facilitated which will highlight the need for clearer guidelines and greater transparency to support international recognition and trade**.
- As aquaculture often evolves faster than supporting policies and programs, functional linkages between food safety authorities, aquaculture and fisheries authorities, and veterinary services are essential to keep pace with technology development. **Promoting multidisciplinary teams, including aquatic veterinarians, aquaculturists, biologists and economists was, therefore, recommended to strengthen collaboration and decision-making towards further development of the aquaculture sector**. Strengthening linkages among these authorities and stakeholders will facilitate practical and sustainable biosecurity measures, ensuring strategies are context-specific and adaptable to varying scales of production.
- **"Healthy production" should be promoted over "profit-driven" approaches**, as it supports profitability by reducing disease losses and it emphasises stakeholders involvement in

biosecurity planning and capacity-building programs, with examples from Thailand and Vietnam.

- The industry, in general, should be **engaged in biosecurity initiatives and simulation exercises to help them develop more practical and effective strategies for disease prevention and health management**.
- On resource mobilisation for aquatic animal health management, it is recommended to **look out for potential donor funding where aquaculture is under-represented**. Example is the pandemic fund wherein proposal focusing on zoonotic aquatic animal diseases can be developed for a possibility of securing project funds for the region.
- With the increasing importance of social behavioural changes (SBC) and gender equality and social inclusion (GESI), **both SBC and GESI should be incorporated into upcoming important meetings (e.g. DAA12) and projects on aquatic animal health**.
- **Survey tools should be developed for assessing biosecurity measures**, similar to the one developed for economic loss (due to diseases) analysis by NVI in collaboration with WorldFish, which can easily be applied in developing countries and be useful for small-scale farmers.
- On the development and implementation of biosecurity plans, **shared templates and basic guidelines should be developed to support a customised veterinary health plans, especially for small-scale farms**.
- For improved understanding and adoption of farm-level biosecurity measures, **biosecurity concepts should be simplified and presented in clear/practical terms**, especially to farms with limited capacity to implement biosecurity measures
- Effective implementation of biosecurity requires collaboration across disciplines. **It is important that centralized repositories for shared protocols be established (e.g. tank disinfection and chlorination) which can enable farms to download and adapt them as needed**.
- On disease reporting, **Australia's report serves as a model for other countries** as it contains detailed epidemiological comments for a better understanding of the disease situation in the country.

The report of the meeting is available for free download at NACA website: https://enaca.org/?id=1395

The regional aquatic animal disease reporting still received low numbers of countries submitting the report. In 2025 (as of the 2nd quarter), only seven countries submitted the disease reports representing a low 21.2%.

NACA, in collaboration with FutureFish and with the support from IDRC, has implemented a project on "Policy and Private Sector Scoping for AMR-InnoVet 2.0" which focuses on the alternatives to antimicrobials that are being developed in Thailand: NanoVac (use of nanobubble technology for vaccine delivery); and, ShrimpGuard (use of novel bacteriophages for bacterial disease control in shrimps). The project also assessed the barriers or challenges in the farm-level adoption of these innovative products, which include:

- Limited farmers' awareness and understanding on the technologies' mechanisms to prevent diseases and its application;

- Commercialisation and market integration;
- Lack of business expertise (innovators), making it difficult to align research outcomes with industry needs;
- High production cost (compared to antibiotics); Market competition with cheaper antibiotics;
- Regulatory barriers.

NACA has organised the Regional Laboratory Proficiency Testing Workshop upon the request of the Australian Department of Agriculture, Fisheries and Forestry (DAFF) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). This is in connection with the third phase of the Proficiency Testing Programme of Australia for aquatic animal disease diagnostic laboratories around the region. Objectives are to: improve participating laboratory personnel's understanding of diagnostic standards, proficiency testing procedures and laboratory quality assurance management systems in order to improve laboratory performance; provide an opportunity for participants to discuss specific issues that they have encountered during the proficiency testing rounds and identify solutions; and, identify current capability, capacity and future training needs, in order to meet Australia's pre-export biosecurity conditions for competent authorities for a number of aquatic animal diseases. It was attended by 45 partcipants (42 laboratories) from 12 countries.

Other NACA projects relevant to aquatic animal health management include "Knowledge Brokering on Nature-based Solutions for Aquaculture Transformation in the Asia-Pacific" (funded by: IDRC) which focused on innovative technologies to mitigate issues and challenges in the aquaculture industry including disease outbreaks. Another is an FAO TCP on the development of national Innovation and Investment Plan (NIIPs) and Regional Aquaculture Transformation Monitoring System (ATMS), which include AAH as one of the issues identified which should be addressed by innovative technologies. One important bottleneck identified in this regard is the heavy regulations on innovative health products (e.g. vaccines, bacteriophages, other biological control measures), which are hindering the adoption of these products for farm-level use.
NACA was invited in some important meetings in AAH as listed below:

- AQUAMAP 2025 (Aquaculture Medicine and Aquatic Animal Health Management in the Asia-Pacific: Status, Contraints and Way Forward), 16-18 January 2025, Cochin, India. E. Leaño was invited as a resource speaker.
- 14th Asian Fisheries and Aquaculture Forum, 12-15 February 2025, Delhi, India. NACA co-sponsored a special "Symposium on Aquatic Animal Diseases: Emerging Challenges and Preparedness". E. Leaño was invited as a keynote speaker.
- FAO Global Agrifood Biotechnologies Conference, 16-18 June 2025, Rome, Italy. E. Leaño was invited as plenary speaker for two sessions: **Innovation pathways for development and localization of biotechnologies**; and, **Fish breeding, diagnostic tools and vaccines for aquatic animals.**
- 12th Symposium on Diseases in Asian Aquaculture, 23-27 September 2025, Chennai, India. E. Leaño was invited as a Lead Presenter.

- World Antimicrobial Awareness Week (IDRC Webinar), 20 November 2025. E. Leaño represented the Asia-Pacific region to discuss on how to bridge the gap between research and policy to advance alternatives to antimicrobials.

DISCUSSION

- Data on contact time, logistics, and economic aspects of using nanobubbles for treating incoming or effluent water were not available at this stage. Nanobubbles stay in the water column longer than micro- or macro-bubbles, allowing disinfectants or treatment agents to remain in contact with potential contaminants before the water is used for production, although exact treatment times have not yet been defined.
- Nanobubble machines will initially require high investment, especially for large shrimp farms with large seawater reservoirs, such as farms in the Philippines using ozone nanobubble treatment before water enters production ponds. Nanobubbles can carry disinfectants, chemicals, or vaccines, allowing more direct delivery in the culture system, including uptake through gills during immersion, and are used together with other farm inputs to reduce disease problems and support production.
- A bacteriophage product used in shrimp culture in Thailand was described as cost-effective when considered per unit of feed. The small bottle of about 50 mL, costing around THB 2,000, is sufficient for use in approximately 500 kg of feeds. Bacteriophages were described as highly host-specific, targeting only the intended bacterial pathogens such as *Vibrio parahaemolyticus* or *V. harveyi*, without affecting other/beneficial bacteria in the aquatic environment.

SESSION 2: UPDATES FROM WOAH AQUATIC ANIMAL HEALTH STANDARDS COMMISSION

Dr. Ingo Ernst gave a presentation on the progress of the Aquatic Animal Health Standards Commission's (AAHSC) work to develop new and revised standards for the OIE Aquatic Animal Health Code and OIE Manual of Diagnostic Tests of Aquatic Animals. Dr. Ernst highlighted some of the ongoing work discussed at the Commission's September 2025 meeting and the draft standards included in the meeting report for members' comments.

D.r Ernst highlighted some of the key activities that may be of most interest to AG members.

Movement of ornamental aquatic animals (Chapter 5.12 of Aquatic Code). A new chapter on movement of ornamental aquatic animals had been adopted by the WOAH General Assembly in May 2025. The chapter provides recommendations for managing the disease risks associated with movement of ornamental aquatic animals. A new definition for 'ornamental aquatic animal' was adopted but some minor changes have been proposed to ensure the scope includes production and steps in the supply chain but not animals kept as pets.

Compartmentalisation (Chapter 4.3 of Aquatic Code). A revised Chapter 4.3 was circulated for comment in February 2025. The purpose of the revision is to provide consistent and clear guidance to facilitate trade and improve acceptance of compartmentalisation while also providing sound risk management guidance. The process to revise the chapter has included a Member survey (Sep 2022) and discussion paper (Sept. 2023). The revised chapter is structured around ten principles for establishing a compartment. The concepts of dependent and independent compartments are included: dependent compartments (status requires disease freedom in a surrounding area) and independent compartments (status is independent of disease status external to the compartment). There has been good engagement on the draft and extensive revisions have been made based on member comments.

Fallowing in aquaculture' (Chapter 4.7 of Aquatic Code) This chapter has been revised to align with new Chapters 4.10. 'Emergency disease preparedness' and 4.11. 'Disease outbreak management' adopted at the 2025 General Session. It includes voluntary fallowing (e.g. as part of good biosecurity practice) and compulsory fallowing (e.g., as part of an outbreak response). There has been good engagement on the draft and revisions made to the Feb 2025 draft.

'Trade measures, importation/exportation procedures and health certification' (Section 5 of Aquatic Code). The commission has developed a plan for revision of all chapters in Section 5 of the Aquatic Code. The purpose of the revisions are to:

- revising older standards and improving quality as necessary
- addressing any gaps in the standards for trade
- improving usability for developing trade measures
- addressing aquatic specific trade issues while maintaining alignment with Terrestrial Code
- improving alignment of chapters within Section 5 and between Section 5 and other sections of the Aquatic Code.

The proposed plan identifies the current structure, alignment with equivalent Terrestrial Code chapters for reference, and provides comments on the proposed actions for each of the section 5 chapters of the Aquatic Code. Members are invited to comment on the proposal.

Susceptible species. A revised list of susceptible species is provided for crayfish plague. The proposed changes have been developed following an assessment applying the criteria for listing species as susceptible that are included in Chapter 1.5.

Aquatic Manual. The Commission is continuing to progressively update the scientific information in all Aquatic Manual chapters and to reformat them into a new template. The revised chapters have clear guidance on recommended tests for surveillance, information on their validation status, consistent case definitions, and updated scientific information. Revised chapters have been provided for:

- Chapter 2.4.5. Infection with *Perkinsus marinus*
- Chapter 2.4.6. Infection with *Perkinsus olseni*
- Chapter 2.4.7. Infection with *Xenohaliotis californiensis*

DISCUSSION

- The comprehensive revision of Section 5 (trade chapters) and their alignment with the Terrestrial Code is a long-term programme already underway, with completion expected to take at least five years. This work includes collaboration on horizontal chapters, ongoing initiatives on electronic certification, and the development of WOAH online training packages to support users in applying the Code for the development of trade measures.
- For Infection with *Megalocytivirus pagrus* 1, Member Countries can specify the reported genogroup (RSIV, ISKNV, or TRBIV), as demonstrated by a recent United States report of

ISKNV in ornamental fish. However, current WAHIS display functions do not allow visualization or mapping of disease status by individual genogroups, a limitation recognised across both aquatic and terrestrial diseases.

- A working group of experts is coordinating an inter-laboratory comparison to assess the performance of available diagnostic methods for *Megalocytivirus pagrus* 1 across the three genogroups. This exercise focuses on evaluating methods rather than laboratory performance and involves experienced, high-performing laboratories. Results are expected in the first half of the coming year and will inform the selection of diagnostic methods included in the revised Aquatic Manual chapter.
- The WOAH Observatory has identified Infection with *Megalocytivirus pagrus* 1 and the declaration of freedom for aquatic animal diseases, as case studies for aquatic animal health under the WOAH Observatory. This selection reflects the transition from a previously listed disease limited to RSIV to a broader listing encompassing three genogroups, and will examine Member Countries' adoption of standards and associated implications for trade.

SESSION 3: UPDATES FROM SEAFDEC AQUACULTURE DEPARTMENT

Ms. Lovelyn Marie Naluaran (on behalf of **Dr. Leobert dela Peña**) presented updates on aquatic animal health activities of the SEAFDEC Aquaculture Department (SEAFDEC/AQD). The SEAFDEC/AQD was established in 1973, with four stations in the Philippines. Three stations are located in the Visayas, Tigbauan Main Station (TMS) (Tigbauan, Iloilo), Dumangas Brackishwater Station (Dumangas, Iloilo), and the Igang Marine Station (Guimaras), while the Binangonan Freshwater Station (Binangonan, Rizal) is in Luzon. The Department has three mandates: 1) to promote and undertake research on aquaculture relevant and appropriate to the region, 2) to encourage human resource development in aquaculture through training and extension, and 3) to disseminate and exchange information in aquaculture. The SEAFDEC/AQD was divided into four divisions: Research Division (RD), Technology Verification and Extension Division (TVED), Training and Information Division (TID), and Administration and Finance Division (AFD). Each division has its own function and carries out activities such as aquaculture research, laboratory services training, publications, extension and production, training, and Library and Museum tours.

A total of 27 commodities are being cultured for research purposes: 13 finfishes (milkfish, seabass, roundscad, mackerel tuna, rabbitfish, Bali sardine, catfish, tilapia, pompano, grouper, snapper, anguilid eel and silver therapon), seven crustaceans (black tiger shrimp, whiteleg shrimp, red claw crayfish, giant freshwater prawn, mangrove crab, slipper lobster and spiny lobster), three mollusks (abalone, oysters and mussels) and four other aquatic organisms (sandfish, polychaetes, seaweed and natural food).

As the center for Aquaculture research, the SEAFDEC/AQD projects were developed to align with the Department's mandates and goals. The Thematic Programs of AQD serve as the backbone of the department's research efforts, with 45 studies currently under the Departmental and Regional Programs. Twenty of the studies are under the Quality Seed for Sustainable Aquaculture (QSSA), 14 from the Healthy and Wholesome Aquaculture (HWA), nine from the program Maintaining

Environmental Integrity through Responsible Aquaculture (MEITRA), two from the Meeting Social and Economic Challenges in Aquaculture Program (MSECAP), and six other studies from the Regional programs including Government of Japan Trust Fund (GOJ-TF) studies.

The Healthy and Wholesome Aquaculture thematic program aims to improve aquaculture production through nutrition and feeding, and fish health management. The Fish Health Component's primary goal is to improve aquaculture production through innovations in disease management, as well as in the diagnosis, control, monitoring, and surveillance of aquatic animals.

Of the 14 projects under the HWA, four are under the fish health component. The first project was entitled, "Surveillance and epidemiology of *Enterocystozoon hepatopenaei* (EHP) in the Philippines". This study aims to survey the epidemiological distribution, occurrence, and prevalence of EHP in the Philippines. As well as establish a protocol on the detection, diagnosis, and transmission mechanism of EHP. This study was funded by GOJ-TF and ended in 2024. The results showed a prevalence pattern of EHP in the Philippines, specifically in Luzon (Zambales and Bataan) and in Visayas (Ajuy and Dumangas, Iloilo) from 2020 to 2023. Furthermore, areas positive for EHP have recurrent disease for 2 to 3 consecutive years, with consistent positive results from 2021 to 2023 in Ajuy and Dumanggas, Iloilo. EHP spores were predominantly detected in the wet mount and histological slides of the shrimp hepatopancreas of the heavily infected shrimp, which were confirmed as 1st step positive using Polymerase Chain Reaction (PCR) Analysis. The transmission mechanism was also confirmed horizontally, with successful transmission via cannibalism of EHP-infected shrimp, cohabitation, and contaminated water containing EHP spores.

To address the growing problem of Antimicrobial Resistance (AMR) in aquaculture, the 2nd project, entitled "Exploiting Predatory Bacteria: Development of Efficient Administration Technology of Marine Predatory Bacteria as Antimicrobial Therapy for Shrimp *Vibrio* Disease Management," was developed. This study aims to use predatory bacteria, such as *Bdellovibrio* and related organisms (BALOs), to control vibriosis in shrimp aquaculture. Marine BALOs (*Halobacteriovorax vibrionivorans*) from a shrimp pond in Iloilo, which can lyse *Vibrio* spp., was successfully isolated. This was processed for encapsulation and is currently being tested for its efficiency in controlling Vibrios via dose- and frequency-based experiments, pathogenicity testing, and *in vitro* and *in vivo* challenge tests.

The 3rd project was entitled, "Control, Management, and Determination of Spore Activation and Infectivity of *Enterocytozoon hepatopenaei* (EHP) in Shrimps. This study aims to identify the etiological factors that contribute to the activation of EHP spores and their infectivity in shrimp, thereby further aiding in determining inhibitors to manage and control EHP in shrimp aquaculture. Low temperatures for spore storage at -10°C, -20°C, -30°C, and -80°C were tested and still showed positive results for 60 days during PCR analysis for EHP. This will then be further introduced via feeding in shrimps to check its viability. Furthermore, continuous reinfection, cohabitation, and other etiological factors will be tested, such as pH, salinity, and spore resistance.

Lastly, the study entitled "Improvement of productivity and quality of cultured seaweeds". This study was conducted to isolate and identify the putative microorganism causing "ice-ice" disease (IID) in seaweeds and optimise seaweed growth and environmental conditions using innovative culture techniques. This study further aimed to establish guidelines and Good Aquaculture Practices

(GAqP) for mitigating IID in seaweeds. Current progress includes isolating potential causative agents of IID and documenting the natural progression and clinical signs of disease manifestations observed in a sea-based nursery cage set-up.

SEAFDEC/AQD also offers disease diagnostic services, which include Level I (gross examination and microscopy), Level II (Bacteriology, histopathology, parasitology, and others), and Level III (Molecular Biology, Virology, and Electron Microscopy). As of the 1st to 3rd quarter of 2025, the fish health diagnostic laboratory has received a total of 4,941 samples of various aquatic organisms involving different services. 37% of the total sample was sent for bacterial counting, 26% for disease detection using PCR, 25% for microtechnique services (histopathology), 5% for parasite detection, and 4% for DNA/RNA extraction. The remaining 3% are samples sent for other analysis, such as fry quality, bacterial identification, aflatoxin test, and finfish necropsy. 55% of the total samples came from within the department, and 45% were from external sources.

DISCUSSION

- The mechanism of *Halobacteriovorax vibrionivorans*, a member of *Bdellovibrio* and like organisms (BALOs), is similar to that of bacteriophages and involves predatory behavior to attach to, colonise, and lyse host cells. The involvement of toxins or enzymes has not yet been examined and remains to be tested. Isolation of these predatory bacteria requires a double-layer agar method dependent on a host, which presents culture challenges; consequently, future research aims to isolate host-independent BALOs.
- Mass production of BALOs involves initial plating followed by broth culture. To increase volume, a host is added to the broth culture, necessitating careful monitoring to ensure the predatory bacteria remain present as the volume expands.
- The microencapsulation process utilizes freeze-dried cells. The bacteria are coated and then freeze-dried, after which viability testing is conducted to confirm survival following encapsulation.
- Farm-level application costs remain a concern, as current small-scale production is expensive. While mass production is expected to reduce unit costs, a specific cost analysis for commercial application has not yet been completed.
- Liquid preparation of BALOs poses stability risks at room temperature and potential pathogen introduction due to the requirement for a host bacterium for multiplication. Microencapsulation is therefore preferred, as it ensures that only BALOs are introduced into the shrimp culture system.
- Storage experiments on *Enterocytozoon hepatopenaei* (EHP) spores demonstrated that samples kept at −10°C, −20°C, −30°C, and −80°C all remained PCR-positive after 60 days. However, a reduction in quantity was observed, with detection shifting from first-step positive at day zero to nested positive by day 60.
- Determination of the actual viability and infectivity of stored EHP spores is pending. Verification will be conducted in late 2025 or early 2026 using staining techniques and quantitative PCR (qPCR) once the necessary reagents are acquired.

SESSION 4: AQUACULTURE BIOSECURITY

4.1. THE HIDDEN HIGHWAYS OF DEATH: CRITICAL BIOSECURITY INSIGHTS FOR SHRIMP PRODUCTION

Prof Andy Shinn gave presentation entitled "***The hidden highways of death: Critical biosecurity insights for shrimp production***". Modern aquaculture facilities represent complex biological systems where every component must function harmoniously to maintain healthy production. Yet despite significant investment in biosecurity infrastructure, many operations remain vulnerable to catastrophic pathogen transmission through routes that remain largely invisible to operators. Understanding these hidden pathways and implementing targeted interventions represents the difference between sustainable production and devastating losses.

The most productive way to understand an aquaculture facility is to view it as analogous to a living organism, with each component serving a vital physiological function. Tanks represent the heart, pumping life through the system. Pipework forms the circulatory network, carrying both nutrients and, unfortunately, pathogens. Aeration systems function as lungs, delivering oxygen throughout the facility. UV systems, ozone generators, and filtration equipment serve as the liver and kidneys, constantly detoxifying and purifying water. Construction materials—tanks, walls, and barriers — act as skin and muscle, providing the first line of defence against invading pathogens. The reproductive system finds its parallel in the broodstock themselves and their valuable egg production. However, it is the facility's "elimination system" — the drainage network, that poses perhaps the most insidious and underestimated threat to biosecurity.

One of the most shocking revelations in recent biosecurity research concerns bacterial behaviour in drainage systems. Contrary to the widespread assumption that bacteria simply wash away, research demonstrates that bacteria actively migrate upward through drainage pipes at approximately 2.5 cm per day — accumulating to 70 cm monthly. This phenomenon, originally discovered through hospital research investigating recurring drug-resistant bacterial infections in sterile wards, has profound implications for aquaculture biosecurity. The mechanism is straightforward yet insidious: bacteria colonise U-bends and pipe interiors, climb against gravity, and recontaminate facilities through splash-back when water contacts drains. In interconnected drainage systems — standard in most facilities — a single contaminated tank can seed an entire farm with pathogens within a week through the plumbing network alone.

Perfect biosecurity at the tank level, including UV-sterilised incoming water and rigorous quarantine protocols, can be completely undermined by *Vibrio* or other pathogens climbing from a floor drain several rooms away. The implications are stark: drainage systems are not passive waste removal infrastructure but active pathogen distribution networks. Critical interventions include conducting comprehensive drainage audits using dye tracer tests rather than relying on potentially inaccurate blueprints, installing minimum 15-cm air gaps between tank outflows and floor drains to prevent direct pipe connections, completely isolating critical areas like broodstock facilities with independent drainage systems, and implementing daily drain cleaning before biofilm establishment.

Many aquaculture operators labour under dangerous misconceptions about the effectiveness of their treatment systems. Most facilities install UV systems, ozone generators, and biofilters, review specifications, and assume protection. The reality proves far less reassuring. Consider a UV system rated for 60 mJ/cm^2 — seemingly adequate for pathogen control. However, multiple factors conspire to reduce actual delivered doses to dangerous levels. Seawater with 75% UV transmittance instead of the assumed 95% immediately reduces effectiveness by 20%. Biofilm accumulation on quartz sleeves — inevitable when cleaning intervals exceed six weeks — causes another 30% loss. Ageing lamps operating at 70% efficiency despite still glowing, combined with increased flow rates from expanded production, can reduce actual delivered doses to barely 20 mJ/cm^2. This dramatically compromised dose proves barely sufficient for bacteria, useless against viruses, and completely ineffective against parasites. *Cryptocaryon irritans* (marine white spot of fish), for example, requires approximately 280 mJ/cm^2 for effective treatment, whilst Nervous Necrosis Virus requires 70-150 mJ/cm^2.

Ozone systems face similar challenges. Whilst standard doses effectively eliminate typical *Vibrio* species, some viruses require 50-200 times higher concentrations. In high-salinity seawater at 35 ppt, ozone residual half-life plummets from 26 minutes to under one minute due to bromide ion interactions. The solution requires fundamental changes in approach: measure rather than trust, using radiometers for monthly UV output verification and ORP sensors coupled with microbial testing for ozone systems. Maintenance must be fanatical, with weekly quartz sleeve cleaning and UV lamp replacement every 12 months regardless of apparent functionality. Facilities must understand their specific pathogens through laboratory testing rather than assuming standard doses provide protection, and systems should be designed for worst-case scenarios, for example, 100-300 mJ/cm^2 for viral or parasitic threats.

Biofilm represents perhaps the most underestimated threat in aquaculture biosecurity. These bacterial communities, encased in protective slime matrices on surfaces throughout facilities, resist water treatments because they exist on surfaces rather than in the water column. Biofilm performs three critical functions from a pathogen perspective: harbouring pathogens in protected environments unreachable by UV or ozone, continuously releasing bacteria to reseed contamination even after apparent disinfection, and facilitating horizontal gene transfer with bacteria in biofilm exchanging antibiotic resistance genes up to 1,000 times more efficiently than free-floating cells. Again, hospital studies have demonstrated that chemical disinfection immediately reduces planktonic bacteria but biofilm rebounds within 48-72 hours, with even industrial-strength treatments providing only temporary relief. The final metre of pipe delivering treated water into culture tanks can completely undermine upstream disinfection efforts if bacteria back-colonise these inlet pipes where moist conditions and air exposure create ideal biofilm formation environments. Effective biofilm management requires mechanical cleaning before chemical treatment, continuous flow to prevent establishment, facility design incorporating cleanout ports every 3-5 metres for access and inspection, multiple disinfection rounds with mechanical cleaning between production cycles, and the use of specialised products like Sanocare PUR for cutting through established biofilms. Prevention remains superior to treatment, as mature biofilm proves extraordinarily difficult to eliminate completely.

Intelligent system design, therefore, prevents problems that are difficult or impossible to solve after construction. Water and air pipes must slope towards outlets to ensure complete drainage without pooling or stagnant water accumulation. Vertical exhaust points at system high points enable verification of complete disinfectant filling during treatment protocols, eliminating air pockets and missed spots through simple physics. Air systems require particular attention. Air blowers need intake filters—fine plankton mesh, felt filter bags, or automotive-style paper cartridge filters—to prevent airborne pathogens from entering production systems. Coastal air commonly contains 10,000 to 1,000,000 bacterial cells per cubic metre, potentially introducing millions of bacteria daily into unprotected systems. For critical applications, HEPA filtration removes virtually all bacteria and fungal spores, whilst UV-C lamps or ozone contact chambers in airlines provide additional protection for high-value operations.

Construction materials themselves require careful consideration. Smooth-bore pipes resist biofilm formation better than rough surfaces, whilst unsealed concrete's porosity traps organic matter and harbours bacteria. Regular inspection protocols should include weekly visual checks for cracks, surface discolouration, and biofilm formation, coupled with swab sampling of high-risk surfaces and robust cleaning protocols using products proven effective against biofilm. Even seemingly minor details matter: condensation forming on pipes above tanks can carry bacteria or contaminants directly into culture water. Such drips, analogous to concerns about air-conditioning ducts dripping into sterile hospital areas, represent an often-overlooked infection source. Insulating pipes, redirecting them, or collecting drips safely provides simple yet effective protection.

Recent research has revealed compelling evidence of pathogen transmission through aerosols — an often-overlooked vector in aquaculture biosecurity. Studies using *Vibrio parahaemolyticus* have demonstrated bacterial spread exceeding 70 m from aerosol-generating sources like pond aerators, with profound implications for farm design and pathogen control strategies. Subsequent research revealed that *Enterocytozoon hepatopenaei* (EHP) also spreads via aerosols, with post-study sampling detecting the pathogen under fingernails and jewellery where moist skin conditions support survival. Normal hatchery operations such as splashing, bursting bubbles, water changes, power washing, etc, all create aerosols that can carry *Vibrio* bacteria, viruses, and parasite stages several metres and remain suspended for extended periods. These droplets contaminate nearby tanks, equipment, and workers' clothing or skin. The problem intensifies during intensive activities like grading, harvesting, or tank cleaning. Mitigation strategies include adequate tank spacing, robust ventilation, splash guards or physical barriers between systems, and treating tank water before activities generating aerosols. HVAC (heating, ventilation and air conditioning) systems themselves can harbour and distribute pathogens if not properly maintained, with biofilms establishing in condensate drainage systems and accumulated bacteria being aerosolised during system cycling. Positioning air intakes away from potential contamination sources and ensuring proper airflow patterns — avoiding inadvertent air movement from dirty zones into clean zones — proves critical.

Research demonstrates that *Vibrio* can survive on human skin for over two hours, meaning workers washing hands in the morning could still carry live pathogens hours later when contacting different tanks. Washing hands in water alone for 30 seconds proves almost as ineffective as no washing at all. Effective hand hygiene requires soap for at least 30 seconds followed by water rinsing and ideally alcohol gel application. Humans touch their faces 15-25 times hourly, with 44% of contacts involving eyes, nose, or mouth—primary infection entry points. Hospital studies found 72-99% of smartphones and approximately 30% of pens carry potentially harmful bacteria. With individuals touching phone screens 2,600-5,400 times daily, these devices represent perfect pathogen transfer vehicles between tanks, systems, and staff. A hospital-style approach—no jewellery in production areas, proper hand disinfection protocols, and protective equipment—significantly reduces transmission risks.

Personnel management deserves equal attention to infrastructure. Equipment should be separated by zone, with dedicated nets for broodstock tanks. Foot baths must function effectively rather than serving as decorative puddles of ancient disinfectant. Ideally, workers should avoid placing hands directly in water and maintain rigorous hand hygiene protocols. Waiting for disease to become clinically apparent in valuable production cohorts means the battle is already lost. Sentinel monitoring systems provide the first line of defence, detecting pathogen presence before catastrophic losses occur. Strategic placement of open Petri dishes throughout facilities, coupled with water sampling and biofilm swabs from pipes and structures, creates baseline understanding of the facility's microbiological landscape and quickly flags dangerous deviations.

Systematic, routine sampling with clear action thresholds enables immediate intervention when bacterial counts exceed pre-determined levels or specific pathogens are detected. For marine hatcheries, sentinel plates placed near water inlets, between tank batteries, near aerosol-generating equipment, and in high-traffic areas reveal contamination patterns that would otherwise remain invisible until significant damage occurs.

Biosecurity is not a one-time checklist but a daily discipline requiring understanding of how pathogens actually move through facilities. Prevention through intelligent design and daily discipline consistently proves superior to reactive chemical treatments. Once pathogens establish—especially in biofilm, drains, or protected niches—eradication becomes extraordinarily difficult and expensive. The essential action plan encompasses auditing drainage systems through physical testing rather than blueprint review, verifying that treatment systems deliver required doses through measurement rather than assumption, inspecting and maintaining physical barriers with religious consistency, attacking biofilm mechanically before it matures, implementing comprehensive personnel protocols that recognise humans as potential vectors, and establishing sentinel monitoring to detect problems before they become catastrophes.

Probiotics for microbial management in culture water (e.g., INVE Sanolife PRO-W), for disinfection of tanks and pipes and biofilm removal (e.g., Sanocare PUR and CID), and Sanolife PRO-TAB as next-generation probiotics delivering high concentrations of *Bacillus* species (minimum 2×10^9 CFU/g) in wafer form provide valuable tools in the comprehensive biosecurity arsenal. These should be deployed as part of integrated programmes rather than standalone solutions.

The facilities that thrive in coming years will be those that recognise biosecurity as the foundation of profitable production. Understanding the hidden highways through which pathogens travel transforms biosecurity from a compliance activity into a strategic advantage. What aquaculture operators cannot see can absolutely devastate their operations — but with proper knowledge and consistent implementation of proven protocols, these invisible threats can be controlled, contained, and conquered.

Discussion

- Nanobubble systems can achieve higher dissolved ozone levels and longer persistence in water, but effectiveness remains dependent on system design and contact time. High organic loads reduce performance, which is why visible dirt and biofilms should be removed first, followed by a second round of disinfection to ensure effective treatment.
- The biosecurity examples presented come from field diagnostics, site walkthroughs, and technical service support for farms facing disease problems. This includes combining routine audits with targeted trials to generate empirical data specific to aquaculture, such as measuring bacterial transmission through aerosols, which has been published in Aquaculture.
- Greater attention to pipework, drainage design, and inspection points during farm and hatchery visits can help identify overlooked biosecurity risks that contribute to pathogen movement within facilities.
- Practical construction guidance was suggested to address small but critical design details not normally visible in hatchery or pond layouts, such as exhaust points that eliminate air gaps during pipe disinfection and features that allow proper inspection and cleaning of pipelines. A ground-level guide focused on these operational details is being considered.
- Aerosol-based cross-contamination remains a concern in experimental and ornamental facilities where multiple batches are held simultaneously. Plastic sheeting between tanks can provide physical separation, while sentinel bacteriology plates can indicate horizontal pathogen spread and inform adjustments to tank layout and experimental design.
- Incoming animals cannot be assumed to be sterile and should be treated as potentially infected. Layered precautions are required, combining infrastructure and biosecurity practices with additional measures such as probiotics, disinfectants, and other health interventions discussed during the session.
- Environmental exposure was illustrated through informal monitoring using agar plates exposed to coastal air for approximately 30 minutes, demonstrating the background bacterial load, including *Vibrio*, present in the surrounding environment.

Session 5: Use of Environmental DNA (eDNA) for Disease Surveillance

5.1. Advancing the Biosurveillance of Emerging Aquatic Pathogens in Singapore with Environmental DNA

Dr. Brian Tan (National Parks Board, Singapore) presented biosurveillance of emerging aquatic pathogens with eDNA. Aquatic viruses and other emerging pathogens pose major threats to global aquaculture productivity. Hence, this underscores the need for scalable and advanced monitoring approaches that provide early warning and support rapid management decisions. While traditional methods for disease diagnostics can be laborious, time-consuming, and often require the sacrifice of live fish, environmental DNA and RNA (eDNA/eRNA) offer a non-invasive alternative for the effective and early detection of multiple pathogens simultaneously. When integrated with next-generation sequencing technologies, eDNA/eRNA-based biosurveillance can also enable pathogen genomic characterisation and provide more comprehensive insights into outbreak dynamics and patterns of co-infection. The recent detection of Tilapia Lake Virus (TiLV) in Singapore illustrates the type of emerging pathogen event that these biosurveillance approaches could monitor, thus supporting efforts to enhance resilience in the country's aquaculture sector.

DISCUSSION

- The application of eDNA for quarantine and shipment assessment was considered most suitable in contained systems, as open sea environments present challenges related to dilution and environmental heterogeneity. eDNA is not yet incorporated into routine diagnostic protocols, but transportation water was identified as a concentrated sample type where diagnostic results can be generated within approximately 24 to 48 hours. Trials conducted in open sea farming environments enabled pathogen detection, but results could not be correlated with clinical signs or disease status. In contrast, testing of water from diseased farms allowed correlation between environmental samples and organ tissues collected from affected fish.
- Differences in virus recovery rates between filtration methods were attributed to physical characteristics of the target pathogens. The larger DNA virus (e.g. RSIV) showed better recovery using vacuum pump filtration, likely due to iron flocculation and aggregation of viral particles, while smaller RNA viruses (e.g. NNV and TiLV) demonstrated higher recovery using centrifugal ultrafiltration. RSIV generally exhibited lower recovery rates compared to NNV, indicating that filtration and concentration methods need to be selected according to virus type.
- Passive sampling approaches using filter membranes placed directly in aquatic environments to capture adhering particles were acknowledged as an existing methodology, particularly when positioned at defined water flow points. This approach has not yet been tested within the current work, and determining optimal filter placement was identified as a key consideration for future exploration.
- The term eDNA was clarified as being used interchangeably with eRNA, with the surveillance methods designed to detect both DNA and RNA viruses. The objective is to develop a single standard operating procedure capable of processing both viral types. In addition to viruses, environmental detection of bacteria has been explored, while parasitic spores have not yet been investigated.
- From a regulatory perspective, environmental detection of pathogen nucleic acid alone was not considered sufficient to support enforcement actions such as isolation, disease declarations, or insurance claims. Without direct confirmation of infection within the animal population, regulatory authorities face limitations in acting on environmental positives. Further validation and guidance, including from WOAH, were identified as necessary to clarify how eDNA findings should inform disease control and regulatory decision-making.

5.2. eDNA for Disease Detection and to Support Surveillance Program of Crayfish Plague

Dr. David Strand (Norwegian Veterinary Institute, NVI) presented the application of environmental DNA (eDNA) for disease detection and surveillance, focusing on crayfish plague management in Norway and selected applications in aquaculture systems. The presentation outlined the development of eDNA-based methods, their integration into national surveillance programmes, and their potential role in early detection and disease monitoring.

Crayfish plague is a parasite associated with North American crayfish that was introduced to Europe in the mid-nineteenth century and reached Norway in the 1970s. The disease poses a severe threat to European freshwater crayfish species, particularly the native noble crayfish (*Astacus astacus*), which is ecologically and economically important in Norway. Although signal crayfish have not been officially introduced in Norway, illegal translocations from neighbouring countries have resulted in established populations that act as carriers of the pathogen, leading to repeated outbreaks and substantial losses of noble crayfish populations.

The presentation described the development of an eDNA detection method initiated in 2008–2009 and its application in freshwater surveillance. A case study from interconnected lake systems demonstrated the performance of eDNA monitoring in comparison with traditional approaches, including trapping and cage trials using live noble crayfish. Water samples were collected through on-site filtration and analysed using quantitative PCR assays targeting both the pathogen and crayfish host species. Results showed that eDNA consistently detected crayfish plague several weeks before mortality was observed in cage trials, enabling earlier recognition of outbreak progression and spatial spread through connected water bodies.

Long-term monitoring data indicated that crayfish plague DNA declined rapidly following host population collapse and was no longer detectable once crayfish were absent. These findings have supported the establishment of Norway's national crayfish plague surveillance programme, which has applied eDNA monitoring for over a decade across multiple river systems to inform management and conservation decisions.

In addition to freshwater systems, the presentation highlighted pilot applications of eDNA in aquaculture. Studies conducted in closed and semi-closed salmon farming systems demonstrated that eDNA could detect gill pathogens and reflect changes in microbial communities following fish introduction. Further work on pasteurellosis showed higher detection sensitivity in treatment chambers used during thermal delousing compared with open net pens, illustrating the influence of water volume and pathogen concentration on detection performance. The presentation concluded that eDNA can support early warning and reduce reliance on destructive sampling, while remaining a complementary tool to conventional diagnostics.

Discussion

- Regarding protocols for restocking water bodies after a crayfish plague outbreak, a five-year monitoring period with no detections is considered the standard to ensure the area is safe. Sampling is typically conducted at approximately ten stations along a river stretch twice a year, specifically in June and August when the plague is most active. Since the pathogen can persist in a river system for many years as it slowly moves upstream, the effort for eDNA sampling is increased during the final two years of the five-year monitoring phase to confirm the pathogen is truly eradicated.

- The spread of crayfish plague can progress through a population of noble crayfish independently of the invasive signal crayfish. Evidence has shown the plague moving upstream through noble crayfish populations while signal crayfish remained restricted to the southern part of the lake. Additionally, fish can act as a contributing factor to this spread; when fish consume infected or dying crayfish, they can transport the pathogen to different parts of the water system as they swim around.
- Sampling methodologies differ depending on the environment and the specific target. For detecting crayfish plague in the wild, water samples are collected close to the shore using tubing positioned just above the bottom to avoid sediment intake. In contrast, aquaculture sampling may range from surface water to depths of 20 meters. Regarding viral pathogens, studies utilize specific filtration methods combined with RNA qPCR assays for detection.
- Using eDNA to identify specific molecular epidemiology or genotypes is possible but relies heavily on the amount of DNA recovered. While the standard assay targets the ITS region for high sensitivity, distinguishing the five known genotypes requires targeting the CO1 region, which is only successful if the DNA concentration is high (Cq values around 33–34). When sufficient DNA is present, it is possible to link the genotype in the water to specific signal crayfish strains. This potential for genetic detection also extends to identifying antimicrobial resistance genes (ARGs) in water.

SESSION 6: UPDATES ON REGIONAL DISEASE REPORTING AND DISEASE LIST

6.1. REGIONAL AQUATIC ANIMAL DISEASE REPORTING

Dr. Eduardo Leaño presented the status of aquatic animal disease reporting in the Asia-Pacific region. In 2024, a total of 13 countries have submitted disease reports, while disease reports were received from only seven countries during the first two quarters of 2025 (Table 1).

Table 1. Disease reports received in 2024 and 2025 (2Q).

Country	2024	2025 (2Q)
1. Australia	4	2
2. Bangladesh	1	
3. Chinese Taipei	4	
4. Hong Kong SAR	4	2
5. India	4	2
6. Indonesia	4	2

7. Malaysia	**3**	**2**
8. Myanmar	**4**	**1**
9. New Zealand	**2**	
10. Philippines	**4**	
11. Saudi Arabia		**2 (first report)**
12. Singapore	**2**	
13. Thailand	**2**	
14. Vietnam	**4**	

The following diseases were reported from the 3rd quarter of 2024 to the 2nd quarter of 2025:

1. **Finfish Diseases:** Infection with epizootic haematopoietic necrosis virus (Australia); Infection with *Aphanomyces invadans* (EUS) (India); Infection with red seabream iridovirus/Infection with *Megalocytivirus pagrus* 1 (Chinese Taipei, Hong Kong, India and Indonesia); Infection with Tilapia lake virus (India, Indonesia and Malaysia); Infection with Koi herpesvirus (Indonesia and Malaysia); Grouper iridoviral disease (Chinese Taipei); Viral encephalopathy and retinopathy (Australia, Chinese Taipei, India and Indonesia); Enteric septicaemia of catfish (India, Indonesia and Vietnam); and, Infection with carp edema virus (India).
2. **Molluscan Diseases:** Infection with *Perkinsus olseni* (India); Infection with abalone herpesvirus (Australia).
3. **Crustacean Diseases:** Infection with White spot syndrome virus (Chinese Taipei, India, Indonesia and the Philippines); Infection with infectious hypodermal and haematopoietic necrosis virus (Australia and India); Acute hepatopancreatic necrosis disease (the Philippines); Infection with infectious myonecrosis virus (India and Malaysia); Infection with Taura syndrome virus (Indonesia); and, Hepatopancreatic microsporidiosis caused by *Enterocytozoon hepatopenaei* (India, Indonesia, Malaysia and the Philippines).
4. **Amphibian Disease:** Infection with *Batrachochytrium dendrobatidis* (Australia).
5. **Other Diseases:** Infection with Tilapia parvovirus (India).

Again, it is emphasised to the member countries that disease reporting is important for the control of transboundary diseases of aquatic animals by complying with their obligations to the WOAH to notify the occurrence of listed and emerging diseases. Sharing of information (including disease occurrences): create awareness so that the industry and regulators can actively take the needed risk management measures including emergency preparedness and response. Additionally, disease reporting is useful for countries that are having negotiations with their trading partners/countries (e.g. export of shrimp products), as most importing countries usually check their disease reporting history with reference to WOAH six-monthly report and/or NACA-WOAH-FAO AAD Reports. This transparency for disease information is very important for the country to build TRUST with their trading partners for export of their aquaculture products.

DISCUSSION

- Singapore confirmed that six-monthly reports to WOAH were up to date, but quarterly reports to NACA had not been completed beyond the second quarter of 2024 and would need to be backfilled using existing six-monthly data. Duplicate reporting between systems was identified as an administrative burden. Institutional separation was noted, with the WOAH Delegate based in Veterinary Services while food fish licensing and related data are managed by the Singapore Food Agency, leading to delays in information flow. Recent changes in food fish licensing arrangements were also cited, alongside ongoing efforts to improve inter-agency communication and workflow.
- Cambodia explained that the previous non-submission of reports was due to limited aquatic animal health disease monitoring activities and unfamiliarity with the NACA reporting process. In recent years, monitoring programmes have been initiated, generating data suitable for reporting. With increased activity in aquatic animal health surveillance, the country expressed commitment to resuming regular disease reporting and awaited further guidance on improvements to the reporting system.
- The Philippines indicated that surveillance information is regularly provided through national channels to the WOAH Delegate, but submission to WOAH depends on the delegate's office. In contrast, reports are submitted directly and regularly to NACA. This situation reflected a broader communication gap observed in several member countries, where separation between aquatic focal points and WOAH Delegates leads to delays or disruptions in official disease reporting.

6.2. PROPOSAL FOR NEW REGIONAL AQUATIC ANIMAL DISEASE REPORTING SYSTEM

Dr. Hirofumi Kugita (WOAH-RRAP) gave a presentation on a new proposal to improve aquatic animal disease reporting in the Asia-Pacific region, focusing on addressing duplication between the voluntary NACA Quarterly Aquatic Animal Disease (QAAD) system and the mandatory WOAH World Animal Health Information System (WAHIS), as well as declining participation in regional reporting. Although the QAAD reporting format was revised in January 2021 to allow rolling monthly data submissions, participation has steadily declined, with fewer than 40% of members currently submitting reports, including several major aquaculture-producing countries. Key challenges identified include the administrative burden associated with duplicate reporting requirements and coordination gaps between national focal points for disease notification, which are often located within terrestrial animal health divisions, and aquatic animal health authorities. While compliance with mandatory WAHIS six-monthly reporting remains high, immediate notification of aquatic animal diseases remains limited compared with terrestrial disease reporting.

To address these challenges, the WOAH Regional Commission endorsed a new reporting approach during its September conference in Jakarta, Indonesia. Drawing on the ASEAN Regional Animal Health Information System (ARAHIS) model for terrestrial diseases, the proposal recommends using the WAHIS Early Warning Module (EWM) for monthly reporting of endemic or stable WOAH-listed aquatic animal diseases. Under this framework, absent listed diseases would continue to be documented through six-monthly reports, while new outbreaks would require immediate notification. For non-WOAH-listed diseases, voluntary monthly reporting to NACA and WOAH-RRAP is encouraged. A preliminary list of nine priority aquatic animal diseases has been identified to pilot this approach. Monthly data submitted through WAHIS would automatically populate the mandatory six-monthly reports, thereby reducing duplicate reporting, while transparency and ease of submission would be enhanced through simplified online tools and a dedicated reporting dashboard.

Discussion

- The proposed new reporting system was described as a measure to reduce duplication between six-monthly WAHIS submissions and quarterly reports to WOAH Tokyo and NACA. While aquatic animal disease reporting was noted as not mandatory, it was reiterated as an obligation of appointed WOAH aquatic animal focal points.
- During the WOAH General Session in May, the Asia–Pacific region was reported to be performing better than other regions globally in terms of aquatic animal disease submissions. Despite this, the declining number of countries submitting reports through the NACA–WOAH regional system remained a concern. Similar institutional challenges were noted in Thailand, where aquatic focal points and WOAH Delegates are located in different departments, contributing to reporting delays.
- The revised regional aquatic animal disease reporting system was agreed to proceed in order to improve compliance with notification obligations and participation in reporting of non-WOAH-listed diseases. The system was intended to remain flexible, with a review planned after six months to one year of implementation to assess its impact.
- Reporting data from the past two years was proposed as a basis for refining the tentative list of nine priority pathogens. Frequently reported WOAH-listed diseases could be considered, with the scope likely to focus on finfish and crustaceans due to limited reporting of mollusc and amphibian diseases. Final decisions on prioritisation are to be made during the consultation with aquatic animal focal points on 18 December.
- Alignment with new reporting systems was noted to require time, based on experience with the ARAHIS system for terrestrial animal diseases. An online coordination meeting on 18 December will be used to explain the revised reporting system and to present survey findings on collaboration between disease notification focal points and aquatic animal health focal points, including national capacity for monthly reporting. An in-person aquatic focal point training for the Asia-Pacific region is being considered for 2026 to review progress and improve implementation.

6.3. Translucent Post-larva Disease (TPD): Disease Card and Endorsement for Listing in the Regional AAD Reporting

Dr. Eduardo Leano presented again the revised disease card for TPD, and sought for further comments and edits among AG members. It was suggested that the latest draft is again circulated after the AGM, and all comments received will be relayed back to Dr. Qingli Zhang for finalisation of the disease card.

For the listing, the criteria for WOAH listing was followed as summarized below:

A. **Consequences**: Significant production losses – In China, the disease has caused 90-100% mortality in shrimp hatcheries within three days upon the onset of the disease signs. This has caused closures of around 80% of hatcheries and significantly affected post-larva production. **CRITERION SATISFIED**.
B. **Spread**: Infectious aetiology is proven – The causative pathogen was identified as *Vibrio* spp. causing TPD (V_{TPD}). International spread is likely – Confirmed presence in China, and reported (thru published literature and presentations in international meetings) in Viet Nam. As shrimp PLs are highly traded commodity (both domestically and internationally), international spread is highly likely. Several countries may be declared free – Some countries around the region are already undertaking surveillance for the presence of the pathogen (e.g. Thailand, Philippines, Malaysia) and reported that TPD is still not present. **CRITERION IS SATISFIED**.
C. **Diagnosis**: A repeatable and robust means of detection – Molecular diagnostics were established using PCR (Jia *et al*., 2024) and Taqman probe based qPCR (Jia *et al*., 2024; Zhang *et al*., 2025). **CRITERION SATISFIED**.

Based on the above criterion, TPD is endorsed for inclusion in the regional AAD reporting under the non-WOAH listed diseases for crustaceans.

Discussion

- Translucent Post-Larvae Disease (TPD) was described as having a major impact at the hatchery level. In China, initial outbreaks reportedly resulted in the closure of approximately 80% of shrimp hatcheries. Although primarily affecting hatcheries, reports indicated that early grow-out stages may also be affected. The disease was attributed to a *Vibrio* species and noted to share similarities with AHPND.
- TPD was considered to meet regional listing criteria based on its significant impact, potential for transmission through international trade in post-larvae, the availability of reliable diagnostic methods, and its limited known geographic spread. The inclusion of TPD in the regional aquatic animal disease reporting programme and the publication of the disease card were supported to address widespread concern within the shrimp industry.
- Availability of diagnostic positive controls was discussed, with coordination ongoing with Dr. Qingli Zhang. Contact details will be included in the disease card to facilitate access to required materials.
- The status of TPD in Vietnam remained unresolved. Reports presented at international meetings originated from a private farm and have not yet been officially confirmed by the

competent authority. Formal confirmation was noted to require investigation and reporting by the Department of Fisheries and Fishery Surveillance. Although outbreaks were claimed to have occurred since December 2023 or January 2024, TPD has not been officially reported through national reporting channels.

SESSION 7. OTHER MATTERS AND CLOSING

- **12th Symposium on Diseases in Asian Aquaculture (DAA12):** Dr. Pravata Pradhan presented a report on the recently held 12th Symposium on Diseases in Asian Aquaculture (DAA 12) in Chennai, India on 23-27 September 2025. DAA12 was organised by the Fish Health Section (FHS) of the Asian Fisheries Society (AFS) in collaboration with ICAR-Central Institute of Brackishwater Aquaculture (CIBA). The event brought together 470 participants including leading scientists, academicians, students, policymakers, and aquaculture industry professionals, to share the latest research and innovations in aquatic animal health. With the overarching theme 'Transformative Innovations Shaping the Future of Aquatic Animal Health Management', the symposium focused on emerging diseases, biosecurity, vaccines, diagnostics, One Health, and sustainable technologies shaping the future of aquaculture in Asia, and it included 18 keynote/lead, 49 oral and 189 poster presentations. A new set of Executive Committee officers and members (2025-2028) were also elected during the 13th Triennial General Meeting (TGM 13).

- The AGM 24 officially closed at 16:30 PM (BKK time), 25 November 2025.

GENERAL RECOMMENDATIONS

From the extensive discussions made throughout the two-day meeting, the following recommendations were formulated by the group:

- AG recommended that potential alternatives to antimicrobials should be promoted, especially at the farm level, through awareness programmes and proper usage. The regulatory barriers in the adoption of these products at the farm level should also be addressed;
- On reporting of *Megalocytivirus pagrus* 1, AG recommended that Member Countries can specify the reported genogroup (RSIV, ISKNV, or TRBIV) in their report submitted to both WOAH-RRAP and NACA. The selection of this disease under the WOAH Observatory case study reflects the transition from a previously listed disease limited to RSIV to a broader listing encompassing three genogroups, and will examine Member Country's adoption of standards and associated implications for trade;
- On hatchery and pond designs, AG recommended that practical construction guidance should be formulated to address small but critical design details not normally visible in hatchery or pond layouts, such as exhaust points that eliminate air gaps during pipe disinfection and features that allow proper inspection and cleaning of pipelines. A ground-

level guide focused on these operational details should be considered, which can play a critical role in the management of most infectious microorganisms that has the potential to cause disease outbreaks if left unattended;

- On prevention of disease spread from aerosols, AG recommended plastic sheeting between tanks which can provide physical separation, and make use of the sentinel bacteriology plates which can indicate horizontal pathogen spread and inform adjustments to tank/pond layouts;
- On the use of eDNA for pathogen detection and disease surveillance, AG recommended that further validation and guidance, including from WOAH, should be pursued to clarify how eDNA findings should inform disease control and regulatory decision-making;
- AG recommended and endorsed the proposed (new) regional aquatic animal disease reporting which will involve reporting of WOAH listed diseased directly to WAHIS, and the non-WOAH listed diseases to NACA and WOAH-RRAP through online Google or Microsoft form. The new reporting system was described as a measure to reduce duplication between six-monthly WAHIS submissions and quarterly reports to WOAH Tokyo and NACA;
- AG recommended and endorsed the disease card for the new crustacean disease, Translucent Post-larva Disease (TPD), and its inclusion in the AP regional disease list for reporting, under the non-WOAH listed diseases for Crustaceans.

ANNEX A

24TH MEETING OF ASIA REGIONAL ADVISORY GROUP ON AQUATIC ANIMAL HEALTH (AGM24) (VIRTUAL MEETING) 24-25 NOVEMBER 2025 13:00-16:00 (BKK TIME; GMT+7)

PROVISIONAL AGENDA:

Day 1 (24 November; Monday)

Welcome and Introduction (15 mins)

- Introduction and welcome remarks (**Dr. Eduardo Leaño, DG NACA**)
- Self-introduction (**all participants**)

Chairperson will take over in moderating the meeting

- Progress since AGM 23 (30 mins; **Dr. Eduardo Leaño, NACA**)
- Updates from WOAH Aquatic Animal Health Standards Commission (30 mins; **Dr. Ingo Ernst, AAHSC, WOAH**)
- Regional aquatic animal health activities of SEAFDEC AQD (30 mins; **Ms. Lovelyn Marie Naluaran, SEAFDEC AQD**)
- The hidden highways of death: Critical biosecurity insights for shrimp production (30 mins; **Dr. Andy Shinn, INVE Aquaculture**)

Note: 15-20 minutes discussion and recommendations after each presentation (Country representatives are encouraged to participate actively in the discussion)

Day 2 (25 November; Tuesday)

- Welcome and recap of day 1 (5 mins; **NACA Secretariat**)
- Advancing the Biosurveillance of Emerging Aquatic Pathogens in Singapore with Environmental DNA (30 mins; **Dr Brian Tan, NParks, Singapore**)
- eDNA for disease detection and to support surveillance program of crayfish plaque (30 mins; **Dr. David Strand, NVI**)
- AP Aquatic Animal Disease Reporting: status and updates (10 mins; **Dr. Eduardo Leaño, NACA**)
- New Aquatic Animal Disease Reporting: Proposal (30 mins; **Dr. Hirofumi Kugita, WOAH-RRAP**)
- Other matters (DAA12-Chennai, India report; TPD disease card and listing) and Closing (20 mins)

Note: 15-20 minutes discussion and recommendations after each presentation (Country representatives are encouraged to participate actively in the discussion)

ANNEX B

List of Participants (AGM 24)

I. Advisory Group Members
World Organisation for Animal Health (WOAH) / Australia
Dr. Ingo Ernst (WOAH AAHSC; DAWE-Australia) Director, Aquatic Pest and Health Policy Animal Division, Australian Government Department of Agriculture, Water and the Environment GPO Box 858, Canberra ACT 2601, Australia Ingo.Ernst@awe.gov.au
WOAH Regional Representation for Asia and the Pacific, Tokyo, Japan
Dr. Hirofumi Kugita Regional Representative WOAH Regional Representation for Asia and the Pacific Food Science Building 5F The University of Tokyo 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113-8657, Japan h.kugita@woah.org
Aquatic Animal Health Research and Development Division, Department of Fisheries, Thailand
Dr. Puttharat Baoprasertkul Director, Aquatic Animal Health Research and Development Division Department of Fisheries, Kasetsart University Campus Ladyao, Jatujak, Bangkok 10900, Thailand puttharat@hotmail.com
SEAFDEC AQD, Philippines
Ms. Lovelyn Marie Naluaran Asdsociate Researcher Fish Health Section, Research Division SEAFDEC Aquaculture Department Tigbauan, Iloilo, Philippines lmnaluaran@seafdec.org.ph
Private Sector
Dr. Andy Shinn Global Technical Expert (Health) INVE Aquaculture (Thailand), 471 Bond Street, Pakkred, Nonthaburi 11120, Thailand a.shinn@inveaquaculture.com
P.R. China
Dr. Liu Hong Director State Laboratory of Aquatic Animal Diseases Shenzhen Customs District General Administration of Customs Shenzhen, Guangdong Province 518045 P.R. China 709274714@qq.com

II. Co-opted members
Dr. Siow-Foong Chang National Parks Board Animal and Veterinary Services JEM Office Tower, 52 Jurong Gateway Road, #09-01, Singapore chang_siow_foong@nparks.gov.sg
Dr. Diana Chee National Parks Board Animal and Veterinary Services JEM Office Tower, 52 Jurong Gateway Road, #09-01, Singapore Diana_CHEE@nparks.gov.sg
Dr. Saraya Tavornpanich Norwegian Veterinary Institute Ås, Norway saraya.tavornpanich@vetinst.no
III. Country representatives/Observers
Dr. Yuko Hood Principal Science Officer Aquatic Pest and Health Policy Section, Animal Health Policy Branch Department of Agriculture, Water and Environment Canberra, Australia Yuko.Hood@awe.gov.au
Dr. Md. Habib Forhad Alam Assistant Director Department of Fisheries Matshabhaban, Ramna, Dhaka, Bangladesh forhadalam477@yahoo.com
Mr. Chan Dara Khan Chief of Office of Aquatic Animal Health & Disease Management Department of Aquaculture Development, Fisheries Administration, Ministry of Agriculture Forestry and Fisheries, Phnom Penh, Cambodia chandara_khan@yahoo.com
Dr. Luk Kar Him, Peter Fisheries Officer (Aquaculture Projects) Agriculture, Fisheries and Conservation Department 5/F, Cheung Sha Wan Government Offices, 303 Cheung Sha Wan Road Kowloon, Hong Kong SAR peter_kh_luk@afcd.gov.hk
Dr. Pravata K. Pradhan Principal Scientist Fish Health Management and Exotics Division ICAR- National Bureau of Fish Genetic Resources Lucknow-226002, India pradhanpk1@gmail.com
Dr. Kua Beng Chu Deputy Director, Fisheries Research Institute, Department of Fisheries Malaysia Penang, Malaysia kbengchu@yahoo.com

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Ms. Fathimath Shazra Mueen Aquaculturist Ministry of Fisheries and Aquaculture Male, Maldives fathimath.shazra@mmri.gov.mv
Dr. May Zun Phyo Staff Officer Department of Fisheries Yangon, Myanmar mayzunphyo7@gmail.com
Dr. Sonia Somga Officer-in-Charge National Fisheries Laboratory Division Bureau of Fisheries and Aquatic Resources Quezon City, Philippines soniasomga@yahoo.com
Dr. Le Hong Phuoc Deputy Director, RIA 2 lehongphuoc@yahoo.com **Dr. Nguyen Thi Thuy** Senior Officer thuyntu@gmail.com Directorate of Fisheries and Fisheries Surveillance Ministry of Agriculture and Environment Hanoi, Viet Nam
WOAH Regional Representation for Asia and the Pacific Food Science Building 5F The University of Tokyo 1-1-1 Yayoi, Bunkyo-ku, Tokyo 113-8657, Japan • **Dr. Chyna Suit-B Yong,** Aquatic Animal Health Officer; s.yong@woah.org • **Dr. Shohei Urushizaki,** Regional Veterinary Officer; s.urushizaki@woah.org • **Dr. Jacqueline Lusat,** Animal Health Information Officer; j.lusat@woah.org
Dr. Brian Tan National Parks Board Animal and Veterinary Services JEM Office Tower, 52 Jurong Gateway Road, #09-01, Singapore Brian_TAN@nparks.gov.sg
IV. NACA Secretariat
Suraswadi Building, Department of Fisheries Compound Kasetsart University Campus, Ladyao, Jatujak Bangkok 10900, Thailand **Dr. Eduardo Leaño**, Director General; Senior Progamme Officer, Health and Biosecurity, eduardo@enaca.org **Mr. Simon Wilkinson**, Senior Programme Officer, Information and Communication, simon@enaca.org **Dr. Derun Yuan**, Senior Programme Officer, Sustainability and Environment, yuan@enaca.org

Mr. Chokanan Prompichai, Senior Programme Officer, Training and Education, chokanan@enaca.org

ANNEX C

List of Diseases in the Asia-Pacific

Reportable Aquatic Animal Diseases
(Beginning January 2026)

1. DISEASES PREVALENT IN THE REGION	
1.1 FINFISH DISEASES	
OIE-listed diseases	**Non OIE-listed diseases**
1. Infection with epizootic haematopoietic necrosis virus	1.Grouper iridoviral disease
2. Infection with infectious haematopoietic necrosis virus	2.Viral encephalopathy and retinopathy
3. Infection with spring viraemia of carp virus	3.Enteric septicaemia of catfish
4. Infection with viral haemorrhagic septicaemia virus	4.Carp edema virus disease (CEVD)
5. Infection with *Aphanomyces invadans* (EUS))	
6. Infection with *Megalocytivirus pagrus* 1	
7. Infection with koi herpesvirus	
8. Infection with tilapia lake virus	
1.2 MOLLUSC DISEASES	
OIE-listed diseases	**Non OIE-listed diseases**
1. Infection with *Bonamia exitiosa*	1. Infection with *Marteilioides chungmuensis*
2. Infection with *Perkinsus olseni*	2. Acute viral necrosis (in scallops)
3. Infection with abalone herpes-like virus	
4. Infection with *Xenohaliotis californiensis*	
5. Infection with *Bonamia ostreae*	
1.3 CRUSTACEAN DISEASES	
OIE-listed diseases	**Non OIE-listed diseases**
1. Infection with Taura syndrome virus (TSV)	1. Hepatopancreatic microsporidiosis (HPM) caused by *Enterocytozoon hepatopenaei* (EHP)
2. Infection with White spot syndrome virus (WSSV)	
3. Infection with yellow head virus genotype 1	2. Viral covert mortality diseases (VCMD)
4. Infection with Infectious hypodermal and haematopoietic necrosis virus (IHHNV)	3. *Spiroplasma eriocheiris* infection
5. Infection with Infectious myonecrosis virus (IMNV)	4. Translucent post-larva disease (TPD)
6. Infection with *Macrobrachium rosenbergii* nodavirus (MrNV; White tail disease)	
7. Infection with *Hepatobacter penaei* (Necrotising hepatopancreatitis)	
8. Acute hepatopancreatic necrosis disease (AHPND)	
9. Infection with *Aphanomyces astaci* (Crayfsh plague)	
10. Infection with Decapod iridescent virus 1 (DIV1)	
1.4 AMPHIBIAN DISEASES	
OIE-listed diseases	**Non OIE-listed diseases**
1. Infection with *Ranavirus* species	
2. Infection with *Bachtracochytrium dendrobatidis*	
3. Infection with *Batrachochytrium salamandrivorans*	
2. DISEASES PRESUMED EXOTIC TO THE REGION	
2.1 Finfish	
OIE-listed diseases	**Non OIE-listed diseases**
1. Infection with HPR-deleted or HPR0 salmon anaemia virus	1. Channel catfish virus disease
2. Infection with salmon pancreas disease virus	
2. Infection with *Gyrodactylus salaris*	
2.2 Molluscs	
OIE-listed diseases	**Non OIE-listed diseases**
1. Infection with *Marteilia refringens*	
2. Infection with *Perkinsus marinus*	

Annex D

Asia Regional Technical Guidelines – Status Overview (adopted from AGM 9 Report)

Element of technical guidelines	Progress / status	Gaps / opportunities
1. Disease reporting *An understanding of the basic aquatic animal health situation is a pre-requisite for prioritising activities, developing national policy and identifying pathogens of national importance.*	• Regional QAAD reporting system established – participation has increased • The QAAD list has incorporated emerging diseases that were later listed by the OIE • Many countries have established national lists for reporting purposes with appropriate supporting legislation	• Participation could improve further – some countries report irregularly • The proposed regional core utilising the OIE's WAHID will streamline reporting and may improve participation • The exact status of individual countries with regard to adoption of national lists and supporting legislation is not know
2. Disease diagnosis *Diagnosis requires various levels of data, starting with farm- or site-level observations and progressing in technical complexity to electron microscopy, immunological and nucleic acid assays and other biomolecular methods. This means all levels of expertise, including that of the farmer and extension officer working at the pond side, make essential contributions to rapid and accurate disease diagnosis.* *Effective diagnostic capability underpins a range of programs including early detection for emergency response and substantiating disease status through surveillance and reporting.*	• Diagnostic capabilities have improved in many countries • NACA disease cards have been developed and maintained for emerging diseases • The Asia regional diagnostic manual has been developed • An Asia regional diagnostic field guide has been developed • OIE reference laboratories • Regional reference laboratories – where no OIE reference laboratory exists • Regional Resource Experts are available to provide specialist advice • Ad hoc laboratory proficiency testing programs have been run	• OIE twinning programs are a means to assist laboratories to develop capabilities • The exact status of diagnostic capability in individual countries is not certain • There is limited or no access to ongoing laboratory proficiency testing programs • Some areas of specialist diagnostic expertise are lacking • Network approaches are a means draw on available diagnostic expertise
3. Health certification and Quarantine measures *The purpose of applying quarantine measures and health certification is to facilitate transboundary trade in aquatic animals and their products, while minimising the risk of spreading infectious diseases*	• Strong progress has been made, particularly for high risk importations (e.g. importation of broodstock and seed stock) • Training has been provided through regional initiatives (e.g. AADCP project) • Commercial implications for trade have driven improved certification practices • Harmonisation with OIE model certificates has occurred	• The importance of supporting aquatic animal health attestations through sound aquatic animal health programs continues to be underestimated, with possible ramifications for trade • Some inappropriate or illegal activities continue and threaten to spread trans-boundary diseases

4. Disease zoning and compartmentalisation *Zoning (and compartmentalization) allows for part of a nation's territory to be identified as free of a particular disease, rather than having to demonstrate that the entire country is free. This is particularly helpful to facilitate trade in circumstances where eradication of a disease is not feasible.Zoning is also an effective tool to restrict the spread of important pathogens and aid in their eradication.*	• Is an emerging need to meet requirements of importing countries • To facilitate trade, some countries are working toward having compartments and zones recognised	• Where common health status can be identified restrictions on trade can be reduced • Training opportunities would be beneficial • Learn from the experience of terrestrial animal industries (e.g. poultry)
5. Disease surveillance and reporting *Necessary to produce meaningful reports on a country's disease status by providing evidence to substantiate claims of absence of a particular disease and thereby support import risk analysis, justify import health certification requirements, and enable export health certification*	• Regional Resource Experts are available to provide specialist advice • Training has been provided through a number of initiatives (e.g. AADCP project) • Many published resources are available, including those of the OIE (publications and the OIE centre for aquatic animal epidemiology) • Collation of surveillance information has improved through participation in international reporting	• Remains a reliance on passive surveillance. Active surveillance may be beneficial but cost is often a barrier. • Methodologies to undertake effective but low-cost active surveillance would be of assistance • Epidemiological expertise is often limited • There is a need to increase surveillance of wildlife to support health status
6. Contingency planning *Important to provide a rapid and planned response for containment of a disease outbreak—thereby limiting the impact, scale and costs of the outbreak*	• Important provides a rapid and planned response for containment of a disease outbreak Some countries have advanced contingency planning with appropriate supporting legislation • Some countries have tested contingency plans through simulation exercises • Resources are available (e.g. Australia's AQUAVETPLAN, FAO guidelines, OIE links to resources)	• The exact status of contingency planning in individual countries is not certain • Training in emergency management frameworks may be useful • Support for developing contingency plans might usefully be directed at particular disease threats e.g. IMN
7. Import risk analysis *The movement of live aquatic animals involves a degree of disease risk to the importing country. Import risk analysis (IRA) is the process by which hazards associated with the*	• Numerous resources and case studies published • The approach has been applied, particularly for some circumstances e.g. import of live *P. vannamei*	• There is a need to build awareness of the concepts • Training can be abstract and disengaging - should aim at trainees learning on scenarios relevant to their circumstances • This is a high priority generic need that is suited to

movement of a particular commodity are identified and mitigative options are assessed. The results of these analyses are communicated to the authorities responsible for approving or rejecting the import.	• However risk analysis is not always applied, or is not applied appropriately • Regional training has been provided (e.g. AADCP project)	development of a central training program
8. National strategies *The implementation of these Technical Guidelines in an effective manner requires an appropriate national administrative and legal framework, as well as sufficient expertise, manpower and infrastructure.*	• Many countries have developed national strategies • Detailed assistance has been provided to some countries (e.g. AADCP project)	• The exact status of national strategies in individual countries is not certain • The OIE's PVS tool provides a means of assessing the progress of individual countries

Annex E: Disease card for Translucent Post-larva Disease (TPD)

Diseases of Crustaceans – **Translucent Post-larvae Disease (TPD)**

Figure 1. Clinical signs of *Penaeus vannamei* affected by translucent post-larvae disease (TPD) / translucent post-larvae vibriosis (TPV) / glass post-larvae disease (GPD). All the samples were at PL7 stage, and body length was about 0.6~0.9 cm. The diseased individuals (indicated by the white arrows) demonstrated syndromes of abnormal hepatopancreas and digestive tract necrosis. The hepatopancreas and digestive tract of the diseased post-larvae were pale and colorless. The bar scales are 10 mm and 2 mm in the figures and the magnified figures, respectively. Source: QL Zhang

General Signs of Disease

Important: affected animals may show one or more of the signs below, but the infection may be present in the absence of any signs, especially during the early phase of infection.

- The diseased shrimps show pale and colorless of hepatopancreas and digestive tract (Figure 1), as well as pale and shrunken body. The affected post-larvae sink to the bottom of rearing tanks because of the decreased swimming capability caused by the disease.
- The disease progresses very quickly, a few individuals initially show clinical signs on the first day, 60% mortality accrues on the second day, and more than 90% mortality may accrue on the

Disease agent

The pathogen of TPD a *Vibrio* spp. causing TPD (V_{TPD}), which carries the *Vibrio* high virulent protein (VHVP)-1 and VHVP-2.

Translucent post-larvae disease

Host range

Crustaceans known to be susceptible to infection with V_{TPD} (RT-PCR and ISH positive) include *Penaeus vannamei, P. chinensis,* and *P. japonicus* (Zou *et al*., 2020; Liu, *et al*., 2023; Jia *et al*., 2024).

Geographical Distribution

TPD occurred in hatcheries in China (2020) and Vietnam (2023) (Zou *et al*., 2020; Vietnam Fisheries Magazine, 2023; Hong Tham, 2024).

Similar Diseases

- Acute hepatopancreatic necrosis disease (AHPND). **Note:** the virulence of V_{TPD} is about 1000 times higher than that of V_{AHPND} (Zou et al., 2020; Yang *et al*., 2021).

Epidemiology

- The disease mostly affects post-larvae at four to seven days old (PL2~PL7), and is highly infectious and lethal
- The morbidity of a diseased population can reach up to 60% in 24h after first observation of clinical signs, and even up to 90–100% in severe cases on the second to third day (Zou *et al*., 2020; Yang *et al*., 2021).
- Horizontal transmission was observed in the hatchery tanks and ponds (Jia *et al*., 2024).

Prevention and Control

- Due to the high lethality and transmission of TPD, it is strongly recommended to stop production, destroy affected stock and thoroughly disinfect all culture facilities as soon as the pathogen enters the culture system.
- When the disease becomes obvious, no chemical medicine or disinfectant has been found that is effective in stopping or slowing down the disease.
- PHMB is generally safe with low toxicity. Animal studies show an oral LD50 exceeding 5,000 mg/kg, classifying it as "practically non-toxic." It causes no skin or eye irritation at proper dilutions and has been approved for use in various medical applications including wound care, surgical disinfection, and even eye drops for treating *Acanthamoeba keratitis*. In aquaculture, PHMB effectively controls harmful bacteria like *Vibrio* species and prevents diseases in aquatic species. The environmental impact appears minimal when used at recommended concentrations.

Translucent post-larvae disease

Histopathology

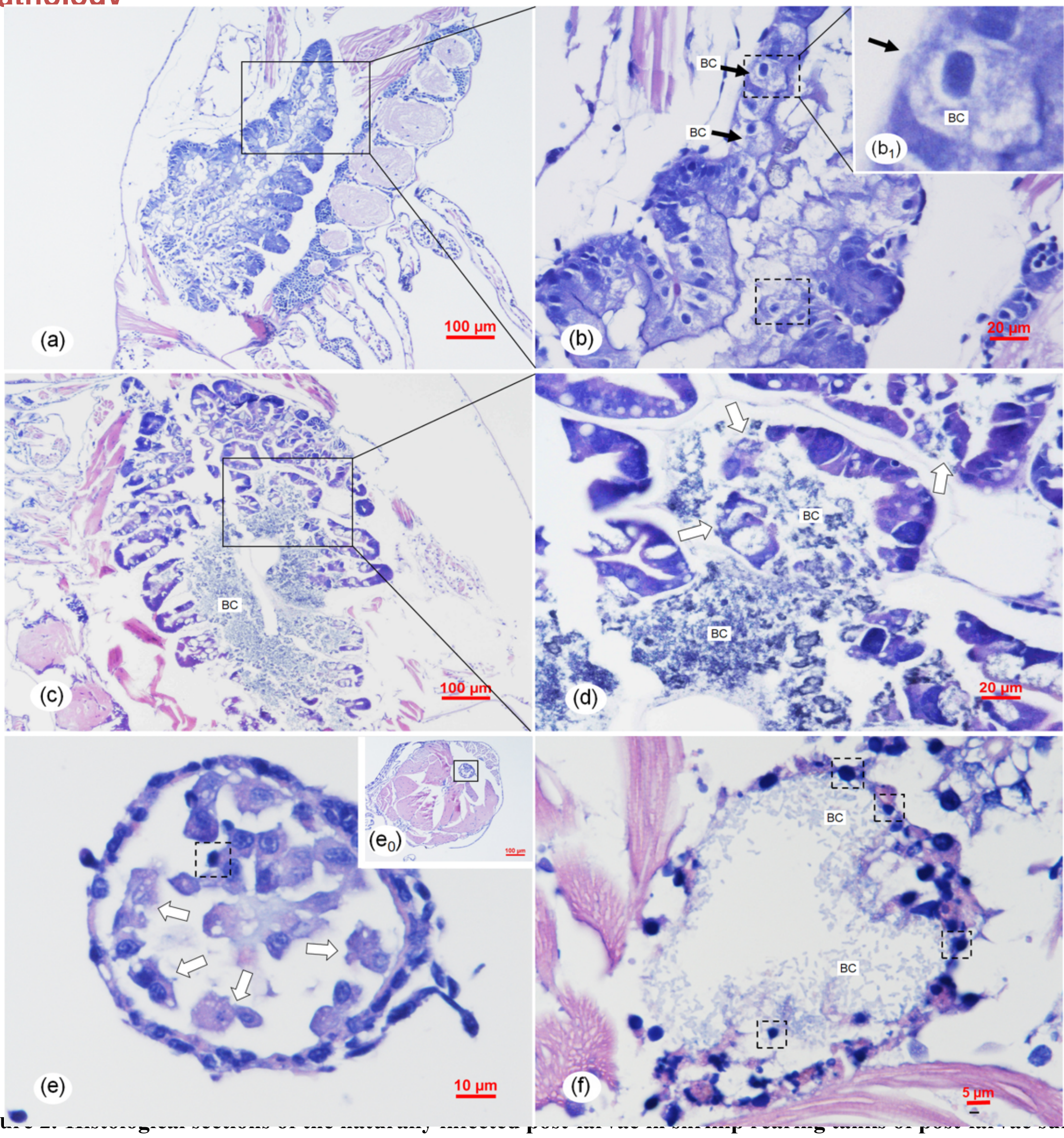

Figure 2. Histological sections of the naturally infected post-larvae in shrimp-rearing tanks of post-larvae suffering from TPD. (a, b) Early phase with active destruction of the hepatopancreas. Note the mild necrosis of epithelial cells (ECs) of hepatopancreatic (HP) tubules, especially the ECs in the dotted boxes showing typical dark, smaller, and condensed nuclei. The bacterial colonization (BC) in the early phase of infection were indicted by the black arrows. The arrowed ECs (black arrow) were B-cells with the large vacuoles. (c, d) Acute phase with massive bacterial invasion. There was vast bacterial invasion of the hepatopancreatic tubules in half of the organs, where the bacterial masses and the tubules were destroyed. Note the detachment/sloughing of hepatopancreatic ECs (white arrows). (e, f) Midgut of an affected digestive tract of a naturally infected post-larvae showing necrosis (dotted box) and sloughing (white arrows) of ECs of the digestive tract. Note the mass BC in the tubule lumens of the digest tract at the midgut. (b), (b1), (d), and (e) are the magnified micrographs of the area in the black frames in (a), (b), (c), and (e0), respectively. (a), (b), and (e) show the pathological change in the early phase of infection. (c), (d), and (f) show the pathological change in the acute phase of infection. Scale bars = (a) 100 µm, (b) 20 µm, (c) 100 µm, (d) 20 µm, (e0) 100 µm, (e) 10 µm, and (f) 5 µm.. Source: QL Zhang

Translucent post-larvae disease

Molecular Diagnostics

PCR methods

Molecular diagnostic method was established based on the sequence of VHVP gene. The reported methods include:

- A comman PCR (PCR) (Jia, *et al*., 2024).

Taqman probe based qPCR methods

- Two different taqman probe based qPCR methods for V_{TPD} were described in 2024 (Jia *et al*., 2024) and in 2025 (Zhang *et al*., 2025). The TaqMan qPCR targeted the double fragments on the sequence of VHVP gene reported by Zhang *et al*. in 2025 has better specificity and compatibility.

Table 1. Primers and Probe for the abovementioned methods

Methods	**Primers/Probe**	**Sequences (5'-3')**	**Ta**	**Target region**
TaqMan Qpcr [1]	vhvp_SpvB-F1	AGTCGTTTGGAGTATTGGGTG	59°C	72 bp
	vhvp_SpvB-R1	GCCATCAGAGGTGTAGATCAC		
	vhvp_SpvB-P1	6-FAM-TCTTCGAGTGCTGCGACCACTTT-TAMRA		
	vhvp_TcdB-F2	GTAATCGTTTGGTTAGCACCG	59°C	77 bp
	vhvp_TcdB-R2	ACCAAACCCACGGAACTC		
	vhvp_TcdB-P2	VIC-CACGGCCATCCCAGACTCCAT-BHQ1		
PCR [2]	VHVP-1-P -F	GAGGAGAGTGTTGACCGAAATC	58°C	362 bp
	VHVP-1-P -R	CTGCGCCAGTAGTAACGATAAG		
	VHVP-2-P -F	GCTGGTCCGGACGGTGCC	60°C	864 bp
	VHVP-2-P -R	GTGATACATTAATACTTGTCTACAA		
	VHVP-3-P -F	CCCGTATCACAGAGCGATTT	58°C	306 bp
	VHVP-3-P -R	CTTTGGTGTCGGTCGTAGTT		
TaqMan qPCR [2]	VHVP-F	AACTCCCGAAATCCGTCAAG	55.7°C	119 bp
	VHVP-R	ACACCCAATACTCCAAACGAC		
	VHVP-P	AGGCATGGACCGTAAAGCTCTCAC		

[1] The TaqMan qPCR detection method targeted the double fragments on the sequence of VHVP gene (Zhang *et al*., 2025).

[2] The TaqMan qPCR detection method targeted the single virulence gene (Jia *et al*., 2024).

Translucent post-larvae disease

List of Experts:

Dr. Qingli Zhang
Maricultural Organism Diseases Control & Molecular Pathology Laboratory
Yellow Sea Fisheries Research Institute
Chinese Academy of Fishery Sciences
106 Nanjing Road
Qingdao, SD 266071
PR China
zhangql@ysfri.ac.cn

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