NETWORK OF AQUACULTURE CENTRES IN ASIA-PACIFIC

Eighteenth Meeting of the Asia Regional Advisory Group on Aquatic Animal Health

REPORT OF THE MEETING

Amari Don Mueang Hotel, Bangkok, Thailand

18-19 November 2019

Prepared by the NACA Secretariat

Preparation of this document:

This report was prepared by the 18th Asia Regional Advisory Group on Aquatic Animal Health (AG) that met at Bangkok, Thailand on 18-19 November 2019.

The Advisory Group 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 Animal Health Organisation (OIE) and the Food and Agricultural Organization of the United Nations (FAO), collaborating regional organisations such as SEAFDEC Aquaculture Department (SEAFDEC AQD) and OIE-Regional Representation in Asia and the Pacific (OIE-RRAP), and the private sector.

Reference: NACA 2019. Eighteenth 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

AAH	Aquatic Animal Health
AAHRDD	Aquatic Animal Health Research and Development Division of DoF Thailand
AAHSC	Aquatic Animal Health Standards Commission of the OIE
AG	Advisory Group
AGM	Advisory Group Meeting
AHPND	Acute hepatopancreatic necrosis disease
AMC	ASEAN Member Countries
AMR	Antimicrobial resistance
AMU	Antimicrobial use/usage
ANAAHC	ASEAN Network of Aquatic Animal Health Centres
ASEAN	Association of South East Asian Nations
AVG	Abalone viral ganglioneuritis
AVM	Abalone viral mortality
BD	*Batrachochytrium dendrobatidis*
BMP	Best management practices
CA	Competent authority
CAAHRI	Coastal Aquatic Animal Health Research Institute
CMNV	Covert mortality nodavirus
COFI	Committee on Fisheries (FAO)
DAWR	Australian Government Department of Agriculture and Water Resources
DIV-1	Decapod iridescent virus 1
DoF	Department of Fisheries (Thailand)
EU	European Union
EUS	Epizootic ulcerative syndrome
FAO	Food and Agricultural Organization of the United Nations
FAO-RAP	FAO Regional Office for Asia and the Pacific
GACC	General Administration of Customs, PR China
GBS	Group B *Streptococcus*
HPM-EHP	Hepatopancreatic microsporidiosis caused by *Enterocytozoon hepatopenaei* (EHP)
ICTV	International Committee on Taxonomy of Viruses
IHHN	Infectious hypodermal and haematopoietic necrosis
IHNV	Infectious haematopoietic necrosis virus
IMN	Infectious myonecrosis
IMNV	Infectious myonecrosis virus
ISKNV	Infectious spleen and kidney necrosis virus
KHV	Koi herpesvirus
LPT	Laboratory proficiency testing
LcBV	*Lates calcarifer* Birnavirus
LcHV	*Lates calcarifer* Herpesvirus
MARA	Ministry of Agriculture and Rural Affairs, PR China
MBV	Monodon baculovirus
NACA	Network of Aquaculture Centres in Asia-Pacific
NAP	National Action Plan
NC	National Coordinator
NFTEC	National Fisheries Technology Extension Center, PR China
NHP	Necrotising hepatopancreatitis
OIE	World Organisation for Animal Health
OIE PVS	OIE Performance of Veterinary Services (tool)
OIE-RRAP	OIE Regional Representation in Asia and the Pacific, Tokyo, Japan

OsHV-1	Ostreid herpesvirus-1
PCR	Polymerase chain reaction
POC	Province of China
POMS	Pearl oyster mortality syndrome
RT-PCR	Reverse transcriptase PCR
SDDV	Scale drop disease virus
SEAFDEC	Southeast Asian Fisheries Development Center
SEAFDEC-AQD	Southeast Asian Fisheries Development Center Aquaculture Department
SHIV	Shrimp hemocyte iridescent virus
SPF	Specific pathogen free
SPR	Specific pathogen resistant
SPT	Specific pathogen tolerant
SVC	Spring viraemia of carp
SVCV	Spring viraemia of carp virus
TCP	Technical cooperation project
TG	Technical Guidelines (Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals)
TiLV	Tilapia lake virus
TSV	Taura syndrome virus
VCMD	Viral covert mortality disease
VHS	Viral haemorrhagic septicaemia
VNN	Viral nervous necrosis
VP	*Vibrio parahaemolyticus*
WAHIS	World Animal Health Information System
WAHID	World Animal Health Information Database
WFS	White faeces syndrome
WHO	World Health Organization
WSD	White spot disease
WSSV	White spot syndrome virus
WTD	White tail disease
WTO	World Trade Organization
YHV	Yellowhead virus

The 18th Asia Regional Advisory Group on Aquatic Animal Health.

Back Row (From Left to Right)

Dr. Chenxu Cai (NFTEC, MARA, P.R. China), **Dr. Eduardo Leaño** (NACA, Thailand), **Mr. Simon Wilkinson** (NACA, Thailand), **Dr. Andy Shinn** (Fish Vet Group, Thailand), **Dr. JIe Huang** (NACA, Thailand), **Dr. Kjetyl Fyrand** (PHARMAQ, P.R. China), **Mr. Weimin Miao** (FAO-RAP, Thailand), **Prof. Timothy Flegel** (Centex Shrimp, Thailand), **Dr. Ingo Ernst** (DA, Australia and AAHSC, OIE, France), **Dr. Chun-Ming Yu** (Observer, BAPHIQ, Taiwan POC), **Dr. Siow-Foong Chang** (National Parks Board, Singapore)

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OPENING SESSION

The 18th meeting of the Asia Regional Advisory Group on Aquatic Animal Health convened in Bangkok, Thailand on the 18-19 November 2019. The meeting was held back to back with the OIE 1st Meeting of the *ad hoc* Steering Committee of the Regional Collaboration Framework on Aquatic Animal Health in Asia and the Pacific held on 20-21 November.

The meeting was opened by Dr. Eduardo Leaño, Aquatic Animal Health Programme Coordinator of NACA and Technical Secretary of the AG. Welcome remarks were given by Dr. Jie Huang, Director General of NACA. After brief self-introduction by all of the participants, Dr. Siow-Foong Chang (NParks, Singapore), Chair of the AG, facilitated the meeting. The meeting agenda (**Annex 1**) was then adopted without amendment. The complete list of participants is attached as **Annex 2**.

SESSION 1: PROGRESS SINCE AGM-17

1.1. PROGRESS REPORT FROM NACA'S REGIONAL AQUATIC ANIMAL HEALTH PROGRAMME

Dr. Eduardo Leaño presented the progress report of NACA's Regional Aquatic Animal Health Programme since the previous AGM 17 which was held in Bangkok, Thailand on 13-14 November 2018 (back-to-back with the OIE Regional Expert Consultation on Aquatic Animal Disease Diagnosis and Control held on the 15-16 November). The report of the meeting (e-copy) was widely circulated among NACA member countries and partner organizations, and published on the NACA website for free download. Three Quarterly Aquatic Animal Disease Reports (3rd to 4th quarters of 2018 and 1st quarter of 2019), were published and made available for free download on both the NACA and OIE-RRAP websites. The increasing importance of aquaculture biosecurity in the prevention and management of transboundary aquatic animal diseases has resulted in a new FAO initiative called the Progressive Management Pathway for improving Aquaculture Biosecurity (PMP/AB), which NACA fully supported. PMP/AB refers to a pathway aimed at enhancing aquaculture biosecurity capacity by building on existing frameworks, capacity and appropriate tools using risk-based approaches and public-private partnerships. Details of this initiative are presented in **Section 2.3**.

NACA has co-organized with the Indian Council of Agricultural Research (ICAR) a school on aquatic animal epidemiology and disease surveillance which was hosted by the National Bureau of Fish Genetic Resources (NBFGR) in March 2019 in Lucknow, India. The school aimed to develop capacity in the field of aquatic animal epidemiology and disease surveillance of the aquatic animal health experts working in India and NACA member countries, and focused on epidemiology; sharing of experiences/lessons learnt in the surveillance programme (India) and experiences of other Asian countries. The Australian Government Department of Agriculture (DA) and Commonwealth Scientific and Industrial Research Organization (CSIRO) in collaboration with NACA organized a Workshop on Regional Proficiency Testing (PT) Program for Aquatic Animal Disease Diagnostics Laboratories in Asia-Pacific on the same month. The workshop was undertaken to offer direct communication with laboratory representatives from the program to assist in the understanding of diagnostic standards, proficiency testing procedures and laboratory quality assurance management system; and, to discuss any issues they had come across during the first two rounds of completed testing. Details of the current PT programme is discussed in **Section 4.4**.

NACA was invited to the 11th ASEAN Fisheries and Consultative Forum (AFCF) held in Da Nang, Viet Nam on June 2019. The Aquatic Animal Health Programme, considered as the flagship programme, of NACA was highlighted in the presentation including the Asia Regional Advisory Group on Aquatic Animal Health (AG), the QAAD Reporting, and issuance of Disease Advisories for emerging and important aquatic animal diseases in the region. Recent activities on TiLV, AMU and AMR in aquaculture, emergency preparedness and response and aquaculture biosecurity were also presented. The increasing importance of AMR in aquaculture has led to the participation of NACA in some important activities in the region which were organized by the FAO-RAP: 2nd Meeting of the AMU/AMR Technical Advisory Group (TAG) for South-East Asia; Regional Forum on Antimicrobial Stewardship in Agriculture; and 1st Meeting of the AMR Technical Advisory Group (TAG) of South Asia.

During the Asian Aquaculture 2018 conference held at the Asian Institute of Technology in December 2018, NACA organized two sessions: Advances in Chinese Aquaculture; and, Advances in Aquaculture Health Management. For the health management session, seven experts from the region were invited to present on current diseases of aquatic animals, recent developments on diagnostics, as well as innovations in disease prevention and control. NACA's collaboration with OIE-RRAP has been strengthened through the recent initiative on Regional Collaboration Framework on Aquatic Animal Diseases in Asia and the Pacific, which was established as a platform to stimulate, support and promote strengthening collaboration among and between OIE Reference Centres (i.e. Reference Laboratories and Collaborating Centres) and Member Countries; and, sharing and exchanging information on test validation, reference materials and positive samples. Details of the Collaboration Framework is presented in **Section 4.2**. NACA also participated in several OIE activities including the 87th General Session of the World Assembly of Delegates (May 2019), and the 31st Conference of the OIE Regional Commission for Asia, Far East and Oceania (September 2019).

Recognizing the important role of NACA in the region, specifically on aquatic animal health management, NACA experts were invited to several important national and international meetings including:

- XX Ecuadorian Aquaculture Congress (September 2019);
- INFOFISH World Shrimp Conference and Exposition (Shrimp 2019; October 2019);
- 51st Annual Convention of the Federation of Institutions for Marine and Freshwater Sciences (October 2019).
- OIE Think Tank on the Development of Codification System for Animal Health Data and its Integration to OIE-WAHIS (November 2019)

DISCUSSION

- Members noted that many of the activities of NACA on AAH are passive and involve supporting the activities of other organisations. While this is desirable to enhance collaboration within the region it would ideally be complemented by more activities that NACA leads from within its own work program. NACA could be more proactive in the development of projects for implementation in the region, especially in dealing with emerging and important issues. Members noted that that resource availability is a key issue but could be addressed by setting a strategic direction for NACA's activities in the region that could be used to attract donor funding to specific projects. It would also demonstrate the value of NACA's activities to member countries by articulating the strategic direction that NACA is taking for the benefit of its members. The group was assured by NACA that efforts are being made to address this issue, and with the recent commitment of PR China to provide more support to NACA, it is hoped that more relevant projects can be formulated soon for funding and implementation.

- Members noted that the Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals (TG) have previously provided strategic direction for AAH activities implementation and guidance in the region. While the TG are still relevant at the present time, there might be a need for revision in response to emerging and related issues on AAH (refer to Annex D).
- Members discussed the dissemination of the annual AGM Report in terms of the number of downloads from the NACA website, the group was informed that since the publication of the recent AGM 17 report last May 2019 (more than 6 months), it now has more than 700 downloads. Moreover, a pdf copy of the report was also shared to NACA's partner organizations, national coordinators for AAH, and governing council members for further circulation. It was noted that the meeting report is usually quite long and a brief summary of key points might assist communication of key meeting outcomes.

RECOMMENDATIONS

- AG recommended that NACA develop an AAH strategy/directions in the Asia-Pacific region focussing on a few important issues for more concerted efforts and collaborative actions towards implementation or seeking donor support (funding);
- AG recommended that NACA to be more proactive in developing AAH projects for implementation in the region;
- AG recommended that NACA to produce a one-page synthesis containing important recommendations and action plan resulting from AGMs, for promotion and wider dissemination among NACA member countries and other stakeholders in the region.

SESSION 2: OIE STANDARDS AND GLOBAL ISSUES

2.1. OUTCOMES OF RECOMMENDATIONS FROM OIE GENERAL SESSION (GS) AND THE AQUATIC ANIMAL HEALTH STANDARDS COMMISSION (AHHSC)

Dr. Ingo Ernst gave a presentation on the progress of the Aquatic Animal Health Standards Commission's (AAHSC) work and the adoption of new and revised standards in the OIE Aquatic

Animal Health Code and OIE Manual of Diagnostic Tests of Aquatic Animals. Dr. Ernst advised that since the 2018 AGM the following activities had occurred:

- the AAHSC met in February and September 2019;
- the 4th OIE Global Conference on Aquatic Animal Health was held on 2-4 April 2019 in Santiago, Chile;
- draft standards of the Aquatic Code and Aquatic Manual had been presented to the 87th OIE General Session in May 2018.

The 4th OIE Global Conference on Aquatic Animal Health had a theme of Collaboration, Sustainability: Our future. Key objectives of the conference were to encourage and support Members and the OIE to improve aquatic animal health and welfare worldwide. The conference focused specifically on managing transboundary and emerging diseases, biosecurity in aquaculture establishments, advances in disease management and improving implementation of OIE International Standards.

The participants of the Conference emphasised the importance of national, regional and global collaboration in response to important new and emerging diseases of aquatic animals, ensuring that the standards are relevant for small scale aquaculture, that biosecurity measures are implemented based on risk and safe trade in genetic material.

During the Conference recommendations to Member Countries and to the OIE had been discussed. These are being considered by the Aquatic Animals Commission in its work to revise and develop OIE international standards in the Aquatic Code and Aquatic Manual. Recommendations, abstracts, and PowerPoint presentations given during the Conference are available at: http://www.oie.int/aquatic-conference2019/?lang=en

The 87th OIE General Session was held in Paris in May 2019. Fourteen new or revised texts for the OIE Aquatic Code and Aquatic Manual were adopted. They are summarized below:

Aquatic Code

- Chapter 1.5. Criteria for listing species as susceptible to infection with a specific pathogen — amendments to improve clarity and addition of article 1.5.9, to allow listing at a taxonomic grouping of genus or higher.
- Updated susceptible species for chapters on Infection with SAV, Infection with KHV, Infection with SVCV.
- Chapter 8.3. Infection with *Ranavirus* species — editorial improvements throughout, update article 8.3.8 on importation of animals for aquaculture.
- Chapter 9.1. Acute hepatopancreatic necrosis disease — appropriate use of disease name and pathogen.
- Model Article X.X.8. Importation of aquatic animals for aquaculture from a country, zone or compartment not declared free from a listed disease — edits to improve clarity.
- Chapter 10.6. Infection with infectious haematopoietic necrosis virus — updated list of susceptible species, amended name of pathogenic agent, align with model article X.X.8.

Aquatic Manual

- Chapter 2.2.9. Infection with yellow head virus genotype 1 — amended disease definition (section 2.2.1.) and susceptible species (section 2.2.2.) to align these sections with other disease-specific crustacean chapters in the Aquatic Manual.
- Chapter 2.3.4. Infectious haematopoietic necrosis — naming convention 'infection with [pathogenic agent]' applied to the title; updated list of susceptible species (section 2.2.1.); amended the list of species with incomplete evidence for susceptibility (section 2.2.2.)
- Chapter 2.3.6. Infection with salmonid alphavirus — substantial edits throughout to ensure consistency with approaches taken and amendments made in other disease-specific chapters; updated list of susceptible species (section 2.2.).
- Chapter 2.3.7. Koi herpesvirus disease — updated list of susceptible species in section 2.2.

Dr Ernst highlighted some of the key issues arising from the September 2019 meeting of the Aquatic Animals Commission meeting. They are summarized below:

- A draft new chapter on Biosecurity for Aquaculture Establishments (Chapter 4.X.) was revised based on member country comments and is expected to be proposed for adoption in May 2020.
- A discussion paper on the Aquatic Code provisions for demonstration of freedom from listed diseases has been revised following member country comments and includes recommendations on the Commission's proposed approaches for amending the Aquatic Code.
- The assessment of DIV-1 for listing has been revised and it remains recommended for listing.
- The species susceptible to infection with VHSV have been revised resulting in a proposed change from 12 to over 70 species.
- For the Aquatic Manual, the process of revising chapters and reformatting them into a new template is well underway. The first four chapters to be updated and formatted into this template include:
    - Chapter 2.3.9. Infection with spring viraemia of carp virus
    - Chapter 2.3.4. Infection with infectious haematopoietic necrosis virus
    - Chapter 2.3.10. Infection with viral haemorrhagic septicaemia virus
    - Chapter 2.1.3. Infection with *Batrachochytrium salamandrivorans* (new)

Dr Ernst informed the AG that the OIE Director General has committed to developing an OIE Strategy on Aquatic Animal Health. The drivers for the strategy include that aquaculture is the fastest growing animal production sector; it supplies an increasing proportion of animal sourced human nutrition; and disease has caused major impacts on production, livelihoods, and the environment. Given the importance of aquatic animal production and the threat of disease to it there is a shared need to develop and implement coordinated and collaborative global actions to improve aquatic animal health.

The OIE has commenced development of the strategy with the assistance of the Aquatic Animals Commission. The strategy is due to be released at the OIE General Session in May 2020. An important aspect of the strategy's development is consultation with member countries, experts and partners to ensure the strategy best meets the common needs of the OIE community. The AG agreed to pilot test a questionnaire that would be one of the tools for this consultation and to survey the views of member countries. The AG provided valuable feedback to further enhance the questionnaire.

DISCUSSION

- Members noted that there is an obligation of member countries to report their disease status in accordance with the requirements of the OIE Aquatic Code. This is fundamental to the global efforts to manage aquatic animal health. However, there remains a strong need to improve performance of each member country for more efficient management of important diseases in the region;
- One of the issues that discourages countries to report emerging diseases is the possible impact on trading of the affected aquaculture commodity. It is important that the disincentives for reporting are discussed with countries' to develop initiatives on disease reporting and to get some useful actions and benefits from such initiatives in order to encourage disease reporting;
- On the implementation of different international standards by countries, there may be a lack of diligent processes and incentives for implementation which may result in technical barriers to trade. In general, the standard setting bodies (e.g. OIE) have little power to enforce their standards which are a set of recommendations that a country may not implement appropriately — there are usually no consequences when this occurs. In some countries, the negative culture of implementing standards may impact the scientific community; for example, academic institutions publishing new disease information resulting in the academic or research institution being blamed for an eventual effect on trade;
- An alternative way to view the value of international standards is to consider the scenario without these standards? Good communication with trading partners, transparency and robust management of aquatic animal health will create trust which will facilitate trade. On disease reporting in particular, transparency underpins trust. Countries losing their credibility are mostly those that do not report or withhold disease information. Such information will eventually become public which might have an effect on trade;
- The application of sanitary measures needs to consider of "culture", which differs from one country or region to another, and results in different non-market values such as indigenous aquaculture practices, biodiversity, ecosystems and other cultural values;
- Reporting of diseases doesn't necessarily mean that trade will be impacted, but rather reporting can facilitate transparency and if appropriate actions or measures are implemented and communicated to trading partners, this will eventually facilitate trust and promote trade.

RECOMMENDATIONS

- AG recommended that member countries understand and meet their obligations for reporting diseases, including emerging diseases, noting that this is fundamental to the integrity of international efforts to control transboundary aquatic animal diseases.

- AG recommended that the disincentives for countries to meet their international obligations for reporting diseases should be explored so that effective measures or support might be put in place to improve reporting. This might include provision of advice or measures to be implemented in the event of a disease outbreak to maintain safe trade wherever possible

2.2. Updates on FAO Initiatives in Asia Pacific in support of Aquatic Animal Health

Mr. Weimin Miao provided an overview of works on aquatic animal health and biosecurity implemented in the region or covering the region by the HQ team. FAO implemented a regional project "Strengthening capacities, policies and national action plans on prudent and responsible use of antimicrobials in fisheries" (FMM/RAS/298/MUL). A number of regional workshops were carried out to raise awareness on AMR, including Aquaculture Biosecurity (P.R. China, Malaysia, the Philippines, Viet Nam). Guidance in the development of the aquaculture component of country National Action Plans (NAP) on AMR within the One Health platform, technical guidance on detailed steps in the design of antimicrobial use (AMU) and AMR survey, inspection systems to include AMR in fish product sampling, waste management, and utilization of fish silage were also provided. Communication campaigns were carried out to aquaculture professionals/producers and the general public (through bulletins, seminars, farm visits, and social media). Collection of data on AMU and AMR was initiated based on preliminary surveillance guideline.

FAO has recently developed an inter-regional TCP project to support a number of countries in addressing the Tilapia Lake Virus Disease (TiLV), which is currently being implemented. Assistance on aquaculture biosecurity to the Pacific Island and Country Territories continues with a recently completed TCP facility for Palau (TCP/PLW/3601/C1: Strengthening Biosecurity Capacity of Palau) and an ongoing project for Federated States of Micronesia (TCP/MIC/3603/C2: National aquatic animal health and biosecurity strategy). The former project, implemented in 2017, achieved the following: (i) preparation of the draft Aquatic Biosecurity Regulations for Aquatic Organisms and the draft Biofouling Management Regulations; (ii) a National Consultation, that discussed the draft regulations; and (iii) the preparation of a Framework for a Biosecurity Database. The latter project, has an expected output of developing a National Strategy on Aquatic Animal Health (NSAAH) and Biosecurity.

The project "GCP/GLO/979/NOR Improving Biosecurity Governance and Legal Framework for Efficient and Sustainable Aquaculture Production" funded by the Norwegian Agency for International Development is aimed to support countries in the sustainable development of their aquaculture industry through improving systems and practices on biosecurity, enhanced and enabling legal frameworks, and promoting responsible and sustainable aquaculture practices. In addition to four international workshops, the project supported a field mission to Indonesia in May 2019 and developed the surveillance design for *Enterocytozoon hepatopenaei* (EHP) affecting shrimp.

The FAO Regional Office for Asia and the Pacific (FAO-RAP) has attached great importance to aquatic animal health management work, under the FAO Regional Initiative on Blue Growth and

One Health Initiative. In collaboration with NACA, the first regional consultation on AMR risks associated with aquaculture in Asia-Pacific was organized, which shared results from 6 selected countries assessment studies on production and use of antimicrobials in aquaculture and related governance and actions taken by the government to address AMR associated with aquaculture. It also identified major issues and capacity gaps in mitigation of AMR risks associated with aquaculture, and recommended strategy and actions for effective mitigation of AMR risk associated with aquaculture in the region. Following the recommendation from the regional consultation, a regional TCP project was developed and approved to support the capacity development in mitigating AMR risks associated with aquaculture in India, Indonesia and Vietnam at the end of 2018.

FAO also organized a regional consultation jointly with NACA on strengthening governance of aquaculture, which covered the governance on aquaculture biosecurity and aquatic animal health management. Currently, FAO is implementing the USAID supported Regional Project on AMR Monitoring and Surveillance, which covers aquatic animal in aquaculture; and has approved a TCP project in supporting the government of Maldives to build capacity in addressing AMR in fisheries and livestock.

Side note: *Mr. Miao, who has participated in several AGM's, is leaving Bangkok for Rome by the end of the November 2019. He extended his sincere thanks to current and former AG members and informed the group that he learnt a lot by attending the AGMs. Lastly, he wishes that the AG will play a more important role to support the countries to better manage aquatic animal health for ensuring human and environmental health and improved efficiency in aquaculture in the region.*

DISCUSSION

- On AMR surveillance, the aquatic environment is influenced by the use of antimicrobials not only from aquaculture but from other sources as well including livestock, agriculture and humans. This needs to be considered is assessing the risks arising from the use of antimicrobials in aquatic animals and in surveillance to assess AMR;
- Managing AMR in aquaculture, should not just focus on controlling antimicrobial usage but should take a holistic and effective approach to manage aquatic animal disease. This may include innovative technologies, improved husbandry practices, vaccination and finding other alternatives to antimicrobials;
- The aquatic environment may be shared with and affected by many other users resulting in a complex aquatic culture environment which may make it challenging to pinpoint whether antimicrobial contamination is caused directly by aquaculture practices or by other industries;
- Aside from the AMR risk to humans and cultured animals, there are other problems that need to be considered such as microplastics, which are now considered a high risk to human health. However, sources of these microplastics especially in the water need to be identified;
- Despite the availability of procedures to monitor AMU and AMR in aquaculture, there are few, if any, good examples of AMR risk analysis for the use of antimicrobials in aquatic

animals resulting in well characterised risk and effective and measurable risk mitigation measures.

2.3. Biosecurity in Aquaculture: Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB)

Dr. Jie Huang presented Dr. Melba Reantaso's presentation on "The Progressive Management Pathway for Improving Aquaculture Biosecurity – A new initiative". The presentation introduces the global trend in aquaculture that serious diseases emerge, spread rapidly and cause major production losses approximately every three to five years along with the development of aquaculture. There is often a long time lapse (typically years) from the time that a serious mortality event caused by an unknown and emerging pathogen is observed in the field, to its subsequent identification and confirmation, to global awareness, to the establishment and implementation of surveillance and reporting/notification systems and cost-effective risk management measures. We can see some examples, from EUS, a fungal disease affecting many finfish species that was first observed in the 1970s and the causative agent confirmed as being of fungal aetiology only in the 1980s. The second example, WSSV of shrimp, first observed in the 1980s, diagnosed in the 1990s and adopted in OIE Aquatic Code in 1997. WSSV is probably the most significant viral disease of shrimp. The third example is KHV that affects the important food fish common carp and the high value koi carp. You will see that since it was first observed in the 1990s, it was only adopted in the OIE AAH Code in 2007. The fourth example is AHPND caused by a strain of *Vibrio parahaemolyticus*, first appeared in 2009 and finally diagnosed in 2013. AHPND is probably the most significant non-viral disease of shrimp.

During the time that all these diseases occur, production and market losses are incurred affecting livelihoods, export earnings and food supply – the cost would have been much less if efforts were focused on prevention compared to the costs for biosecurity measures, compensation and other alternatives. Aquaculture health economics is required to set a systemic way of assessing the economic and social impacts of aquatic animal diseases. The Global Burden of Animal Diseases (GBAD) will take a combination of economic and animal health approaches. PMP/AB refers to a pathway aimed at enhancing aquaculture biosecurity capacity by building on existing frameworks, capacity and appropriate tools using risk-based approaches and public-private partnership. It is an extension of the Progressive Control Pathway that is used for the reduction, elimination and eradication of a range of major livestock and zoonotic diseases. It is expected to result in sustainability, including reduction of disease burden, improvement of health at farm and national levels, minimization of global spread of diseases, optimization of socio-economic benefits from aquaculture, attraction of investment opportunities into aquaculture, and achievement of One Health goals. Aquaculture biosecurity refers to the cost-effective management of risks posed by infectious agents to aquaculture through a strategic approach at enterprise, national and international levels with shared public-private responsibilities. PMP/AB has 4 stages and follows the principles of being risk-based, collaborative and progressive. The four stages and expected results include:

- Stage 1: Biosecurity strategy (risk) is defined;

- Stage 2: Biosecurity systems implemented;
- Stage 3: Enhanced biosecurity and preparedness; and,
- Stage 4: Sustainable biosecurity and health management systems established to support national aquaculture sectors.

All countries at any stage of aquaculture development can select an entry point using any one of 4 scenarios. The FAO COFI-SCA during its 10th session deliberated on the Agenda: Preventing and managing aquatic animal disease risks in aquaculture through a PMP, of which the Working Document can be found at the link: http://www.fao.org/3/na265en/na265en.pdf. The five major pillars that will be covered by the AB Programme are: Pillar 1-Strengthening disease prevention at the farm level; Pillar 2-Improving aquaculture biosecurity governance; Pillar 3- Expanding understanding of aquaculture health economics; Pillar 4-Enhancing emergency preparedness; and, Pillar 5-Actively supporting pillars 1-4 with several cross-cutting issues. Biosecurity measures are less expensive when put in place proactively and preventatively, than reactionary responses to disease outbreaks. Designing and applying a holistic global aquaculture biosecurity programme, taking into account the years of experience and research by both public and private actors, livestock sector achievements, and various bottlenecks observed and experienced, especially in developing countries has now become essential.

Dr. Huang also introduced a biosecurity system approach which can be implemented at the farm level. The framework of a biosecurity system includes a master (a responsible organization and stakeholders), target (aquaculture system, aquatic populations), standards (legislation, standards, and recommendations), a plan (strategies, control programs, production plans), actions (implementation of plans according to standards), and information (records, documentation, reporting, and communication). Based on the framework, a biosecurity system can be identified at the global level, regional level, country level, local level, or farm level.

For the farm level, the concept of biosecurity should not only be applicable for high level hatcheries or farms, but for all type of farms, including small scale family farms or large scale extensive farms. A grading system for aquaculture biosecurity based on implementation of a biosecurity plan at the farm level is recommended for different capabilities of farms. Aquaculture biosecurity grade 1 (ABG1) is diagnosis based treatment, by which farms control disease according to diagnosis or contingency plan only, without surveillance and risk assessment, ABG2 is surveillance based prevention, by which farms plan disease control with improved facilities and management according to partial population-based surveillance, but with inadequate risk assessment. ABG3 is risk-analysis based control, by which farms may take integral control under guidance of risk analysis, with an inadequate traceability system. ABG4 is systemic disease freedom, by which farms implement comprehensive biosecurity to achieve disease free status that is auditable and sustainable. ABG5 is official certification, for by which farms obtain official veterinary certification for a free compartment. The lower biosecurity grades can be achieved in traditional extensive farms, or most intensive or indoor farms while the higher biosecurity grades can be implemented in larval rearing hatcheries and nursery hatcheries, or breeding centers and broodstock production centers. The top biosecurity grade can be implemented for disease-free licensed hatcheries or farms.

A five year progressive course was suggested in the framework elements for the establishment of a biosecurity system in a farm. Standard operation protocols (SOPs) need to be established for each operation of production procedures in the farm to guide the biosecurity system. The contents of SOPs should be different with different aquaculture biosecurity grades. The higher grades need more detailed contents in the SOP.

The International Workshop on Aquaculture Biosecurity was held during 24-25 September 2019 in Qingdao, P.R. China and was hosted by the Yellow Sea Fisheries Research Institute, CAFS in collaboration with NACA, FAO, and OIE. The workshop introduced country level approaches in PMP/AB and farm level biosecurity approaches. Representatives from P.R. China and USA reported the national level experiences on biosecurity. Representatives of enterprises in Thailand, Saudi Arabia, Indonesia, and P.R. China reported on farm level practices and experiences on biosecurity in shrimp hatcheries. The workshop highlighted four outcomes. Firstly, biosecurity should consider its cost-efficiency. Secondly, biosecurity needs a dynamic process in the development and implementation of SOPs. Third, biosecurity is a risk-oriented management scheme. The preliminary biosecurity is to establish capability of diagnosis and response for aquatic animal diseases. For high-density intensive large-scale breeding hatcheries, it is recommended to establish a high-level biosecurity system. Fourth, in many Asian countries, biosecurity is still a relatively new concept that needs to be advocated in aquaculture practice.

DISCUSSION

- On PMP/AB, it is good to see a tool for implementation of biosecurity measures in aquaculture. It can be used to upgrade security levels, or to fit-in to whatever biosecurity measures are currently applied on a farm;
- For pilot-implementation of PMP/AB, donor agencies should select countries that are both advanced or still developing their biosecurity plans for aquaculture;
- Biosecurity can also follow other systems such as ISO and HACCP, wherein conducting risk assessment throughout the production pipeline can be undertaken;
- In Norway on fish vaccination, success also depends on bringing the stress level down at culture facilities, raising immunity of the cultured animals, as well as proper government regulations on the use of vaccines which should be strictly implemented and with which farmers seriously abide.
- In general, biosecurity in aquaculture is a highly complicated process industry that involves the culture environment (freshwater, brackishwater, marine), diverse cultured species (fish, crustaceans, molluscs, amphibians), and a variety of culture systems that are being practised by farmers (extensive, semi-intensive, intensive, hyper-intensive, etc.).

SESSION 3: REVIEW OF REGIONAL DISEASE STATUS

3.1. UPDATES ON FINFISH DISEASES IN ASIA

Dr. Siow-Foong Chang presented an update on important finfish diseases in the region. On the novel aquatic birnavirus reported in a recent publication (Chen et al., 2019. Detection and characterization of a novel marine birnavirus isolated from Asian seabass in Singapore, Virology Journal, 16:71, https://doi.org/10.1186/s12985-019-1174-0), the birnavirus was isolated from sick Asian sea bass (*Lates calcarifer*). Sequencing of the genome and physical tests suggested that it is closely related to the *Blosnavirus* genus than to the *Aquabirnavirus* genus within the Birnaviridae family. Challenge studies and subsequent re-isolation of the virus fulfilled Koch's postulates with fish showing mild skin lesions, similar to field observations. Further detection of the virus in recent samples from sick fish suggests that the virus could predispose fish to secondary bacterial infection. This novel virus was named *Lates calcarifer Birnavirus* (LcBV). Further studies will be needed to better understand the role of this virus in causing disease in sea bass aquaculture.

The significance of scale drop disease virus (SDDV; https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2014191445&tab=PCTDESCRIPTION&maxRec=1000) and *Lates calcarifer* herpesvirus (LcHV; https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2018029301&tab=PCTDESCRIPTION&maxRec=1000) in the region was also presented. These two diseases are primary pathogens which continue to contribute to significant losses in sea bass culture. The difference in epidemiology and presentation of the viruses were noted. SDDV spreads slower in a group of fish and causes chronic severe mortalities usually about 1 month post exposure. LcHV causes acute and high morbidity which can be within 1 week post-exposure, followed by severe secondary bacterial infection, including vibrioisis and marine flexibacterioisis. Both SDDV and LcHV appear to be present in areas where *Lates calcarifer* are commonly farmed in Asia. These diseases are easily masked by secondary bacterial infection and more targeted tests are required to identify the significance of these pathogens.

An update on Tilapia lakes virus (TiLV) was also shared. It was highlighted that the virus had been reported in many tilapia farming regions in Asia, North America, South America and Africa. In addition, the lack of surveillance and thorough investigation of all mortality incidents means that the geographic distribution of TiLV may be wider than currently reported. The use of common disinfectants effective against TiLV and the evidence indicating likely vertical transmission of the virus was also shared. References: Yamkasem et al., 2019. Evidence of potential vertical transmission of tilapia lake virus. J. Fish Dis., 42: 1293–1300. https://doi.org/10.1111/jfd.13050; Thammatorn et al., 2019. Minimal risk of tilapia lake virus transmission via frozen tilapia fillets. J Fish Dis., 42: 3-9. https://doi.org/10.1111/jfd.12924; Mugimba et al., 2018. Detection of tilapia lake virus (TiLV) infection by PCR in farmed and wild Nile tilapia (*Oreochromis niloticus*) from Lake Victoria. J Fish Dis., 41: 1181–1189. https://doi.org/10.1111/jfd.12790); Jaemwimol et al., 2019. Virucidal effects of common disinfectants against tilapia lake virus. J Fish Dis., 42: 1383–1389. https://doi.org/10.1111/jfd.13060).

The ongoing detection of *Streptococcus* infections in fish, with *S. iniae* and *S. agalactiae* being the predominant types affecting multiple fish species, and the continued impact caused by iridoviruses (Megalocytiviruses and Ranaviruses) in various fish, were also shared.

The use of heat treatment in fish hatcheries and nurseries has been successfully used in *Lates calcarifer* and tilapia, and works for other fish species as well. This practice involved thermoregulatory treatment of larval and juvenile fish by increasing the temperature of the water, thereby modulating the immune system possibly via the heat shock protein mechanism. The heating effect can be effective in controlling viral diseases, such as VNN, RSIV, ISKNV, SDDV, LcHV etc. Heating of the fish is most effective if tailored as a routine programme to individual aquaculture systems, integrated with the biosecurity and health management system in combination with vaccination. It can also be applied as an emergency protocol at the first appearance of a viral disease in a batch of fish. When applied in such a situation, repeat treatment may be required depending on the incubation period of the viral pathogen. However, operations should be mindful that high rearing temperatures could predispose to bacterial and parasitic diseases, and impact on water quality.

DISCUSSION

- On ISKNV disease in seabass, it was noted that this disease can be especially severe among smaller fish (5-10 g), thus it is important to report and assess the impact of this disease. Mortalities are size dependent. Once the fish reach around 30 g, better survival is observed (even if the fish is infected). However, fish of >100g can still be infected and suffer severe mortalities of not well managed;
- On *Lates calcarifer Birnavirus* (LcBV), a question still exists on its similarity to yellowtail ascites virus, which should be resolved through further studies and/or characterization of these two viruses;
- It was observed that there are fewer problems when seabass are cultured in ponds, compared to when they are cultured in sea cages;
- For VNN is now reported among freshwater fish and can cause very high mortality. Ornamental fish are thought to be carriers of the virus;
- Heat treatment for seabass is working for prevention and control of VNN, which could be brought by heat shock protein (similar to shrimps). Elevation of water temperature, however, can cause proliferation of other pathogens such as bacteria. Activating the heat-shock protein can be accomplished by heating the shrimp fast;
- To effectively manage VNN, biosecurity measures should start from the broodstock. The use of the heat treatment protocol or disinfection of eggs could be attempted for hatcheries.

3.2. CURRENT STATUS OF SHRIMP DISEASES IN ASIA

Prof. Timothy Flegel gave the following presentation on recent developments in crustacean health. As with previous reviews (e.g., AGM17) levels of disease threat for *P. monodon* and *P. vannamei* (the two most cultivated species) depend on the shrimp species cultivated and on the geographical location of farms. For viral pathogens in Asia, white spot syndrome virus (WSSV) and yellow head virus type-1 (YHV-1) are still the most lethal threats for both species, although the latter has still been confined to Thailand. As with AGM17 there has not been any news of spread of a new, lethal YHV variant (YHV-8) that was reported from P.R. China (Dong et al. 2017. Arch Virol 162: 1149-1152). However, there is still no disease card containing a specific detection method posted at the NACA website. Again, it would be good if a comparative virulence study could be carried out with YHV-1 and YHV-8.

With respect to WSSV and the outbreak of white spot disease (WSD) in Queensland, Australia in 2016-2017 (see AGM 17 report), a recent publication from Queensland presents a very comprehensive epidemiological analysis of WSSV types found in shrimp from many countries (Oakey et al. 2019. Arch Virol: 1-22), including samples from the Queensland outbreaks. The study did not provide any support for a proposal that the outbreak originated from supermarket shrimp used as bait by local fishermen. Curiously, the samples from that outbreak gave a consistent genetic profile that could not be clearly linked to any of the hundreds of other WSSV types studied, including those from nearby Indonesia. This corresponds to the position in an earlier review on the safety of frozen shrimp products prepared and packaged for direct retail sale for human consumption (Flegel, 2009. Aquaculture. 290: 179-189). This found no proven cases of disease transmission in shrimp by this route via normal use pathways, or even by its diversion to fishing bait. However, there are publications that have speculated transmission by these pathways in shrimp and they have often been cited elsewhere in a textual context that suggests the transmission pathways have been scientifically proven.

By contrast, past experience for all aquaculture species (spanning more than 100 years) has revealed that almost all explained cases of transboundary disease transmission have resulted from movement (often illegal) of living animals destined for aquaculture (Flegel & Fegan, 2002. Fisheries Science. 68 Supplement 1: 776-788; Flegel, 2009. Aquaculture. 290: 179-189). There are very few verified cases for transmission via dead, fresh-chilled or frozen aquaculture products prepared and packaged for direct sale for human consumption. Examples of these few exceptions include diversion of product from its intended use for direct feeding to cultivated, susceptible species in aquaculture facilities (either through ignorance of the danger or due to illegal package labelling) or due to improper disposal of waste from factories that re-process and re-package imported products. These pathways can be easily blocked by suitable mitigation measures. Despite these facts, many counties use the OIE list of shrimp and fish pathogens to justify pathogen screening by PCR with imported aquaculture products prepared and packaged for direct retail sale for human consumption without having carried out a risk analysis. If found positive, the products are either rejected or subjected to the cost of mandatory cooking that also decreases the value of the imported products. This is especially problematic when post-arrival testing of a product is carried out for pathogens that are endemic in the importing country and/or when similar domestic products are on sale without application of the same measures.

The disease card for covert mortality nodavirus (CMNV) from P.R. China (Zhang et al. 2014. J Gen Virol. 95: 2700-2709), is still under revision. So far, negative impacts from CMNV have not been reported from other countries, although it has been detected by PCR in Thailand (Thitamadee et al. 2016. Aquaculture. 452: 69-87).

For *P. vannamei* only, the next most important viral threat is still infectious myonecrosis virus (IMNV) with reports of outbreaks from India (Sahul Hameed et al. 2017. J Fish Dis. 40: 1823-1830) and an outbreak (resolved) from Malaysia in June 2018 (OIE 04/06/2018- 07/06/2018). We have also obtained positive RT-PCR test results for IMNV in grossly normal, captured adult specimens of *P. monodon* from the Andaman Sea (unpublished) suggesting that IMNV may now be present in wild stocks of *P. monodon* in the seas surrounding Indonesia. This is especially important in countries that cultivate both *P. vannamei* and *P. monodon* (sometimes on the same farm) and that use captured *P. monodon* as the source of PL. At the very least, it is recommended that captured *P. monodon* from the region be tested for IMNV before use as broodstock for PL production. This information reveals the importance in maintaining biosecurity against IMNV in Asian countries.

As with AGM 15 to 17, there have been no reports of disease outbreaks in rearing ponds caused by Taura syndrome virus (TSV) or infectious hypodermal and hematopoietic necrosis virus (IHHNV) probably because the genetically-selected, domesticated shrimp stocks currently being cultivated are tolerant to infections by these viruses. However, deformity caused by IHHNV should not be confused with *P. vannamei* exhibiting abdominal segment deformity disease (ASDD) that is associated with an endogenous retrovirus-like agent (Sakaew et al. 2013. BMC Veterinary Research. 9: 189).

With respect to IHHNV, a recent publication from Australia concluded that reduced growth and profit in cultivation of *P. monodon* was caused by IHHNV infection (Sellars et al. 2019. Aquaculture. 499: 160-166) but this cannot be accepted without further corroboration. The conclusion is suspicious because it was based entirely on positive, quantitative PCR test results for IHHNV and negative PCR test results for two types of yellow head virus (YHV). The study included no histological examinations or PCR tests for the possible co-presence of HPV and/or MBV, the two main viruses that have been confirmed in several publications to be associated with retarded growth in *P. monodon* (whether or not they occur in dual or multiple viral infections that include IHHNV) (Flegel et al. 2004. Aquaculture. 240: 55-68). Further, the publication did not include any histological, immunohistochemical or *in situ* hybridization results for these two viruses or for IHHNV itself, to confirm the severity of disease in terms of pathological lesions. In addition, the extrapolations of crop yields and monetary values from the 0.16 ha study-ponds to 1 ha production-ponds in order to calculate projected farmer losses (A$64,000) were unrealistic. The actual mean harvest for 0.16 ha from the low IHHNV ponds was 2,120 kg while that from the high IHHNV ponds was 1,525 kg, a difference of approximately 590 kg (Table 3 of the study). This alone would have been sufficient reason to try to determine the cause of the difference. However, extrapolation of these values to mean production of 13.25 T per ha for the low IHHNV ponds and 9.95 T per ha for the high IHHNV ponds (a difference of 3.3 T) does not correspond with actual experience in 1 ha ponds, and it inflates the projected loss beyond reason. Normally, yields of around 8 T with approximately 80% survival and 30 pcs/kg (i.e., mean size 33g) at 120 days is considered a good harvest target for *P. monodon* in an actual 1 ha pond. However, in all 4 ponds in this study, growth was well under that target at 120 days (mean size of 20 g or 50 pcs/kg) and it didn't reach 33 g even by 155 days. In addition, mean weights in the 4 study ponds at the standard 120 DOC, although under target weight, were not significantly different. Clearly, all of the ponds were well under performance when compared to normal 1 ha culture ponds, so the projections to normal 1 ha ponds given in the paper was unrealistic, to say nothing of the cost of 35 additional days of culture to reach the a mean size of about 30 g (still under the normal 120-day target of 33 g).

Given the time taken to begin to see a statistically significant difference between mean size in the low and high IHHNV ponds, it is possible that the ponds with shrimp that gave high IHHNV qPCR scores were actually dually infected with MBV that is also endemic in Australia. MBV has been shown to correlate with retarded growth that does not become apparent until after the 2nd month of cultivation but can often be compensated by culture for approximately 20 DOC beyond the normal target of 120 DOC in normal ponds (Flegel et al., 2004 Aquaculture. 240: 55-68). Growth retardation by HPV is more severe and becomes apparent prior to 2 months of cultivation (Flegel et al., 2004 Aquaculture. 240: 55-68), so it is doubtful that it could have been involved in these study ponds. In conclusion, the results of this study cannot be clearly understood until the status of the study shrimp with respect to MBV and HPV infection has been determined, should appropriate samples still exist.

There is also another questionable publication recently claiming outbreaks of "typical runt deformity syndrome (RDS)" caused by IHHNV in growout ponds in India (Jagadeesan et al. 2019. J. Coastal Res. 86: 107-111). This study lacks the rigor to prove the occurrence RDS (i.e., no clear picture of rostral deformity, no controls presented for in situ hybridization tests, no clear pictures of Cowdry A-type inclusions and no elimination tests for other possible, causative pathogens such as *Enterocytozoon hepatopenaei*. In addition, this study did not give the coefficient of variation (CV) for size of the cultivated shrimp in the ponds. This is a vital part of the case description for RDS in *P. vannamei* (Carpenter & Brock, 1992. Diseases of Cultured Penaeid Shrimp in Asia and The United States. Oceanic Institute, Honolulu, 285-293). It is not sufficient to show a picture of specifically selected small to large shrimp without indicating the population distribution of those various sizes. Finally, the conclusions of both these studies are not consistent with the majority of previous work on the impact of IHHNV on *P. monodon* production and on the current worldwide lack of valid reports for significant production losses caused by IHHNV in cultivated *P. vannamei* in the past decade or so.

Thus, the lack of reports on significant negative economic impact of IHHNV in production ponds worldwide suggests that it may no longer fit the criteria for listing by OIE. Thus, it was recommended that the tropical countries that currently dominate global shrimp cultivation coordinate efforts to summarize their current and past data on the impact of IHHNV and by collective analysis determine whether IHHNV still fulfils the OIE criteria for listing. If not, it is recommended that they prepare a collective proposal to OIE to have IHHNV removed from the currently listed diseases of crustaceans. This is important because, in contrast to no reports of production losses due to IHHNV disease in the past decade, there have been substantial losses due to restrictions on frozen shrimp products destined for direct human consumption, simply because IHHNV is listed by OIE, and despite the fact that IHHNV is prevalent in the restricting countries where similar domestic products are on sale without application of the same measures. Such actions can have an important negative and unnecessary impact on the income of countries whose economies depend heavily on shrimp exports.

For *P. monodon* only, the next most important viral pathogen is Laem Singh virus (LSNV) and an integrase-containing element (ICE) that are together associated with monodon slow growth syndrome (MSGS). So far, however, this has been reported only from Thailand (Panphut et al. 2011. BMC Vet Res. 7: 18). This virus does not cause growth retardation in *P. vannamei*. In 2015 and 2016 Chinese next generation sequencing projects revealed a multitude of new viruses in invertebrates, including crustaceans (Li et al. 2015. eLife. 4: e05378; Shi et al., 2016. Nature. 540: 539-543). Among these was Wenzhou shrimp virus 9 (WZSV 9) that was unassigned to any taxonomic group. We have found that it has 99% identity to our published and unpublished database sequences of LSNV and to recent amplicons we have obtained using archived material infected with LSNV by using primers designed from the second fragment of the WZSV 9 genome. The existence of the 2-fragment genome explained our failure to obtain the full LSNV genome sequence by genome walking. In conclusion, WZSV 9 and LSNV constitute the same virus.

Less important for *P. monodon* only are hepatopancreatic parvovirus (HPV) and monodon baculovirus (MBV), and only when captured *P. monodon* are used for production of PLs without implementation of proper preventative measures. As stated at AGM16, work at Centex shrimp has shown that MBV is not infectious for *P. vannamei* (Gangnonngiw and Kanthong, 2019. Aquaculture 499: 290-294).

In 2019, there have been no reports of spread from P.R. China of *Macrobrachium rosenbergii* Taihu virus (MrTV) from the family Dicystroviridae like TSV (Pan et al., 2016. Int J Mol Sci. 17: 204) or of *Macrobrachium nipponense* reovirus (MnRV) (Zhang et al., 2016. J Fish Dis. 39: 371-375). Nor have there been further reports of *Cherax quadricarinatus* iridovirus (CQIV) (Xu et al. 2016. Dis Aquat Org. 120: 17-26) that was assigned to a new genus *Cheraxvirus* (Li et al. 2017. J. Gen. Virol. 98: 2589-2595) and that was also called shrimp hemocyte iridescent virus (SHIV) and assigned to a new genus *Xiairidovirus* (Qiu et al. 2017. Scientific Reports. 7; Qiu et al. 2018. Arch. Virol. 163: 781-785). Fortunately, these two names have now been included as synonyms of Decapod iridescent virus 1 (DIV-1) in the genus *Decapodiridovirus* (Chen et al. 2019. Viruses. 11: 387; ICTV proposal 2018.004D) by the International Committee on Taxonomy of Viruses (ICTV).

A draft disease card has been prepared for DIV-1 and presented to NACA for consideration. In addition, the assessment has been done for DIV-1 to be listed in OIE code by OIE AAHSC and comment is being collected from MCs of OIE. Finally, unpublished work carried out in our laboratory in Thailand using preserved shrimp from a laboratory challenge with DIV-1 have revealed by histology and *in situ* hybridization analysis that the lymphoid organ (LO) is a prime target for DIV-1 and can give clear signs of histopathology in the early stages of infection before the pathognomonic, cytoplasmic inclusions formed in hematopoietic tissue (HPT) are easily seen.

Thus, using histological analysis of both the HPT and LO can help in diagnosis of DIV-1 infections. Very recent work (unpblished) has found some captured broodstock-size specimens of *P. monodon* from international waters of the Indian Ocean that were PCR positive for DIV1. The specimens were grossly normal in appearance and showed no histological lesions pathognomonic for DIV1. A report has been prepared for publication at the NACA website.

A revised version of the disease card for covert mortality nodavius (CMNV) (Zhang et al. 2014. J Gen Virol. 95: 2700-2709) has been prepared, although no disease outbreaks caused by this virus have so far been reported outside of P.R. China. However, a recent report of CMNV in Japanese flounder indicates that it may be a possible carrier for transfer of the virus to shrimp (Wang et al. 2019. J. Gen. Virol. 100: 166-175). Finally, a new picornavirus (Order Picornavirales, Family *Iflaviridae*) in red claw (*Cherax quadricarinatus*) in Australia has been reported and it has been called *Chequa iflavirus* (Sakuna et al., 2017. Virus Res. 238: 148-155). So far there are no reports of it from other countries in Asia or with regard to its virulence for penaeid shrimp.

The current top bacterial disease threat for shrimp in Asia is still acute hepatopancreatic necrosis disease (AHPND) that is now a listed crustacean disease by OIE. It is caused by isolates of *Vibrio* (*V. parahaemolyticus, V. harveyi, V. owensii and V. campbellii*) that produce two Pir-like toxins (PirvpA and PirvpB) that can cause massive sloughing of shrimp hepatopancreatic tubule epithelial cells (the pathognomonic lesion of AHPND). We can now add *V. punensis* to the list of AHPND-causing species (Restrepo et al. 2018. Scientific Reports 8: 13080). AHPND bacteria may carry the toxin genes in a plasmid (pAP) (Kondo et al., 2015. Genome Announc. 3, e00978-00915; Xiao et al., 2017. Sci Rep 7: 42177; Han et al., 2017. Aquaculture 470: 84-90) or in a bacterial chromosome (Wangman et al., 2018. Aquaculture. 497: 494-502).

Again, it was emphasized that the term early mortality syndrome (EMS) is not equivalent to AHPND since AHPND is only one of the causes of EMS, albeit a major one (Sanguanrut et al., 2018. Aquaculture 493: 26-36). Also, there is a report of PirVP plasmid transfer from *V. campbellii* to *V. owensii* in the laboratory, resulting in its conversion to VOAHPND (Dong et al., 2019. Aquaculture. 503: 396-402), and there has been the first report of a VPAHPND outbreak in the USA (Texas) (Dhar et al., 2019. Dis. Aquat. Org. 132: 241-247). In Asia, problems with AHPND have declined since tolerant SPF shrimp stocks have been developed and since farmers have learned to alter culture-pond management to reduce its negative impact.

The other major emerging disease of concern in Asia is hepatopancreatic microsporidiosis (HPM) caused by *Enterocytozoon hepatopenaei* (EHP). Please refer to the AGM17 report for a summary of developments up to November 2018 and to the review on shrimp diseases in Asia (Thitamadee et al. 2016. Aquaculture. 452: 69-87). Since that time, progress is still slower than ideal and many questions remain still unanswered. To me the most urgent problem is to find the environmental reservoir(s) for EHP. The prevalence in ponds and the prevalence of infected post larvae supplied to farmers are still much higher than desired. Given the current knowledge regarding EHP, the reason for failure to consistently deliver EHP-free PL to farmers needs to be urgently determined, addressed and rectified.

EHP is sometimes associated with shrimp exhibiting white feces syndrome (WFS) (Tang et al., 2016. J Invertebr Pathol. 140: 1-7) but sometimes not (Tangprasittipap et al., 2013. BMC Vet Res. 9: 139). The reason why is still under study. However, it is important to understand that WFS is a syndrome based on gross signs of disease (similar to diarrhea in humans). It is exhibited by floating mats of white shrimp fecal strings in rearing ponds and can be caused by bacteria, gregarines, algae and aggregated transformed microvilli sloughed from the shrimp HP tubule epithelium (Sriurairatana et al., 2014. PLoS One. 9: e99170). Thus, diagnosis is required to determine the cause of WFS. When it does occur in conjunction with EHP infections, it appears to be always accompanied by unknown bacteria, raising the possibility that one of the causes of WFS may be EHP interacting with a bacterial partner or partners. One recent metagenomic study gives support to this hypothesis in revealing the presence of many previously unidentified bacteria in WFS shrimp (Hou et al., 2018. Appl Microbiol Biotechnol. 102: 3701-3709). Some of the bacteria identified were obligate anaerobes that would be missed in normal procedures for isolation of shrimp bacterial pathogens under aerobic conditions.

As in AGM 16 and 17, many other questions regarding EHP are still unanswered: Are there life stages in other host species (i.e. environmental carriers)? Do other cell or spore types exist for internal reinfection and external transmission (Vávra and Lukeš, 2013. Adv Parasitol. 82: 253-319)? Is therapeutic treatment possible? Are *Artemia* and polychaetes that are positive for EHP by PCR actually infected? What is the relationship between Asian EHP and its variant reported from Venezuela (Tang et al., 2017. Aquaculture. 480: 17-21) and possibly other countries in Central and South America? As I suggested in AGM17, it would be good if an international group of interested researchers could be assembled and funded to answer these questions in a coordinated manner so that results could be obtained quickly without excessive overlap.

The other emerging, crustacean, intracellular parasite mentioned at AGM16 (*Spiroplasma eriocheiris*) was reported to infect not only the Chinese mitten crab *Eriocheir sinensis* (Wang et al., 2004. Microbiol. Immunol. 150: 3035-3040) but also *Procambarus clarkii*, *Machrobrachium rosenbergii, M. nipponensis* and *P. vannamei* (Wang et al., 2011. Int J Syst Evol Microbiol. 61: 703-708). However, I have seen no reports of disease outbreaks caused by *S. eriocheiris* in cultivated *P. vannamei* from other countries. We found infections in *M. rosenbergii* from Thailand and Bangladesh (Srisala et al., 2018. Aquaculture. 493: 93-99) but our oral challenge tests with *P. vannamei* fed infected HP tissue of *M. rosenbergii* did not result in detectable infection or disease (unpublished).

Finally, there are some very exciting recent results that prove the existence of heritable, adaptive antiviral immunity in insects and show how it operates via autonomous genetic modification (AGMOR) (Whitfield et al., 2017. Curr. Biol. 27: 3511-3519. e3517; Poirier et al., 2018. Cell Host and Microbe. 23: 353-365; Tassetto et al., 2019. eLife. 8.). These studies validate predictions of what has been called the viral accommodation hypothesis (Flegel and Pasharawipas, 1998. Adv Shrimp Biotech. BIOTEC, Bangkok, pp. 245-250; Flegel, 2001. World Aquaculture Society. 190-214; Flegel, 2007. Dev. Comp. Immunol. 31: 217-231; Flegel, 2009. Biology Direct. 4: 32) and they open the way for development of novel disease prevention measures in shrimp aquaculture. These include the possibility of using circular DNA constructs for therapeutic applications and of tailoring domesticated, SPF shrimp stocks for tolerance to multiple shrimp viruses. The work shows that autonomously genetically modified organisms (AGMO) are ubiquitous in crustaceans and insects and reveals that the issue of GMO is a paper tiger.

RECOMMENDATIONS

- AG recommended that countries currently dominating global shrimp cultivation (including the Asia Pacific) should coordinate efforts to prepare data on the impact of IHHNV on shrimp production in the past 10 years and to analyse it to determine whether it still fits the criteria for OIE listing;
- AG recommended that an international group of interested researchers/experts be assembled and funded, to answer the important questions on EHP (as presented above) in a coordinated manner so that results could be obtained quickly without excessive overlap, and to better understand the mechanism and epidemiology of EHP infection in shrimps;
- AG recommended that countries within the region apply the sanitary measures of the OIE code appropriately and, where measures exceed the standards, countries must be able to support those measures through a sound a transparent risk analysis process.

3.3. UPDATES ON AMPHIBIAN AND MOLLUSCAN DISEASES IN THE ASIA-PACIFIC REGION

Dr. Andy Shinn reported current updates on amphibian and molluscan diseases in the region.

MOLLUSCS

Despite the average year-on-year annual increase in aquatic production, which over the period 1960-2017 has been consistently >6% (FAO, 2019), disease outbreaks have continued to constrain the sustainable development of aquaculture and remain a major hurdle to surmount. While annual losses due to disease have been estimated at ca. 40% (FAO, 2012; Bastos Gomes *et al*., 2017), and given that FAO lists 589 species / categories of product within the industry, it is not surprising that obtaining precise estimates of loss for many diseases, which may cover a range of cultured species, is difficult. Despite the potential challenges of this, Shinn *et al*. (2018) have attempted to begin ranking the top 100 diseases in aquaculture by looking at the cumulative magnitude of economic loss. Only the top amphibian and molluscan diseases in the Asia-Pacific region are considered here and are ranked on cumulative losses specifically to aquaculture where data permit estimates to be made. The impact of *Batrachochytrium dendrobatidis* on amphibian biodiversity, for example, is enormous and in economic terms inestimable but the current impact of infection on frog culture is small. The following top ten diseases in mollusc and amphibian culture, therefore, could be:

Perkinsus marinus	US$ 1460.0 M
Marteilia refringens	US$ 387.6 M
Haplosporidium nelsoni	US$ 132.6 M
Pectenophilus ornatus	US$ 45.7 M

Bonamia	US$	32.0 M
Ostreid herpes virus	US$	5.5 M
Elizabethkingia miricola	US$	2.06 - 45.51 M
Nepinnotheres novaezelandiae	US$	2.2 M
Spionid mudworms	US$	1.2 – 1.9 M
Mikrocytos	US$	1.1 M

This list and the rankings are, of course, open to much debate as certain figures may be regarded by some as either over inflated or arguably sensationalist used to elicit an industry or government response, while others may consider the information for other diseases an underestimation to the current situation. In the absence of detailed information, these are at best crude estimations and rankings. The criteria used is drawn from the literature, from reported stock losses (tonnage and their calculated market value), and from the frequency of disease episodes. This is drawn from a larger ongoing project which sets out to define predictive models of loss to provide better estimates of loss. It is appreciated that the rankings and the estimates of loss are dynamic and will vary annually, given the ephemeral appearance and disappearance of some diseases, and/or the magnitude of disease outbreaks.

Pacific Oyster Mortality Syndrome (POMS)

Pacific Oyster Mortality Syndrome (POMS) is an acute, contagious, viral disease caused by Ostreid herpesvirus-1 microvariant (OsHV-1 µvar) that results in high rates of mortality within days of infection. Infection of the oysters' haemocytes results in hypertrophy, nuclear margination and pycnosis of nuclei; immune-suppression by the OsHV-1 viral infection causes fatal bacteraemia in Pacific oysters (de Lorgeril *et al*., 2018). OsHV-1 µvar has caused repeated seasonal outbreaks of mass mortality in *Crassostrea gigas* populations in Europe, New Zealand and in New South Wales, Australia.

The POMS virus was first detected in Tasmania in Jan 2016 where it caused a high level of mortality and is now established in Tasmania with a natural spread to other areas expected. By controlling the movement of oysters, it is anticipated that this will help slow the overall spread of the virus, giving the local industry enough time to establish long term strategies to manage the disease. To address this, there is within Tasmania a POMS-resistant oyster breeding programme; this has met its primary goal of achieving a 70% survival in one-year-old oysters providing the first steps towards industry recovery. Tasmania now produces around 3 million dozen oysters every year, compared to 4 million dozen before the outbreak. In the region, South Australia had a POMS scare in October last year when high mortality rates, some up to 60%, were reported at several locations. The virus is present in Adelaide's Port River but, so far, all growing areas have been cleared.

Elsewhere in the region, an ongoing mortality event in bay scallop (*Argopecten irradians*) hatcheries in Korea that began in November 2017 has resulted in 90% of the 5-10-day old larvae being lost. As the hatcheries have not been able to produce spat, the industry has incurred huge losses. Ostreid herpesvirus-1 mu Var was confirmed and is the first mortality report in bay scallops (Kim *et al*., 2019).

In the determination of which husbandry practices could be used to reduce the likelihood of infection, a study conducted by Evans *et al.* (2019) looked at the practice of oyster emersion versus immersion on the OsHv infection of oysters. From the findings of a study conducted by de Kantzow *et al.* (2017), they concluded that by decreasing the time that oysters were immersed by raising the height of the growing infrastructure by 300 mm above the industry standard, could help reduce the mortality rate of adult oysters in New South Wales by half. The study of Evans *et al.* (2019) investigated the protective effect of tidal emersion on infection by OsHV-1 in a controlled lab environment. Adult *C. gigas* (24-mo old) and *C. gigas* spat (5-mo old) were infected with OsHV-1 by intramuscular injection and housed with either twice daily emersion or constant immersion. Contrary to prior field studies, adult oysters subjected to emersion had sig. higher mortalities (67.2%) than constantly immersed adults (11.3%). No significant difference was observed between treatments for the spat. These results suggest that the beneficial effect of high growing height on adult oysters in the field is due to avoidance of infection with OsHV-1, rather than an effect on oyster physiology.

Bonamia

Bonamia ostreae was discovered for the first time in 2016 and then in two oyster farms in Big Glory Bay in Southland, New Zealand in May 2017, which led to the Ministry for Primary Industries pulling millions of potentially infected oysters from the sea. The haplosporidian parasite *B. ostreae* was first reported in oysters (*Ostrea chilensis*) from the Marlborough Sounds, New Zealand in 2016. Infection is driven by infected cells being released from dying oysters; *B. ostreae* cells persist in seawater for only a few days, while most of the bay's water stays for 7 to 13 days. The 2017 operation to remove oyster stock (2300 cages from 12 farms) resulted in USD 5.4 M worth of compensation being paid to 8 farms (USD 2.5 M to those on Stewart Island). Removing the farms removed its highest chance of infection persisting and progressing. After two years of clear tests, the Ministry of Fisheries hoped that Big Glory Bay would be the first example of *Bonamia* eradication in the world, but oysters lifted in April were suspected of being infected and confirmed in the press in October 2019 (Stuff, 2019; Williams, 2019).

Black-heart disease in Kumamoto oysters

Other notable mollusc mortality events in the Asia-Pacific region include the report of black-heart disease in Kumamoto oyster (*Crassostrea sikamea*) spat caused by *Polydora lingshuiensis*. A report by Ye *et al.* (2019) reported that a 50 ha, 10 m deep, oyster pond in Guangxi Province, P.R. China which was stocked with 1 M spat on the 28th July 2017 into >10,000 nets experienced 50.8% mortality over a 2-mo period resulting in 100% of the stock being infected in under 35 days. The oysters were reported as having mud blisters which turn black and appear burnt because of the mud, detritus, faecal deposits, and anaerobic metabolites of the polydorids that accumulate within the blisters - these molluscs are said to have "black heart" disease.

Other notable impacts on mollusc health and / or losses

In addition to pathogen-related impacts and losses on cultured populations of mollusc, there have also been reports of several mass mortality events due to changing environmental and climatic conditions.

Mollusc mass mortalities

In Hai Loc Commune, Thanh Hoa, Vietnam, for example, there was a mass mortality of clams (species unspecified) in March 2019 across a 221-hectare co-managed area by 248 households. Within this plot, 143 ha held by 161 households reported clam mortality rates of between 70-100% mortality, while a further 78 ha of clam beds managed by 87 households had losses of between 30-70%. The beds were stocked at a density of 2,500-3,000 spat m^2 but the loss of stock was suggested to be due to a reduced resistance because of competition for resources. While farmers had noted some level of mortality over the last 10 years, this was the first time that mortality had been on this magnitude (Intelliriver Source, 2019).

Similarly, the death of over 20 million Akoya pearl oysters (*Pinctada fucata*) in Ehime, Mie, Japan - the first major die-off since 1996 represents a ca. Y 300 M (US$ 2.76 M) impact to the industry. The cause of mortality has been attributed to multiple factors which include underfeeding and overcrowding (Jiji, 2019).

Use of neonicotinoids within the industry

There are also growing concerns regarding products used within mollusc industries and the products that molluscs by virtue of their filter feeding nature may sequester from the environment.

There is, for example, concern regarding the use of neonicotinoids. In 2015, Washington State granted local shellfish growers' permission to spray imidacloprid (IMI), a neuroactive insecticide, used to tackle burrowing shrimp, which are thought to lead to increased oyster mortalities due to the amount of sediment they stir up. The use of neonicotinoids like IMI, however, have also been linked to declines of bees, birds and fish and so the permit has been withdrawn (The Fish Site, 2019). IMI is also used elsewhere and there are concerns regarding its use. In the Sydney rock oyster industry, IMI has been shown to significantly affect the biochemical processes and metabolites in oysters, with implications for food quality and safety (Ewere *et al*., 2019a, b). There are also concerns about the sublethal impacts of such products on, for example, aquaculture produced shrimp (Butcherine *et al*., 2019).

High levels of endocrine disruptors found in cultured populations of green mussel

A recent study by Ocharoen *et al.* (2019) highlighted high levels of two endocrine disruptors, bisphenol A (BPA) and 17β-estradiol (E2), in several populations of green mussels, *Perna viridis*, cultured in the Gulf of Thailand. The study which looked at culture sites close to the Map Ta Phut Industrial Estate, the world's eighth largest petrochemical hub, found some of the highest levels in SE Asia.

Bisphenol A, an organic synthetic compound which also acts as a xenoestrogen, used in the manufacture of polycarbonate plastics and in the protective lining of many food and drink containers has been found in mussels cultured in the Gulf of Thailand at levels of between the levels of <1.3 - 109.97 ng g^{-1} (compared to the next highest reported level of 1.1-13.7 ng g^{-1} in *P. viridis* cultured India). In 2010, the US EPA set a chronic reference dose at 50 µg kg bdy wt day^{-1}. Later in 2018, the European Food Standards Agency lowered the Tolerable Daily Intake to 4 µg kg bdy wt day^{-1} BPA.

17β-estradiol, a natural potent estrogen frequently used in menopause hormone therapy was also found at high levels in mussels at up to 152.8 ± 18.00 ng L^{-1}. The bioaccumulation of both endocrine disruptors in mollusc tissues raises concern for human food safety; high levels of these endocrine disruptors may also explain the skewed sex ratios seen within certain mollusc populations (74-89% of the mussels at high E2 sites in the current study were female). This study highlights the impact of non-disease agents on the health of cultured populations of mollusc and the need for surveillance of farm sites near highly populated urban areas and or sites of intense industrial activity.

Microplastics

There is also concern regarding the accumulation of microplastics (MPs) in aquatic life and aquaculture products. In 2016, an estimated 335 million tons of plastic was produced. An estimated 2-10% (268,940 tons) ends up in the oceans (Jambeck *et al*., 2015), of which an est. 92% is MP (<5 mm; Eriksen *et al*., 2014). Polyethylene (PE) is the predominant plastic found in the sea and marine sediments (Suaria *et al*., 2016). A study by Fernandez and Albentosa (2019) looked at the uptake, elimination and accumulation of <22 um PE MP from the digestive gland of *Mytilus galloprovincialis* following their challenge with two doses (2 mm3 L^{-1} and 4 mm3 L^{-1}). The study found that: the uptake of MPs increased with increasing concentration; that small MPs (2-4 µm) were not efficiently cleared; that large MPs >10 µm were eliminated quickly and at similar rates to microalgae of a similar size; and, that after 6 days depuration, 85% of the MPs were cleared with 2-6% retained within the digestive gland of which 71-74% were MPs measuring 2-3 µm and 21-24% were MPs measuring 3-4 µm. The persistence of MPs inside mussels implies a high likelihood of their transference along the food chain.

Oceanic heatwave

An oceanic heatwave, a consequence of lower than normal rates of heat loss from the sea coupled with lower than usual water circulation, resulted in sea temperatures as high as 5˚F above normal was reported in September 2019 (NOAA Fisheries, 2019). The reasons for its appearance remain unclear but it has been suggested that this was due to a Pacific decadal oscillation during which there is a flipping of surface waters from a cold to a warm phase in the mid-latitude Pacific Ocean. The heatwave termed "the Blob" by meteorologists resembles that of the original "Blob" of 2014-15 which caused cascading changes to marine ecosystems - effecting zooplankton, the foraging behaviours of many animals, toxic blooms, mass die-offs etc (Milstein, 2014; Anon, 2015; Bond *et al*., 2015; Welch, 2015; Vaughan, 2019). The current "Blob" is similar in size to the original covering an area of 4 million square miles, but the warmer water is thus far staying to surface waters and not extending into deeper waters as was seen with the original event.

While the focus of this report is on diseases impacting on the health, welfare and sustainability of cultured and managed populations of mollusc and amphibians, it is important to be mindful of various environmental impacts and human activities that may exert additional pressures on populations with potential consequences through the food chain.

AMPHIBIANS

***Batrachochytrium dendrobatidis* (*Bd*)**

Remains as a key amphibian disease of concern with infection having resulted in the declines of 501 amphibian species to the point of extinction or near extinction (Bittel, 2019). *Batrachochytrium dendrobatidis* has been quoted as "... the worst pathogen in the history of the world, as far as we can tell, in terms of its impacts on biodiversity" (Mat Fisher, Imperial College London).

In aquaculture, frogs are regularly traded. American bullfrogs, *Lithobates catesbeianus*, for example, are widely distributed and are thought to be carriers of *Bd* due to their low inherent susceptibility to infection. Bullfrogs often escape captivity and can establish feral populations. This raises the need to assess the risks of other commonly traded species. In 2016, the U.S. Fish and Wildlife Service banned imports of 201 high-risk species of salamander to prevent future outbreaks of the closely related *Batrachochytrium salamandrivorans*. No such restrictions regarding the trade in frogs, however, have been imposed. Canada, however, has placed a complete ban on the importation of all amphibians.

In the control of *Bd*, there have been few successful strategies. The use of probiotic formulations to protect amphibians by killing or inhibiting *Bd* have, however, shown promise. The North American bullfrog while a common carrier of *Bd*, also has a diverse skin microbiota that includes lactic acid bacteria (LAB). In trials conducted by Niederle *et al.* (2019), a series of LABs were isolated from bullfrog skin and then used to challenge eight genetically diverse *Bd* isolates. Of these: 32% of the LABs inhibited at least one *Bd* isolate with varying rates of inhibition; 90.3% of LABs exhibited hydrophilic properties that may promote adhesion to the cutaneous mucus; 59.7% of the LABs showed exopolysaccharide synthesis; while 66.1% produced biofilm at different levels (21% weak, 29% moderate, 16.1% strong). All these properties combined may confer protective benefits against *Bd* through competitive exclusion. Compatibility assays indicated that all the LABs that were tested could be included in a mixed probiotic formula with the suggestion that *Enterococcus gallinarum* CRL 1826, *Lactococcus garvieae* CRL 1828, and *Pediococcus pentosaceus* 15 and 18B represent optimal probiotic candidates for the control and mitigation of *Bd*.

Another *Bd* mitigation experiment conducted by Rebollar *et al.* (2016) looked at the potential of using the antifungal probiotic bacterium *Janthinobacterium lividum* on tadpoles of green frogs (*Lithobates clamitans*). The study looked at the direct and indirect transmission of the bacterium and found that transmission occurred rapidly by both routes. Indirect transmission that included a potential substrate, however, was seen to be more effective. *Janthinobacterium lividum* was seen to colonise the skin but its relative abundance on the tadpole skin decreased over time. Inoculation did not significantly alter the skin bacterial diversity, which was dominated by Pseudomonas. The indirect horizontal transmission was seen to be an effective bioaugmentation method but further work is needed to determine the best conditions, substrates etc, under which a probiotic can persist on the skin so that bioaugmentation becomes a successful strategy to mitigate *Bd*.

A third study by Bosch *et al.* (2015) representing a 5-year programme of study on the island of Mallorca, Spain populated by only a single amphibian, the midwife toad (*Alytes muletensis*), looked at effects of the direct application of an antifungal agent. The study included all ponds on the island. Tadpoles collected from each pond were bathed daily for seven days in aged tapwater containing 1.0 mg/l itraconazole and then returned to their respective ponds after all the hard structures surrounding each breeding site had been disinfected with 1% Virkon S (final conc). There was no *Bd* infection seen in animals swabbed the following spring.

Elizabethkingia miricola

Elizabethkingia miricola is a Gram negative, non-motile, non-spore forming bacilli that has resulted in a contagious condition in black-spotted frog (*Pelophylax nigromaculatus*) farms in Hubei, Hunan, Sichuan and other south-central Chinese provinces. In this region, 13,180 acres is used for the culture of frogs (av. 240 kg per acre) with an annual production of 70,000 tonnes. In May 2016, infected frogs were reported to have a meningitis-like disease, resulting in disorientation and a circular swimming behaviour, cataracts, and agitation or lethargy, with consequential high rates of mortality. Over 60% of the frogs at infected farms in Hunan Province displayed clinical signs with a consequential mortality of 60-90%. Economic losses are estimated at US$ 2.06 M in Hunan and at US$ 45.51 M if a mortality rate of 60% is representative of the industry. Hu *et al.* (2017) investigated the strain of *E. miricola* by whole-genome sequencing and found to be closely related to isolates from humans, suggesting that *E. miricola* is capable of being epizootic and may pose a health threat to humans. *Elizabethkingia miricola* is, for example, known to have become a vital opportunistic pathogen in immunocompromised patients and those with cystic fibrosis (Zdziarski *et al*., 2017; Kenna *et al*., 2018).

Infections have unfortunately also been reported in Chinese spiny frogs (*Quasipaa spinosa*) - a species listed by IUCN as "Vulnerable" in the wild due to over harvesting. This species is also cultured; the mortality of frogs at a farm in Ya'an County, Sichuan Province, P.R. China was 36% within 20 days (Lei *et al*., 2018). This finding suggests that the range of susceptible hosts to *E. miricola* is expanding. A further concern is that it may serve as a reservoir of infection to humans.

Bullfrog rotten skin disease

Bullfrogs are commonly reared at high density and in poor environments where high temperatures and humidities are very likely contributory factors. Several references to bullfrog rotten skin disease in the grey literature over the past year have been made. The disease appears to be commonly reported in young frogs after metamorphosis, spreading rapidly, infecting all individuals within a pool within 4-10 days with consequential mortality rates of up to 30-70%. When the bullfrog rot disease occurs, the skin of the bullfrog loses its lustra and white spots appear. As the disease progresses, the skin begins to fall off and rot, revealing muscle tissue, and when severe, it spreads to the whole body. At the same time, black granular protrusions appear in the eye, eventually leading to loss of vision.

Bullfrogs are relatively fierce frogs - they often kill each other and bite in competition for food, causing secondary infections of bacteria and fungi, which leads to skin inflammation and ulceration. When densities are high and the feeding regime is either insufficient or not timely, then there can be elevated rates of aggression. The poor nutritive value of frog feed, which may lack essential trace elements (notably vitamins A and vitamin D), can lead to skin ulceration. Remedial action is in improved husbandry, controlling stocking densities, improvements to water quality management, improved nutrition and through a strengthened health care programme.

The report of rotten skin disease though does not appear to be new. Shu *et al.* (1997), for example, who examined one such case indicated that *Proteus mirabilis* was the cause of the rotten-skin disease in bullfrogs, while an infection of *Aeromonas hydrophila* caused a concommitant red-leg disease. This is supported by a recent report of *P. mirabilis* and *Yersinia kristensenii* as the causative agents of rotten skin disease in farmed giant spiny frogs (*Paa spinosa*) (see He et al., 2020).

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Discussion

- On the reports of chytrid infections among wild frogs which has caused extinction of some species, there are no reports so far on chrytrid infections among cultured frogs.
- The rotten skin disease of bullfrog is mainly due to general bacterial lesions. The clinical signs are similar to the *Ranavirus* infection among frogs cultured in Thailand. This is only based on one report and no molecular investigation was undertaken;
- In P.R. China, the giant salamander is also reported to be infected with *Ranavirus*;
- Iridovirus (which include *Ranavirus*) used to be common in Singapore and Taiwan POC, but eventually disappeared and replaced by Megalocytivirus;
- Currently, there are six (6) *Ranavirus* species;
- Currently, there is a lack of scientific team working on diseases of amphibians as well as molluscs; the surveillance efforts for these group of animals are not enough and very limited (based on OIE data);

Recommendations

- AG recommended to identify and invite an amphibian (and molluscan) disease expert(s) to join in the next AGM, especially on *Ranavirus*;

Session 4: Reports on Aquatic Animal Health Programmes from Partner Agencies

4.1. Aquatic Animal Health Activities of the Fish Health Section, SEAFDEC/AQD, Philippines

Dr. Eleonor Tendencia presented highlights of the Aquaculture Department, Southeast Asian Fisheries Development Center (SEAFDEC AQD) Fish Health Section (FHS) activities which include both Research and Extension.

Under Research, there are four studies on penaeids, four on finfish and one on seaweeds as listed below:

- Establishment of threshold infection levels for WSSV and other pathogens such as VP_{AHPND} in penaeid shrimp;
- Application of adjuvants, carriers and RNAi technology to enhance the antiviral immune response of shrimp to WSSV;
- Epidemiology of the Early Mortality Syndrome (EMS);
- Production of *Penaeus vannamei* using biofloc system with sludge removal facility (SRF) to demonstrate the productivity of old earthen ponds during the wet season;

- Enhancement of vaccine efficacy for the prevention of viral nervous necrosis in high value marine fish;
- Establishment of protective measures against persistent and emerging parasitic diseases of tropical fish;
- Efficacy of different therapeutants against *Caligus* sp. infestation in tropical fish under laboratory conditions;
- Detection, quantification, and viability of Tilapia Lake Virus (TiLV) in pond soil and water as influenced by water quality parameters and culture management;
- Safeguarding the future of the Seaweed Industry of the Philippines: Disease and Pest Detection.

Under Extension are the Training and the Diagnostic Services. For the Training component, Fish Health Management is included in all training courses offered by SEAFDEC/AQD. Specialized Course on Fish Health Management is also offered upon request. For the Diagnostic Services, the FHS accept samples (aquatic organism, soil, water) from the private sector, as well as from SEAFDEC research studies for disease detection. Treatment/Prevention is also recommended. On-site fish disease investigation is also done by Fish Health Staff upon the request of farm operators.

The Diagnostic laboratory of the FHS is capable of the following laboratory analyses:

- PCR:
    - Fish Viruses: VNN, RSIV, TLIV, KHV, SVCV
    - Shrimp Viruses: WSSV, IHHNV, HPV, MBV, IMNV, TSV, GAV, XSV, MrNV
    - Other shrimp pathogens: AHPND, EHP
- Duplex QPCR: WSSV and IHHNV in soil, water, tissue
- Other tests: Larval shrimp health monitoring, Bacterial Count/isolation/identification, Fungal isolation, parasite detection/ identification, Aflatoxin test

To aid in the diagnosis of fish mortality cases, especially on environmental parameters, SEAFDEC/ AQD has the Laboratory for Advance Aquaculture Technology (LFAAT) which is capable for the following analyses:

- Electron microscopy
- Water Analysis: DO, pH, alkalinity, NH4-N, NH3-N, NO3, NO2, PO3, total hardness, TSS, Chlorophyll a, heavy metals (Fe, Cu), calcium-magnesium
- Soil analysis: pH, OM, Fe, avail S, avail P, CNS,

Other activities of SEAFDEC/AQD are the implementations of strict biosecurity measures and undertaking of International meetings. Biosecurity measures are implemented in all shrimp production units: hatchery and grow-out. Stricter biosecurity measures are practiced in the shrimp hatchery which has its own biosecurity complex.

The FHS of SEAFDEC/AQD in 2018 implemented the ASEAN Regional Technical Consultation on Aquatic Emergency Preparedness and Response Systems (ASEAN RTC on AEPRS) for Effective Management of Transboundary Disease Outbreaks in Southeast Asia which was held on 20-22 August 2018 at the Centara Grand at Central Plaza Ladprao, Bangkok, Thailand with funds from the

ASEAN Secretariat through the Japan-ASEAN Integration Fund (JAIF). The Government of Thailand, through its Department of Fisheries hosted the Consultation in coordination with the ASEAN Network of Aquatic Animal Health Centres (ANAAHC) and the Network of Aquaculture Centers in Asia and the Pacific (NACA). Power point presentations of the participants are available at http://www.seafdec.org.ph/2018/asean-rtc-on-aeprs/. The Proceedings of the Regional Technical Consultation on Aquatic Emergency Preparedness and Response Systems for Effective Management of Transboundary Disease Outbreaks in Southeast Asia was launched during the SEAFDEC/AQD 46th Anniversary Celebration last 11 July 2019. E-copy of the Proceedings is available at https://www.seafdec.org.ph/wp-content/uploads/2019/01/RTC-on-AEPRS-Proceedings.pdf. A Regional Technical Guidelines and Mechanism for Early Warning System for Aquatic Animal Diseases was drafted and adopted during the 41st ASEAN Ministers on Agriculture and Forestry (AMAF) Meeting on 15 October 2019. A consultant also analysed the Survey on National Emergency Preparedness and Response Systems in ASEAN Aquaculture.

Another meeting implemented is the Promotion of Sustainable Aquaculture, Aquatic Animal Health, and Resource Enhancement in Southeast Asia (SARSEA). The meeting was held on 25-27 July 2019 at the Richmonde Hotel, Iloilo City, Philippines. The meeting aimed to identify the needs and requirements of member countries to promote sustainable aquaculture, aquatic animal health and resource enhancement practices. There were two technical sessions: Aquatic Animal Health; and Sustainable Aquaculture and Resource Enhancement. The following are the recommended R&D Projects during the workshop:

1. Training of professionals for disease surveillance and management.
   A. Training: In-country/On-site Training to enhance capabilities
   B. Disease Surveillance- Emerging and Endemic Diseases
      Shrimp: EHP, WFD, AHPND, WSSV and SHIV
      Freshwater Fish: Tilapia (TiLV) and Streptoccocal Infection
      Marine Fish: Fish Iridovirus and Vibriosis
2. Training of professionals for proper use of antimicrobials for aquaculture applications and monitoring/preventing emergence of antimicrobial resistance.
3. R&D efforts in developing platform technologies in delivering therapeutics via oral route against major diseases (e.g. WSSV in shrimp, TiLV for Tilapia, and Streptococcal Infection).
4. Development of point-of-care diagnostics.

General recommendations from the workshop are:

1. Enforcement of the established guidelines (e.g. on disease surveillance and disease reporting, etc.).
2. Adaption of established guidelines for food safety and traceability.
3. Enhance collaboration and sharing of information and knowledge among ASEAN member states.

Discussion

- The biosecurity measures undertaken in the hatchery and grow-out facilities for shrimp culture were commendable. It was pointed out that one of the off-shoots of such biosecurity program was the revival of the *P. monodon* culture in the Philippines (coined as *Balik Sugpo*), which was not mentioned in the report. The grow-out facilities recently harvested 2.8 T of *P. monodon* from a 0.5 ha farm, after two failed culture trials. Based on the recent harvest result and economic analysis done for grow-out production, the pay-back period is two years;
- The recorded harvest for *P. monodon* was promising, but how can this be translated to the revival of the tiger prawn industry in the Philippines remains a question. This is considering the investment that was needed to have a fully operational biosecure hatchery and grow-out facilities, which might not be practical for (or not affordable to) ordinary shrimp farmers to invest and operate;
- Moreover, the broodstock used in the biosecure hatchery were still sourced from the wild which might not be sustainable in the long run as wild population of *P. monodon* is continuously dwindling. The AG was informed that there is a plan to import SPF *P. monodon* broodstock from Hawaii for the production of high-health PLs needed for grow-out production;

Recommendations

- With the recorded success of the *Balik Sugpo* program, despite few failed trials, AG recommended that a manual or brochure be produced that will include the improved management practices for *P. monodon* culture, especially on disease prevention and management.

4.2. Aquatic Animal Health Activities of OIE Regional Representation in Asia and the Pacific, Japan

Dr. Jing Wang presented updates on aquatic health activities implemented by OIE regional representation in Asia and the Pacific. OIE RRAP conducted several activities related to aquatic animals including: OIE expert consultation meeting on aquatic animal disease diagnosis and control in November 2018 in Bangkok; Regional side event of the OIE Global Conference on aquatic animal health in April 2019 in Santiago; 31st Conference of the OIE regional commission for Asia, the Far East and Oceania in September 2019 in Sendai.

Establishment of the OIE Regional Collaboration Framework on Aquatic Animal Health was highlighted in her presentation to introduce the OIE new initiative aim to strengthen collaboration among and between OIE Reference Centres (i.e. Reference Laboratories and Collaborating Centres) and Member Countries in the region; and share and exchanging information on test validation, reference materials and positive samples. OIE regular activities, teleconferences about the Aquatic Animal Health Specialist Commission report; regional common position; Regional Delegates' Secure Access System were also presented.

The situation of aquatic animal disease reporting (WAHIS six-month report & QAAD report) in the AP region, the World Animal Health Information System renovation (WAHIS+) as well as the technical support to harmonization of QAAD report and WAHIS was introduced. Jing Wang highlighted the OIE will work closely with NACA on the matter of merging QAAD report to OIE WAHIS+.

Discussion

- The presentation has mentioned about the recent activity of OIE-RRAP in Bangladesh regarding AMU and AMR. This activity is at its initial stage and the AG was informed that other South Asian countries will also be involved in the future, especially those with developed NAP on AMU/AMR;
- For the said project in Bangladesh, *Aeromonas* is used as indicator bacteria for AMR assessment. The original plan of the project was to consider the top 20 cultured species for AMU/AMR monitoring, but due to the limitation of resources, only the top 10 cultured species were included in the monitoring;
- The aquatic animal disease surveillance programme in Bangladesh is mainly focussed on cultured species intended for export (e.g. shrimps). Limited or no disease surveillance are undertaken for cultures species intended for domestic consumption.

4.3. Aquatic Animal Health of AAHRDD, Thailand

Dr. Thitiporn Laoprasert presented the aquatic animal disease status and management in Thailand. The Aquatic Animal Health Research and Development Division (AAHRDD) is the Competent Authority of Thailand for aquatic animal diseases. Its missions are for: research and development on aquatic animal health and diseases, disease diagnosis, disease prevention and control; issuance of health certificates for live aquatic animals and has responsibility for both coastal and freshwater AAH management; approval of fish farm standards for the importation and exportation of live aquatic animal; surveillance and monitoring programs on OIE-listed diseases in wild and cultured populations of aquatic animals; provision of disease diagnostic services for fish farmers at either AAHRDD laboratories or on site clinics, and advice for health management, disease prevention, control and treatment for a more effective AAH management; serving as the national reference laboratory for aquatic animal disease diagnosis; conducting AMR and AMU surveillance under the National Action Plan on AMR.

Thailand's disease management and control are undertaken under collaboration with international partners including OIE, FAO, CODEX (AMRTF) and NACA, bilateral linkages with trade partners including EU, USA, Australia and P.R. China, and joint research projects with university in Japan and JICA. Nationally, the AAHRDD works closely with Universities for some research projects, and with farmers' association for disease prevention and dealing with exotic/emerging diseases. It also provides internship programmes on disease diagnosis for university students. Overall aquatic animal health management follows recent national laws and regulations including Royal Ordinance on Fisheries B.E 2558 (2015) for farm registration and standards, and Animal Epidemic Act B.E. 2558 (2015) for disease prevention and control. Under the Epidemic Act, DOF staff have been appointed by the Minister (Agriculture and Cooperatives) as authorized health inspectors and veterinarians. Currently, there are 40 notifiable aquatic animal diseases under the Act, which is used for disease surveillance.

Biosecurity is strictly being implemented especially for imported aquatic animals through approved quarantine facilities for aquatic animals and aquatic animal products. At present, mandatory quarantine procedures are applied for imported common carp/Koi carp and marine shrimps. Health certificates from the country of origin are strictly required for imported carps (should be free from KHV and SVCV) and marine shrimps (free from WSSV, IHHNV, YHV, TSV and IMNV). Active and passive disease surveillance are regularly done all over the country for different aquaculture operations to disease information, declare country free status, update disease status of the country (thru OIE WAHIS and NACA QAAD), and provide information/data for trade. Samples were usually collected by DOF officers from different centers all over the country, whereas disease diagnoses are carried out by 21 diagnostic laboratories including two national reference laboratories.

The Thailand National Action Plan on Antimicrobial Resistance (NAP-AMR) was adopted in 2017 for implementation from 2017 to 2021, and following the One Health approach (human, animal and environment). For the fisheries sector, AMR surveillance is undertaken through multi-sectoral approach including the public sector, professional associations, civil society organizations, research institutes, private sector, development partners based in Thailand (e.g. WHO, FAO, USAID). The five goals of the NAP-AMR are: 50% reduction in AMR morbidity; 20% reduction in AMU in humans; 30% reduction in AMU in animals (including aquatic animals); 20% increase in public know-how on AMR and awareness in appropriate AMU; and improvement of national AMR system capacity to level 4. Specifically for aquaculture under the different national regulations, some veterinary drugs are prohibited for use in fish farms, and fish produce must be free from veterinary drug residue. Moreover, the Food and Drug Administration requires registration of all veterinary drugs prior to manufacturing, importation and selling.

To increase the overall capacity of AMR system in the aquaculture sector, the DOF has undertaken several training for officers and laboratory staff on national laws and regulations on AMR, AMR analysis, prudent AMU, and disease diagnosis. At the farm level, DOF provides disease diagnosis, advise for health management, disease prevention and control treatment, and conduct seminars of AMU/AMR awareness. For AMR surveillance, samples (water and diseased/healthy animals) were collected from intensive shrimp and tilapia farms all over Thailand for bacterial isolation and AMR analysis. The bacteria included are *Escherichia coli*, *Salmonella* spp., *Vibrio cholerae*, and the pathogenic *Aeromonas* spp., *Streptococcus* spp., and *V. parahaemolyticus*.

In fulfilling the goal of 30% reduction in AMU among (aquatic) animals, several gaps and constraints have been identified as follows:

- The need to use legislative and social measures to strengthen law enforcement in controlling the use of veterinary drugs;
- The need to develop national guidelines for AMU in aquatic animals;

- The need to strengthen training programmes on rational AMU, for government staff and aquatic animal farms;
- The need for relevant research to provide evidence-based information for implementation of important policies on AMU and AMR, and to better understand AMR relation/pathway between the aquatic animals and the environment;
- The need to strengthen AMR surveillance system;
- The need to strengthen and harmonize laboratory capacity for AMR analysis; and
- The need for capacity building for field epidemiology on AMR.

DISCUSSION

- On AMU under the BAP, local farmers are required to keep records. However, there are still no concrete data available on the actual usage of antimicrobials in the aquaculture sector. Farm records are one of the ways to monitor AMU, and they are required to show these to the Fisheries Extension Officers when required. Frequently, however, it is difficult to convince farmers to keep farm records and to report AMU;
- The DOF has already developed a scheme for veterinary prescription in aquaculture, and currently, the Department has 10 veterinarians to implement this measure to control AMU. At present, farmers are encouraged to use antimicrobials properly, and only those (chemicals) that are registered and allowed for use in aquaculture;
- Most exporters (shrimp) collect samples of shrimps from farms that they intend to buy from, for antimicrobial residue analysis. If residue is detected, then the pre-agreed terms of purchase from the farmers are no longer binding. This provides an incentive to encourage farmers not to use antimicrobials;
- The developed national regulations and NAP for AMU/AMR look simple, but practical application and implementation is very difficult, especially at farm level;
- Solving AMR in aquaculture is still far from being accomplished because the work involved is just too much. Farmers' cooperation in this programme is encouraged as they need to maintain their farm's registration, one of the requirements for issuance of health certificates by the DOF;
- The establishment of small-scale farmers association make them stronger or influential in seeking support from the government, and in making a stand in response to important issues and problems in the aquaculture sector;
- The 30% reduction in AMU target came from the animal sector in general (including livestock), and this percentage is a considerable challenge for the aquatic sector. At present, the rate of drug use reduction is around 5% (based on the aquaculture production for the whole country). Many farmers already stopped using antimicrobials because of the non-effectivity of most approved antimicrobials intended for aquaculture use. However, it is really difficult to obtain exact numbers on the reduction of AMU;
- Reaching the target (30%) is not difficult for many intensive or large-scale farms, however, the challenge is among small-scale farmers as they are more difficult to manage thus they should be dealt with slowly. Shrimp farms are mostly large-scale at present, but fish culture is still dominated by small-scale farms.

4.4. AQUATIC ANIMAL HEALTH ACTIVITIES OF AUSTRALIA

Dr. Ingo Ernst presented updates on aquatic animal health program of the Department of Agriculture. The Australian Government Department of Agriculture provides national leadership and coordination of AAH management, while state and territory governments are responsible for managing aquatic animal health within their borders. Within the Department of Agriculture there are areas responsible for:

- National coordination of aquatic animal health management, (e.g. national strategic planning, diagnostic capability, surveillance and disease reporting, training); emergency disease preparedness and response (including contingency planning and testing); national coordination of responses to disease emergencies; international engagement such as reporting of disease status, involvement in standards setting, and regional capacity building.
- Import biosecurity policy including risk analysis
- Biosecurity operations
- Export certification.

AQUAPLAN 2014-2019

Australia's national strategic plan for aquatic animals (AQUAPLAN) aims to strengthen aquatic animal health management systems to support fisheries and aquaculture. AQUAPLAN 1998-2003 and AQUAPLAN 2005-2010 have built most of the country's national systems for managing aquatic animal health. AQUAPLAN 2014-2019 concluded recently and is currently under review.

Dr. Ernst provided an overview and some examples of the achievements of AQUAPLAN 2014-2019 under each of its 5 objectives.

<u>Objective 1.</u> Improving regional and enterprise-level biosecurity

Outcome: Best practice biosecurity planning is in place across a number of sectors.

- Generic biosecurity plan guidelines and template
- National Biosecurity Plan Guidelines for land-based abalone, barramundi, oyster hatcheries and farmed prawns
- National biosecurity survey complete and plans underway to provide support to farms to develop and implement enterprise level biosecurity plans

<u>Objective 2.</u> Strengthening emergency disease preparedness and response capability

Outcome: Preparedness and response capability has been strengthened.

- A draft industry-government emergency animal disease response agreement is complete and final negotiations are underway
- Priorities for a program of emergency response exercises has been developed
- The National Biosecurity Response Team comprises trained biosecurity emergency response specialists and includes aquatic animal expertise.

<u>Objective 3.</u> Enhancing surveillance and diagnostic services

Outcome: Improved confidence to detect significant emerging and exotic diseases and to substantiate Australia's disease status

- Sensitivity of the passive surveillance system assessed
- Aquatic animal diseases significant to Australia: identification field guide updated and available on mobile
- Test validation (e.g. WSSV, OSHV-1, AVG).

Objective 4. Improving availability of appropriate veterinary medicines

Outcome: Additional veterinary medicines and chemicals are available to support aquatic animal health.

- Industry-government workshop to identify ways to improve access to veterinary medicines
- 15 veterinary medicines minor use permits progressed.

Objective 5. Improving education, training and awareness

Outcome: Numbers of trained aquatic professionals have increased.

- Merit based training scheme to provide grants for aquatic professionals to build expertise through short, focused training
- Communication strategy for AQUAPLAN 2014-2019 implemented.

A review of AQUAPLAN 2014-2019 is underway to examine the process for plan development, implementation processes, achievements and considerations for a successor strategy. All key industry and government stakeholders are contributing to the review which is due for completion by mid-2020. More details on the current AQUAPLAN can be obtained at http://www.agriculture.gov.au/animal/aquatic/aquaplan.

Aquatic Deed

There has been significant work to develop a joint industry-government agreement for emergency aquatic animal disease responses, called the aquatic deed. The aquatic deed is a framework for sharing costs, responsibilities and for joint decision-making for responses to aquatic emergency animal diseases. This joint initiative of industry and government has involved negotiations among 9 government parties and approximately 10 aquaculture and fisheries industries. A draft of the agreement was largely completed pending final negotiations, followed by a signing process. Key elements of the aquatic deed involve provisions for sharing responsibility (e.g. for costs and decision making), for risk mitigation (e.g. surveillance and biosecurity measures) and to encourage early reporting and rapid response (e.g. provisions for compensation).

Regional Proficiency testing program

The Australian Government had supported a regional laboratory proficiency testing (LPT) program in 2012-2014 which was successfully completed. The Department of Agriculture has since implemented a second LPT program for 5 years in the Asia-Pacific region which commenced in 2018. The current LPT has a similar format as the previous one and is open to national laboratories of competent authorities in the region. Three rounds of testing have been completed. A workshop for the participating laboratories was also held in March 2019 and included 50 participants from 12 countries.

Active and passive surveillance programs

Active surveillance projects have commenced for both farmed and wild abalone and for barramundi hatcheries. The aim is to provide additional evidence of freedom from exotic diseases and from some endemic diseases (for farms or certain regions).

A project to determine the sensitivity of Australia's passive surveillance system has commenced and has been focussed on the abalone, yellowtail kingfish, and barramundi sectors. Phase 1 of the project has included a survey to better understand reporting behaviours. Phase 2 of the project (pending) is intended to include quantitative approaches to determine the sensitivity of the passive surveillance system for specific diseases.

WSD outbreak – current situation

The WSD outbreak occurred in Australia in late 2016 and initiated a coordinated emergency response that aimed to eradicate the disease from all affected farms. All affected farms were destocked and decontaminated and remained fallow for 18 months. Enhanced biosecurity measures were put in place on farms in the affected area and industry as a whole, including development of national biosecurity guidelines for the prawn industry. Three prawn farms in the affected area restocked in late 2018 and their harvests were completed in April 2019 with no disease issues. Movement restrictions remain in place for the control area and have been supported by an extensive communications and enforcement program.

A national risk-based surveillance program for WSSV outside the control area covers over 50 sites around the country. All surveillance has resulted in negative results outside of the restricted area. Surveillance within the control area has been negative for the last 2 rounds of testing and is ongoing.

Marine pest management

Dr. Ernst noted that there are advantages in taking an approach to aquatic biosecurity that covers both marine pests and aquatic animal diseases. One example is where marine pests may be vectors for disease (e.g. OsHV-1) or where approaches and technology may be complementary. A brief overview of some initiatives on marine pest management were provided.

MarinePestPlan 2018-2023 is Australia's National Strategic Plan for Marine Pest Management and is an equivalent of AQUAPLAN. The plan is a joint industry, government, research and NGO initiative. It aims to enhance national marine pest biosecurity, consistent with international and domestic obligations.

The plan includes 5 objectives and one aims to strengthen the national marine pest surveillance system. An example of an activity under this objective is a project to modify and trial remotely operated underwater vehicles (ROVs) for use in marine biosecurity surveillance. The ROVs are intended to be a national resource for marine biosecurity surveillance and may provide significant cost and safety advantages. Potential uses include inspecting vessel hulls, port infrastructure, and marine environments. Various features have been trialled including high resolution cameras, live streaming, sonar, sample collection devices, and virtual reality. Training workshops have been held for operators of the ROVs.

DISCUSSION

- On the on-going PT programme, the list of diseases included in the tests was based on the priority list by the participating laboratories, which include both finfish and crustacean diseases. There are no molluscan diseases included as these were not prioties of the participating laboratories. Confidentiality is an important component of the programme and is a accreditation requirement for the PT priovider. None of the participating laboratories know the identity of the other laboratories when the results are delivered to them;
- On the eradication of WSD, the AG noted that it is encouraging that the aggressive response appears to have been successful. The response included aggressive measures to prevent WSSV establishing in wild populations. The Queensland and Australian governments invested heavily in the response, in particular the depopulation and decontamination of infected farms.
- In Moreton Bay, some sampling sites had up to 5% prevalence in the wild population and some prawns displayed clinical signs. The AG noted that progress made from the detection of infection to the recent negative results in all WSD surveillance efforts is indeed a substantial achievement;
- The laboratories responsible for sample analyses under the active surveillance are all government laboratories. For samples from imported shrimp products, only one government laboratory is responsible for screening of animal pathogens, and a few private laboratories are also accredited by the government for pathogen-specific testing. The laboratories use real time PCR for testing.

RECOMMENDATIONS

- AG recommended that other government-accredited laboratories in the country be involved in future PT programmes, and not just government laboratories.

4.5. AQUATIC ANIMAL HEALTH ACTIVITIES OF P.R. CHINA

Mr. Chenxu Cai (on behalf of Dr. Qing Li) presented updates on aquatic animal health activities and achievement in P.R. China. In 2018, the total output of fishery products was 64.6 million T, among which aquaculture accounted for 49.9 million T or 77.3% of the total fishery production. Of the total aquaculture production, marine accounted for 20.3 million T (40.7%), while freshwater 29.6 million T (59.3%). Pond culture was the most popular one in multiple aquaculture systems, which produce around 49.2% of the total aquatic products. The Animal Husbandry and Veterinary Bureau of the Ministry of Agriculture and Rural Affairs (MARA) is in charge of animal epidemic disease prevention and quarantine nationwide. The Bureau of Fisheries at MARA mainly undertakes the responsibilities related to epidemic disease prevention and quarantine of aquatic animals. On the other hand, the Department of Animal and Plant Inspection and Quarantine of General Administration of Customs of China (GACC) is responsible for establishing the quarantine regime, undertaking and supervising the inspection and quarantine of entry (import) – exit (export) animals, plants and their products. National Fisheries Technology Extension Center (NFTEC) is the national agency of aquatic animal disease prevention and control, undertaking the responsibilities of monitoring, forecasting and prevention of aquatic animal diseases.

Team structure for Aquatic Animal Disease Prevention and Control Agencies (AADPCA) has been expanded in 2018, and by the end of year, 2,921 official fish veterinarians were appointed, 14,145 rural fish veterinarians were certified, and 4,002 licensed fish veterinarian were certified via a qualifying examination. MARA formally approved trials of Jiangsu Juveniles Quarantine in the original hatchery in 2017. This has effectively controlled the spread of aquatic animal diseases and thus far achieved the desired outcome. Following on from the successful experience in Jiangsu, MARA expanded the trial locations to Tianjin, Zhejiang, Anhui, Shandong and Guangdong in 2018.

In 2018, steady progress has been made in the surveillance of major aquatic animal diseases in significant aquaculture areas through the Report of Aquatic Animal and Plant Diseases and the National Aquatic Animal Disease Monitoring and Surveillance Programme organized by MARA. The surveillance programme included seven fish diseases (SVC, KHVD, CEVD, GCHD, CHN, IHN, VNN) and four shrimp diseases (WSD, IHHN, SHIVD, EHPD) that are specifically monitored. Major broodstock and high genetic seed farms at both national and provincial levels, hatcheries, ornamental fish farms and grow-out farms were included in the surveillance programme (i.e., specified monitoring sites). Report of Aquatic Animal and Plant Diseases has been started since 2000. In 2018, more than 4,000 monitoring sites covering 310,000 hectares of aquaculture area were set up in P.R. China with more than 6,000 personnel participating. The survey was carried out under the guidance of *Technical Norms on Aquaculture Animal and Plant Disease Survey and Report*.

In accordance with the "Nationwide Capacity Building Plan on Improvement of Animal and Plant Protection (2017-2025)" project, 690 million RMB will be invested by 2025 in order to implement a series of projects for monitoring, preventing and controlling aquatic animal diseases. This is supported by the AADPCA at national and local levels to further optimize the national monitoring network for aquatic animal diseases.

To improve the capacity of aquatic animal disease epidemic prevention system and to strengthen the capability for diagnosis of important aquatic animal diseases affecting trade, aquaculture industry sustainability and productivity, MARA has carried out an annual Proficiency Testing (PT) programme since 2014. In 2018, the programme included testing on 11 aquatic animal pathogens (SVC, KHV, CEV, GCH, CHN, Tilapia Lake Virus (TiLV), WSSV, IHHN, SHIDV and EHP) participated by 153 laboratories, of which 137 were assessed with acceptable proficiency.

The National Committee on Standardization of Aquatic Animal Disease Prevention has been established since 2001. It is responsible for drafting guidelines, policies and technical measures for standardization of aquatic animal disease prevention. By the end of 2018, 135 national and industrial standards for aquatic animal infectious disease prevention have been established.

MARA Expert Committee of Control of Diseases in Aquaculture (Expert Committee) has been set up in 2012. In 2017, the Expert Committee entered into its second term with 37 members, sub-divided into three professional working groups in the fields of marine fish, freshwater fish, and crustaceans and molluscs. The Expert Committee act as the advisor for policy making, as well as for providing suggestions and support for work related to aquatic animal disease prevention and control in P.R. China.

The National Remote Aquatic Animal Disease Diagnosis Service Network managed by NFTEC provides tools for self-service diagnosis all over the country. Frontline technical personnel were greatly helped by this platform. By the end of 2018, there were 700,000 views on the website with free diagnosis provided for over 7,300 cases.

In 2018, P.R. China continued to strengthen international cooperation and exchanges in the aquatic animal health management, earnestly fulfilled international obligations on aquatic animal health, and actively participated in the formulation and revision of international standards for aquatic animal health. P.R. China strived to safeguard the healthy development of domestic fisheries and, as a major aquaculture country and a trading power of aquatic products, made significant contributions to global aquatic animal health. Since restoring its legitimate rights and interests in OIE in 2007, P.R. China has been earnestly fulfilling its obligations and responsibilities, and actively participates in OIE-related activities. P.R. China continues to actively participate in the formulation and revision of the international aquatic animal health standards, including revision of the OIE *Aquatic Animal Health Code* and the *Manual of Diagnostic Tests for Aquatic Animals*. One Chinese laboratory was also designated as an OIE Reference Laboratory for Infectious Haematopoietic Necrosis Virus (IHNV).

DISCUSSION

- The AG looks forward to the publication of the Annual Aquatic Animal Health Report in English, and hope that hard- or e-copy of the report will be disseminated among relevant institutions (including NACA);
- On the national PT programme, participating laboratories are mostly government and government-accredited laboratories;
- The red-claw or freshwater crayfish (*Procambarus clarkii*) has a very high demand in the domestic market (around 1.6 million T), but aquaculture of this species is not much. In Thailand, the culture of this species is also limited, normally in rice fields;
- White spot disease is also reported to impact the freshwater red claw crayfish. Previous studies on infection of red claw crayfish by WSSV also showed their susceptibility to the virus;
- On CQIV discovery, infected animals samples were sourced from the market and not from farms.

4.6. AQUATIC ANIMAL HEALTH ACTIVITIES OF THE NORWEGIAN VETERINARY INSTITUTE RELEVANT TO ASIA PACIFIC REGION

Dr. Saraya Tavornpanich presented the current aquatic animal health activities of the Norwegian Veterinary Institute (NVI), highlighting important activities in the Asia-Pacific region. The NVI is the national research institute in the areas of animal health, fish health and food safety, whose primary function is supply of independent research-based knowledge support to the authorities. It is the National Reference Laboratory for more than 30 diseases of terrestrial and aquatic animals, the OIE reference laboratory for Infection with infectious salmon anaemia virus, Infection with *Gyrodactylus salaris* and Infection with salmonid alphavirus, and the OIE collaborative center for Epidemiology and Risk Assessment of Aquatic Animal Diseases, Europe.

The recent NVI aquatic animal health activities in Asia and the Pacific include as follows: in partnership with WorldFish, NVI co-authored in publications of TiLV review paper and the TiLV fact sheet; NVI has been involved in a project to carry out a rapid epidemiological assessment of tilapia mortalities in Bangladesh and Egypt in order to identify challenges and obstacles for adverse disease events reporting; and, a development of a digital epidemiology questionnaire gathering data on mortality events in tilapia and data on the socio-economic impact of the mortality events. The digital questionnaire is due to be released for public use in 2020. NVI is a partner institute for a capacity building project "Fish for Development Program, Myanmar" which had a kick-off meeting in Spring 2019. This project is funded by the Norwegian Agency for Development Cooperation (NORAD) with the aim to reduce poverty through socio economic development, food security, sustainable management and profitable business activities.

NVI is a partner in a capacity building project under the supports of FAO Fisheries and Aquaculture (FAO-FIRA) and NORAD called "Improving Biosecurity Governance and Legal Framework for Efficient and Sustainable Aquaculture Production". In this project, the FAO 12-points checklist of aquaculture diseases (e.g. EHP in Shrimp) has been revised and implemented, and a risk-based surveillance in two pilot participating countries: Indonesia has been done, and Vietnam to be carried out in February 2020. This project aims to improve aquaculture biosecurity governance through implementing PMP/AB tools and enhancing interpretation and implementation of international standards by bringing together state and non-state (producers and value chain stakeholders) actors, international and regional organizations, research, academe, donor and financial institutions to design and implement mandated biosecurity measures.

Other activities include scientific conference, workshop, and training. NVI provided teaching the epidemiology-part of the FAO training course on TiLV in Guangzhou, P.R. China in June 2018, workshops with the Ministry of Marine Affairs and Fisheries on the Norwegian experience/practices in marine fish farming in 2017 Jakarta Indonesia, and co-organized the 2nd International Global Conference in Aquatic Animal Epidemiology (AquaEpiII) and provided training in Diagnostic and Risk Assessment of Aquatic Animal Diseases in November 2019, Hua Hin, Thailand.

Discussion

- On the recently held AquaEpi II conference, there seems to be very limited promotion or dissemination of information among the aquatic animal health community, thus there was limited or no participation at all from some countries (e.g. P.R. China). It was suggested by the group that in the next meeting (which will be held in India), pro-active dissemination of information and promotion should be done by the organizers to attract more participants from as many countries as possible;
- The group also commended the on-going projects of NVI in the region and expressed that more collaborative projects on aquatic animal health management should be implemented by NVI in the region.

Session 5: Disease Reporting

5.1. Infection with Decapod Iridescent Virus 1 (DIV-1); formerly Shrimp Hemocyte Iridescent Virus (SHIV)

Dr. Hong Liu presented the update study on Shrimp hemocyte iridescent virus (SHIV) which is now known as Decapod iridescent virus 1 (DIV1), and is synonymous to *Cherax quadricarinatus* iridovirus (CQIV). Looking back at the history of this virus, from July to November 2014, Xu et al. (2016) identified a new iridescent virus in *C. quadricarinatus* samples in Fujian Province and temporarily named the new virus as CQIV. In December 2014, Qiu et al. (2017) identified a new iridescent virus in farmed *P. vannamei* from Zhejiang Province and named it SHIV based on the infected organs and susceptible species. SHIV and CQIV both have a typical icosahedral structure with a mean diameter of about 150 nm. Phylogenetic analysis supported that SHIV and CQIV belong to a new genus, which was originally proposed to be named *Xiairidovirus* or *Cheraxvirus*, in the family Iridoviridae (Qiu et al. 2018b; Li et al. 2017). In March 2019, the Executive Committee of the International Committee on Taxonomy of Viruses (ICTV) approved the proposal made by Chinchar et al. that a new species of Decapod iridescent virus 1 (DIV1) in a new genus *Decapodiridovirus* to include SHIV 20141215 and CQIV CN01 as two original isolates (ICTV, 2019).

Clinical signs included reddish body, hepatopancreatic atrophy with colour fading, empty stomach and guts, and whitish area under the carapace at the base of rostrum. Moribund individuals sink to the bottom in deep water and dead individuals can be found every day, with a cumulative mortality up to 80% (Chen et al. 2019; Qiu et al. 2017; Qiu et al. 2019a).

Currently known susceptible species of DIV1 include *P. vannamei*, *M. rosenbergii*, *Exopalaemon carinicauda*, *M. nipponense*, *Procambarus clarkii*, and *C. quadricarinatus* (Xu et al., 2016; Qiu et al., 2017; Qiu et al., 2019a; Chen et al., 2019). Two species of crab, *Eriocheir sinensis* and *Pachygrapsus crassipes* could be infected with DIV1 in experimental challenge through intramuscular injection (Pan et al., 2017), but cannot yet be identified as susceptible species. DIV1 could also be detected in *P. chinensis*, *P. japonicus*, *M. superbum*, *Nereis succinea* or some cladocera by PCR method (Qiu et al., 2017; Qiu et al., 2018c; Qiu et al., 2019a; Qiu et al., 2019b).

Infection with DIV-1 has been reported in some coastal provinces of P.R. China since 2014. Target surveillance in P.R. China in 2017-2018 revealed that DIV-1 has been detected in 11 of 16 provinces (Qiu 2018c; Qiu et al., 2019b). The geographic distribution of DIV-1 may be wider than currently known, since mortality may not have been investigated in other countries or regions.

Challenge tests have demonstrated that direct horizontal transmission was an important route of transmission. There is no evidence of vertical transmission. However, some samples from hatcheries have been found to be DIV-1 positive. Target surveillance in P.R. China in 2017-2018 revealed that the virus has been detected in shrimp and crayfish at temperatures from 16°C to 32°C, and no positive samples have been detected when the temperature exceeds 32°C (Qiu 2018c; Qiu et al., 2019b).

Histopathological examination showed the existence of dark eosinophilic inclusions mixed or surrounded by basophilic staining, and karyopyknosis in the haematopoietic tissues, epithelium, haemocytes of gills, pereiopods, and hepatopancreatic sinus (Chen et al. 2019; Qiu et al. 2017; Qiu et al. 2019a). *In situ* hybridization (ISH) and *in situ* digoxigenin-labeled loop-mediated isothermal amplification (ISDL) showed positive signals in the haematopoietic tissues, epithelium, haemocytes of gills, pereiopods, and hepatopancreatic sinus (Chen et al. 2019; Qiu et al. 2017; Qiu et al. 2019a). TEM revealed a large number of DIV-1 both inside and outside hematopoietic cells. At the margin of the cytoplasm, many virions were budding from the plasma membrane and an outer viral envelope was acquired. Virion formation took place in the virogenic stromata containing numerous immature and empty capsids, few mature virions, and were devoid of cellular organelles, with paracrystalline array of viral particles and budding virions in the same cell. Assembly of nucleocapsid can be observed in the virogenic stromata (Qiu et al. 2017; Qiu et al. 2019a).

A nested PCR method and a real-time PCR method has been developed and validated. The nested PCR is carried out in two separate steps using two pairs of primers targeting the ATPase gene of DIV1. In the first step, the PCR amplifies a 457 bp amplicon. In the second step, a 129 bp amplicon is amplified. The detection limit of the nested PCR was as low as 36 fg DNA of infected tissue. The diagnostic sensitivity (DSe) and the diagnostic specificity (DSp) compared with the real-time PCR were 98.3% and 97.6%, respectively (Qiu et al. 2017). For the real time PCR, the detection limit was as low as 4 copies/reaction, and the DSe and DSp compared with the nested PCR were 99.2% and 95.3%, respectively (Qiu et al. 2018b).

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RECOMMENDATIONS

- AG recommended that SHIV be replaced by Infection with Decapod iridescent virus 1 (DIV-1) in the QAAD list commencing the first quarter of 2020.
- AG recommended that the disease card for DIV1 be finalized, and publish it as soon as possible at NACA website.

5.2. QAAD REPORTING AND REVISION TO THE QAAD LIST

Dr. Eduardo Leaño presented the status of QAAD Reporting in the Asia-Pacific region. There are now a total of 83 QAAD reports published since its inception way back 1998. At present, only e-copies of the report is published at both NACA and OIE-RRAP websites. Website downloads during 2018 ranged from around 600 to 1,100, while the 1st quarter report for 2019 (uploaded in May 2019, has a total of around 300 downloads.

Only 11-13 out of the 34 countries have submitted reports in 2018 and 2019 representing 32-38%, which is still very low. A total of 9 countries (Australia, Hong Kong SAR, India, Iran, Myanmar, New Zealand, Philippines, Singapore and Vietnam) regularly submit quarterly reports, while 5 countries submit irregularly (missing some quarterly reports). Twenty (20) countries did not submit quarterly reports for the period covered in this report. As in AGM 17 last year, this scenario of decreasing numbers of countries submitting the quarterly reports is alarming, and ways to convince the countries to resume reporting should be formulated immediately.

There were no changes in the list of diseases for the QAAD reporting for 2019, aside from the change of name of Iridovirus in crayfish to Shrimp hemocyte iridescent virus (SHIV). Reported diseases for finfish include Infection with infectious haematopoietic necrosis (reported by Iran and Japan), Infection with viral haemorrhagic septicaemia (Iran and Japan), Infection with *Aphanomyces invadans* (India), Infection with red seabream iridovirus (Hong Kong, Japan, Singapore and Taiwan POC), Infection with Koi herpesvirus (Japan, Hong Kong and Singapore), Grouper iridoviral disease (Taiwan POC), Viral encephalopathy and retinopathy (Australia, Japan, New Caledonia, Philippines, Taiwan POC and Singapore), Enteric septicaemia of catfish (Vietnam), Carp edema virus disease (Japan), and Tilapia lake virus (India, Malaysia and Philippines). For crustaceans, reported diseases were Infections with viruses including White spot syndrome virus (India, Iran, Japan, Philippines, Taiwan POC and Vietnam), Infectious hypodermal and haematopoietic necrosis virus (Australia, India and Philippines), and Infectious myonecrosis virus (India). Also reported were bacterial disease Acute hepatopancreatic necrosis disease (Philippines, Taiwan POC and Vietnam), and parasitic disease Hepatopancreatic microsporidiosis caused by *Enterocytozoon hepatopenaei* (India, Philippines and Taiwan POC).

For molluscs, Australia reported Infection with *Bonamia exitiosa*, while Australia, India and New Zealand reported the presence of Infection with *Perkinsus olseni*. No country reported any amphibian disease for the period covered in this report. Other reported diseases are:

Singapore:

- *Lates calcarifer* herpesvirus
- Big belly bacteria (Asian seabass)
- Scale drop disease virus (Asian seabass)
- Infectious spleen and kidney necrosis virus (Asian seabass)
- *Mycobacterium* sp. infection (grouper)
- Streptococcosis (snapper)

Bangladesh:

- Streptococcosis (tilapia and climbing perch)

Myanmar

- Parasitic infestation (*Dactylogyrus* spp., *Trichodina* spp.) in freshwater fish

Dr. Ingo Ernst reported that there is no addition to the OIE list of diseases. Two diseases (Tilapia lake virus, and Decapod iridescent virus 1) proposed for listing are still under evaluation for OIE listing.

DISCUSSION

- There will be no changes in the QAAD list of diseases for 2020, except for the change in the name of SHIV to DIV-1 as endorsed in **Section 5.1**.

SESSION 6. OTHER MATTERS AND CLOSING

6.1. PARTICIPATION IN FUTURE AG MEETINGS: A BRIEF VISION

Dr. Jie Huang made a brief vision on participation in future AG meetings. He summarized challenges of health issues in aquaculture in NACA Members, which included multiple diseases in diversity of aquaculture species and complexity of eco-system, large gaps in knowledge and understanding on health issues in aquaculture, gaps exist between governance for aquaculture health and actual industrial needs, different infrastructures in Aquatic Animal Health Services, interests of research and experts usually do not follow the immediate needs of disease prevention and control, differentiations of capability and complexity of people in disease control forces, limited funding, experts, and tools for aquaculture health, complexity and shortage in validity of products and technologies, insufficient pathways and platforms for communication between resources and needs, and difficulties in professional language and country languages. Based on the challenges, he pointed needs of NACA Members related to aquaculture health on knowledge, governance, capability, products, biosecurity, prevention, diagnosis and detection, surveillance, response, and trade.

After the presentation, Dr. Huang suggested that participants for future AGMs may be considered to be increased to a maximum of 30 persons, with consideration of cost related aspects and best interaction. It may be considered to have representatives which include experts from NACA Members, international organizations, sub-networks, enterprise. *Ad hoc* participants for specific subjects may also be considered.

DISCUSSION

- AG is an expert group and does not really represent a country but expertise in the field of aquatic animal health management;
- AG was originally formed in response to the emergency disease outbreak in the 1990's, the Epizootic Ulcerative Syndrome. The AG became responsible in consolidating relevant information about the disease, and releasing disease advisories and other important issues on aquatic animal health (e.g. disease reporting). Afterwards, AG became a group of experts who advise on how NACA's aquatic animal health programme could be run or could be sustained;
- AG is an expert group discussion, and whatever issues were discussed and endorsed by the group can be tabled or presented in other NACA platforms wherein member countries are represented (e.g. annual Governing Council Meeting and Technical Advisory Committee meeting), or other regional gathering on aquatic animal health (e.g. Symposium on Diseases in Asian Aquaculture). Thus, there is no need to seek representation of NACA member countries in AGMs.

RECOMMENDATIONS

- AG recommended that the current format of AGM be maintained, i.e. limited number of participants to include experts in the region as well as representatives of NACA partner organizations and the private sector;
- AG recommend that *ad hoc* members can be invited on specific topics of interest or current aquatic animal health (and related) issues (e.g. molluscan and amphibian diseases).

6.2. ADOPTION OF REPORT AND DATE OF NEXT MEETING

Report of the meeting (Discussions and Recommendations) was circulated by e-mail to all AG members, co-opted members and observer for comments and adoption.

The next meeting will be held back-to-back with the 11th Symposium on Diseases in Asian Aquaculture scheduled to be held in Kuching, Sarawak, Malaysia on 29 September to 2 October 2020 (final dates of the AGM 19 to be decided after consultation with members).

ANNEX A

18TH MEETING OF ASIA REGIONAL ADVISORY GROUP ON AQUATIC ANIMAL HEALTH (AGM 18)
18-19 NOVEMBER 2019
AMARI DON MUANG AIRPORT HOTEL, BANGKOK, THAILAND

AGENDA:

<u>Day 1 (18 November, Monday)</u>

<u>09:00 – 12:00</u>

Opening Session

- Welcome address: **Dr. Eduardo Leaño**, Coordinator, Aquatic Animal Health Programme, NACA
- Opening Remarks: **Dr. Jie Huang**, Director General, NACA
- Self introduction

(AG Chairperson, Dr. Siow Foong Chang, will take over)

Session 1. Progress Reports

- Progress since AGM 17 **(Dr. Eduardo Leaño**, NACA)

DISCUSSIONS AND RECOMMENDATIONS

Session 2. OIE Standards and Global Issues

- Outcomes of recommendations from OIE General Session and the Aquatic Animal Health Standards Commission (**Dr. Ingo Ernst**, AAHSC, OIE)
- Updates on FAO initiatives in Asia-Pacific in support of aquatic animal health management (**Mr. Weimin Miao**, FAO-RAP)
- Biosecurity in Aquaculture: Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB) (**Dr. Jie Huang**, NACA)

DISCUSSIONS AND RECOMMENDATIONS

Group Photo
Lunch

<u>13:30 – 17:00</u>

Session 3. Review of Regional Disease Status

- Updates and emerging threats on finfishes: diagnosis, management and prevention (**Dr. Siow Foong Chang,** NParks, Singapore)
- Updates and emerging threats on crustaceans: diagnosis, management and prevention (**Prof. Tim Flegel**, Centex Shrimp, Thailand)
- Updates on other diseases (molluscs and amphibians): diagnosis, management and prevention (**Dr. Andy Shinn**, Fish Vet Group, Thailand)

DISCUSSIONS AND RECOMMENDATIONS

NACA hosted dinner (18:30 - ; venue to be announced)

Day 2 (19 November, Tuesday)

09:00 – 12:00

Session 4. Reports on Aquatic Animal Health Programmes from Partner Agencies with focus on *Disease Management, Prevention and Control*

- Fish Health Section, SEAFDEC Aquaculture Department, Philippines (**Dr. Eleonor Tendencia,** SEAFDEC AQD)
- OIE-Regional Representation in Asia and the Pacific (**Dr. Jing Wang**, OIE-Tokyo)
- Aquatic Animal Health Research and Development Division, Thailand (**Dr. Thitiporn Laoprasert,** AAHRDD)
- Australian Department of Agriculture and Water Resources (**Dr. Ingo Ernst**, DAWR-Australia)
- Aquatic animal health activities of P.R. China (**Dr. Chenxu Cai**, MARA, P.R. China)
- Norwegian Veterinary Institute, Norway (**Dr. Saraya Tavornpanich**, NVI)

DISCUSSIONS AND RECOMMENDATIONS

Lunch

14:00 – 17:00

Session 5. Special Session: Regional Aquatic Animal Health Management Activities of Private Sectors

- PHARMAQ (Zoetis)-Asia (**Dr. Kjetil Fyrand**)
- Fish Vet Group Asia (**Dr. Andy Shinn**)

DISCUSSIONS AND RECOMMENDATIONS

Session 6. Disease Reporting

- SHIV: Status and updates including change of name to DIV1 (**Dr. Hong Liu**, GAC, PR China, TBC).
- QAAD Reporting: status and updates (**Dr. Eduardo Leaño**, NACA)
- New OIE Disease List and revisions to the QAAD List for 2018 (**Dr. Ingo Ernst**, AAHSC, OIE)

DISCUSSIONS AND RECOMMENDATIONS

Session 7. Other Matters

- Participation in future AG meetings (**Dr. Jie Huang**, NACA)
- Others

DISCUSSIONS AND RECOMMENDATIONS

Session 8. Closing

ANNEX B

List of Participants (AGM 18)

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Annex C:
List of Diseases in the Asia-Pacific

Quarterly Aquatic Animal Disease Report
(Beginning January 2020)

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))	5. Tilapia lake virus (TiLV) disease
6. Infection with red seabream iridovirus	
7. Infection with koi herpesvirus	
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. Infection with Decapod iridescent virus 1 (DIV-1)
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)	
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 alphavirus	
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 (Updated 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, some of which were later listed by the OIE • Many countries have established national lists for reporting purposes with appropriate supporting legislation	• Participation could improve further – many countries report irregularly, and some do not submit reports at all • The exact status of individual countries with regard to adoption of national lists and supporting legislation is not known. • The development of new OIE WAHIS set for launching in 2020 will benefit QAAD reporting, and might replace paper-based submission of reports (if the new system will work well)
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 and some countries in the region have availed of such in recent years (e.g. P.R. China and Indonesia) • The exact status of diagnostic capability in individual countries is not certain • Recent Proficiency Testing Programs have facilitated improvement of PCR diagnostic capacities of country laboratories in the region for for major shrimp and finfish diseases. • Some areas of specialist diagnostic expertise are lacking
3. Health certification and Quarantine measures *The purpose of applying*	• Strong progress has been made, particularly for high risk importations (e.g. importation of broodstock and seed stock)	• The importance of supporting aquatic animal health attestations through sound aquatic animal health programs

quarantine measures and health certification is to facilitate transboundary trade in aquatic animals and their products, while minimising the risk of spreading infectious diseases	• 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	continues to be underestimated, with possible ramifications for trade • Some inappropriate or illegal activities continue and threaten to spread transboundary 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*	• 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 • Recent workshops on emergency preparedness and response has formulated recommendations for the region in dealing with emerging

		aquatic animal diseases • Support for developing contingency plans might usefully be directed at particular disease threats e.g. IMN, TiLV, DIV-1
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 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.*	• Numerous resources and case studies published • The approach has been applied, particularly for some circumstances e.g. import of live *P. vannamei* • However risk analysis is not always applied, or is not applied appropriately • Regional training has been provided (e.g. AADCP project)	• 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 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 and implementation of national strategies in individual countries is not certain • The OIE's PVS tool provides a means of assessing the progress of individual countries, but very few countries in the AP have undertaken the assessment for aquatic veterinary services (Philippines, Maldives and Vietnam; Indonesia in 2020)