Fish Health Section
Asian Fisheries Society

Message from the Chair

Warm greetings to all members of the Fish Health Section of the Asian Fisheries Society!

Welcome back to another edition of the Fish Health Section Newsletter, Number 21. A special thank you to our Editor, Dr. Neeraj, and his dedicated team for their invaluable contributions to this publication.

The society was established in 1989, is still standing strong, and will stand strong because of dedicated members like all of you. The vehicle for spearheading our society would be our website, journal, and activities. I hope the Fish Health Section Newsletter will serve as an effective medium for members to share the latest developments within the society and encourage more information from members.

Since 2020, we have been meeting virtually, and it was only at our Fish Health Section Conference in September 2023, Bangkok, Thailand, that we were finally able to see each other face-to-face. With the theme 'From the Pillars to the Next', it was heartening to see so many familiar faces of loyal members who supported and contributed to society in so many ways. To see our young researchers actively participate in our activities and engage with our amazing and dedicated seniors, I am pleased to share that we successfully achieved the objectives of the event.

It is timely that FHS-AFS hosts the physical event to strengthen its commitment by providing a platform for delegates to jointly explore progress and development in aquatic animal health and to share recent research findings as well as establish new networks. Sincere thanks to our enthusiastic pillars, Dr. Melba, Dr. Supranee, Dr. Rohana, and Dr. Celia, who initiated the call for a physical meeting after a 5-year gap between DAA10 (2017) and DAA11 (2022). On the same occasion, I would like to express our gratitude to the Department of Fisheries Thailand and the Network of Aquaculture Centres in Asia-Pacific (NACA) for their support in co-organising the Fish Health Section Conference; without their support, this conference would not have been possible.

We also released the DAA12 teaser, and we look forward to welcoming everyone to our upcoming DAA12 in India. Stay updated by following us on our website and Twitter!

Lastly, I wish each of you the very best in all your endeavours.

Thank you.

Dr. Kua Beng Chu
Chairperson of FHS Executive Committee (2022-2025)
E-mail: kuaben01@dof.gov.my

Fish Health Section
Asian Fisheries Society

22nd Meeting of the Asia Regional Advisory Group on Aquatic Animal Health

November 6-7, 2023

The 22nd Meeting of the Asia Regional Advisory Group on Aquatic Animal Health (AGM 22) was organized by the Network of Aquaculture Centres in Asia-Pacific during November 6-7, 2023 in a fully virtual platform. The meeting was attended by 14 members and co-opted members, and 15 observers who are representatives of NACA member countries including Australia, Bangladesh, Cambodia, P.R. China, India, Indonesia, Lao PDR, Malaysia, Maldives, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam.

The first day of the meeting was co-moderated by Dr. Andy Shinn and Dr. Leobert dela Peña, while the day-2 was moderated by Dr. Eduardo Leaño. Important updates and issues on aquatic animal health management in the Asia-Pacific region were discussed including:

- Progress since AGM 21 (Dr. Eduardo Leaño, NACA)
- Updates from WOAH Aquatic Animal Health Standards Commission (Dr. Ingo Ernst, AAHSC, WOAH)
- Updates on WOAH Asia-Pacific Network on Aquatic Animal Health (AP-AquaNet) (Dr. Thitiwan Patanasatienkul, WOAH-RRAP)
- Farm level biosecurity: updates on SEAFDEC AQD's Oplan Balik Sugpo (Dr. Leobert dela Peña)
- Farm level biosecurity: from a tilapia parasites perspective (Dr. Andy Shinn)
- Aquaculture Biosecurity (PMP/AB) and FAO's AAH Initiatives in the AP region (Dr. Melba Reantaso, FAO)
- Updates on Aquatic Animal Disease Reporting and disease list (Dr. Eduardo Leaño, NACA)
- FHS-AFS Conference: From the pillars to the next; highlights of the conference (Dr. Eduardo Leaño, NACA)

The report of the meeting is being prepared and will be published at NACA website (www.enaca.org) within the first quarter of 2024.

Fish Health Section
Asian Fisheries Society

4th International Symposium on the Control of Aquatic Animal Diseases (CAAD)

November 26-28, 2023

The 4th International Symposium on the Control of Aquatic Animal Diseases (CAAD) was organized during November 26-28, 2023, in National Cheng Kung University (NCKU), Tainan, Taiwan. This international symposium was conceptualized under the guidance of Animal and Plant Health Inspection Agency, Ministry of Agriculture, Taiwan and organized jointly by International Center for the Scientific Development of Shrimp Aquaculture, Department of Biotechnology and Bioindustry Sciences and the Training Program for Interdisciplinary Talents of Precision Health: Diversified Health, NCKU. The theme of the symposium was to discuss the current trends in aquatic animal diseases, diagnosis and to develop sustainable and ecofriendly aquatic disease management approaches. The 4th International Symposium on the Control of Aquatic Animal Diseases was a hybrid symposium which had around 150 participants on-site and about 220 participants online representing 28 countries. It was a 2-day symposium which included scientific sessions on first day and visit a to the International Center for the Scientific Development of Shrimp Aquaculture and the World Organization of Animal Health (WOAH) reference laboratory for acute hepatopancreatic necrosis disease (AHPND) and white spot disease (WSD) on the second day.

The symposium was inaugurated by Dr. Jung-Pin Hsu (Deputy Director General, Animal and Plant Health Inspection Agency, Ministry of Agriculture) followed by Prof. Ju-Ming Wang (Dean, College of Bioscience and Biotechnology, NCKU), Dr. Jorge Galindo-Villegas, (President & Board leader, International Society of Fish and Shellfish Immunology) and Prof. Chu-Fang Lo (National Chair Professor, International Center for the Scientific Development of Shrimp Aquaculture, NCKU). The scientific sessions comprised of keynote and invited speeches from eminent scientists and experts from various part of the world namely, Dr. Eduardo M. Leaño (NACA, Thailand), Prof. Arun K. Dhar (The University of Arizona, USA), Prof. Hidehiro Kondo (Tokyo University of Marine Science and Technology, Japan), Prof. Subha Bhassu (University of Malaya, Malaysia), Dr. Kallaya Sritunyalucksana Dangtip (NSTDA, Thailand), Dr. Mary Nia M. Santos (NFRDI, Philippines), Prof. Dang Thi Lua (Ministry of Agriculture and Rural Development, Vietnam), Dr. Saengchan Senapin (NSTDA, Thailand), and Prof. Han-Ching Wang (NCKU, Taiwan). In addition, the sponsors of the symposium also presented their research findings related to the disease management of aquatic animal diseases such as Dr.

Wei-Chih Huang (DaBomb Protein Biotech Corporation, Taiwan), Dr. Jeff Chia-Kai Hsu (Innocreate Bioscience Company Limited, Taiwan), Mr. Simon Chung (GeneReach Biotechnology Corporation, Taiwan). The scientific sessions covered a wide range of topics that outlined the impact of diseases on international trade, effective disease management programs in Vietnam and Philippines, drawbacks in current disease diagnosis methods and ways to expedite the pathogen discovery using next-gen sequencing, miRNA regulation, and lateral flow immunoassay. Some experts shared their experience in developing effective treatments such as application of postbiotics, identifying the right time to vaccinate the fish and the potential use of IFN-γ adjuvant candidate for fish vaccination in aquatic animal disease management.

The visit to the International Center for the Scientific Development of Shrimp Aquaculture was an opportunity to see the end-to-end process of shrimp breeding and hatching. The shrimp center housed specific rooms for maturation, mating, spawning, egg washing, larva and postlarva rearing. In addition, the center also handles algae cultivation and grow-out raceway all maintained with high level of biosecurity. The center uses smart and IoT applications to maintain and regulate the water quality (pH, temperature, salinity, dissolved oxygen) and to reduce human intervention in most of the areas. The WOAH reference laboratory for AHPND and WSD is a state-of-the art laboratory with qualified professional who carry out disease diagnosis with utmost care and reliability. The shrimp center is an ISO-17025 certified laboratory that strictly adheres to standard practices and policies for their sample analysis and reporting. Overall, the symposium gave valuable insights into the control of aquatic animal diseases that can positively impact the aquaculture.

Fish Health Section
Asian Fisheries Society

Fish Health Section Conference: From the Pillars to the Next

September 6-8, 2023

The Fish Health Section Conference: From the Pillars to the Next was successfully held during September 6-8, 2023 at Swissotel Bangkok Ratchada, Bangkok, Thailand. Initially coined as “handover conference" and with the theme “Learning from the past to inform the future”, the event gathered 17 FHS pillars which include founding members and past officers/members of Executive Committee (ExeCom). Headed by Dr. Richard Arthur (Canada) who founded the Asian Fish Health Network (under IDRC project) which eventually gave birth to the FHS, the pillars had a great reunion and catching-up, gave advice, and shared their experiences with the younger generation of fish health enthusiasts. The Conference was attended by 158 participants/students from 16 countries around the world including Australia, Bangladesh, Canada, China, Ethiopia, Indonesia, Italy, Japan, Malaysia, Norway, Philippines, Saudi Arabia, Taiwan, Thailand, United Kingdom and Vietnam. A total of 35 abstracts were received, and these were delegated to 20 oral presentations and 15 poster presentations.

In the opening session, Dr. Melba Reantaso (FAO) gave a brief backgrounder of the Conference on how it was conceptualized. Welcome messages were then delivered by Dr. Eduardo Leaño (Secretary/Treasurer of FHS) representing Dr. Kua Beng Chu (Chairperson of FHS), Dr. Jie Huang (Director General of NACA), and Dr. Murni Marlina Binti Abd. Karim (Secretary of AFS) representing Prof. Neil Loneragan (President of AFS). Mr. Chalermchai Suwannarak (Director General of DOF, Thailand) delivered the opening remarks and officially declared the conference open.

The pillars were then introduced to the participants before the informal meet and greet, so as to name faces especially for the younger generation. Everyone was then invited to engage in discussions with the pillars and the rest of the participants. Poster viewing (with presenting authors) was also done during the informal session.

Dear departed pillars were also honored: Dr. Takahisa Kimura (Japan); Dr. Darnas Dana (Indonesia); Dr.

Lee-Hong Susan Lim (Malaysia); Prof. Donald V. Lightner (USA); Prof. Kishio Hatai (Japan); Dr. Pan Jin Pei (China); Dr. Akhmad Rukyani (Indonesia); and, Dr. Hariyadi Mangunwirya (Indonesia).

A video recap of the recently held DAA 11 was then presented, together of the DAA 12 teaser which will happen in August 2025 in Chennai, India. Prof. Mohamed Shariff then presented a lecture on the importance of publication especially with the Asian Fisheries Science, the official journal of the parent society AFS.

Plenary sessions (plenary presentations and panel discussion) were held on day 2 of the Conference, featuring experts on finfish and shrimp health as listed below:

Finfish Health:

Prof. Ikuo Hirono	Fish Immunology Research for Fish Vaccine Development
Dr. Andy Shinn	Translocation of tilapia's tiny terrors: Nile tilapia and its parasites
Assoc. Prof. Win Surachetpong	New Challenges, New Solutions: Mitigating Emerging Diseases in Aquatic Animal Health
Mr. Amorn Luengnaruemitchai	Practical Biosecurity Measures in Tilapia Hatchery

Shrimp Health:

Prof. Chalor Limsuwan	Challenges and Diseases Management in Shrimp Aquaculture
Prof. Grace Chu-Fang Lo	Passing on the Torch of Wisdom in Shrimp Aquaculture Research
Prof. Han-Ching Wang	Taking up the Torch of Wisdom: An Interdisciplinary Cooperation of Science, Implementation and Vision for Shrimp Aquaculture
Dr. Kallaya Sritunyalucksana	Scientific, Technological and Social Solutions for Sustainable Aquaculture

Day 3 of the Conference featured oral presentations from the younger generation of researchers and students. Out of the 20 presentations, seven (7) were from students who were judged based on the overall content and clarity of presentations as well as the question and answer session. The panel of judges is composed of Dr. James L. Torres (Philippines), Dr. Janejit Kongkumnerd (Thailand), and Dr. Stephen Pyecroft (Australia). The winners were:

- **Hiraoki Saito** (Tokyo University of Marine Science and Technology, Japan): *Cell-mediated and Humoral Immune Responses of Goldfish after Live-attenuated virus Vaccination and High-Water Temperature Treatment against Herpesviral Hematopoietic Necrosis (HVHN)*
- **Cong-Yan Chen** (National Cheng Kung University, Taiwan): *White Spot Syndrome Virus Facilitates and Relies on host de novo Nucleotide Synthesis to Support Viral Pathogenesis*
- **Suwimon Paimeeka** (Kasetsart University, Thailand): *Novel Multiplex PCR Assay for the Detection of Three Major Viruses Affecting Global Tilapia Aquaculture*

Closing messages and remarks were delivered by Dr. Janejit Kongkumnerd, representing DOF-Thailand, and Dr. Kua Beng Chu, Chairperson of the FHS.

Fish Health Section
Asian Fisheries Society

Phase II of National Surveillance Programme for Aquatic Animal Diseases launched in India

The Phase II of National Surveillance Programme on Aquatic Animal Diseases (NSPAAD) in India was launched by Hon'ble Union Minister of Fisheries, Animal Husbandry and Dairying, Shri Parshottam Rupala on February 27, 2023 at ICAR-Central Institute of Brackishwater Aquaculture, Chennai in the presence of Minister of State, Fisheries, Animal Husbandry and Dairying and senior officers including Secretary, Joint Secretary (Marine Fisheries), Department of Fisheries, Govt. of India; Coordinator, NSPAAD and Deputy Director General (Fisheries Science), Indian Council of Agricultural Research, and Director, ICAR-NBFGR, Lucknow and Director, ICAR-CIBA, Chennai. Over 400 participants including representatives from different organizations like Coastal Aquaculture Authority, Marine Products Development Authority, National Fisheries Development Board; representatives from fish and shrimp industry; officials from different state fisheries departments; representatives from different NSPAAD collaborating centres and fish farmers attended the programme. The Phase II of NSPAAD (2022-25) is supported under Pradhan Mantri Matsya Sampada Yojana (PMMSY), a flagship programme of Government of India. Phase II of NSPAAD involves the State Fisheries Departments (SFDs) and makes disease surveillance an integral and continuous activity of the Department, and the programme has pan-India coverage.

The important highlights of the NSPAAD include: developing a strong network of aquatic animal health laboratories in the country; developing diagnostic capability for detection of World Organization for Animal Health (WOAH)-listed and emerging aquatic animal pathogens; strengthening of passive disease surveillance in the country; providing scientific advice to the farmers for management of disease; detection of 10 new pathogens from the country for the first time; establishing mechanisms for first-time confirmation of exotic and emerging diseases and issuing alerts/advisories to stakeholders following suspicion of a new disease to prevent spread of the disease; and establishing a transparent disease reporting system to international organizations, namely WOAH and Network of Aquaculture Centres in Asia-Pacific (NACA). Under the programme, a "ReportFishDisease" (RFD) App has been developed to strengthen the farmer-based reporting. This app can help in directly connecting fish farmers with field-level fisheries officers and health experts to address aquatic animal diseases.

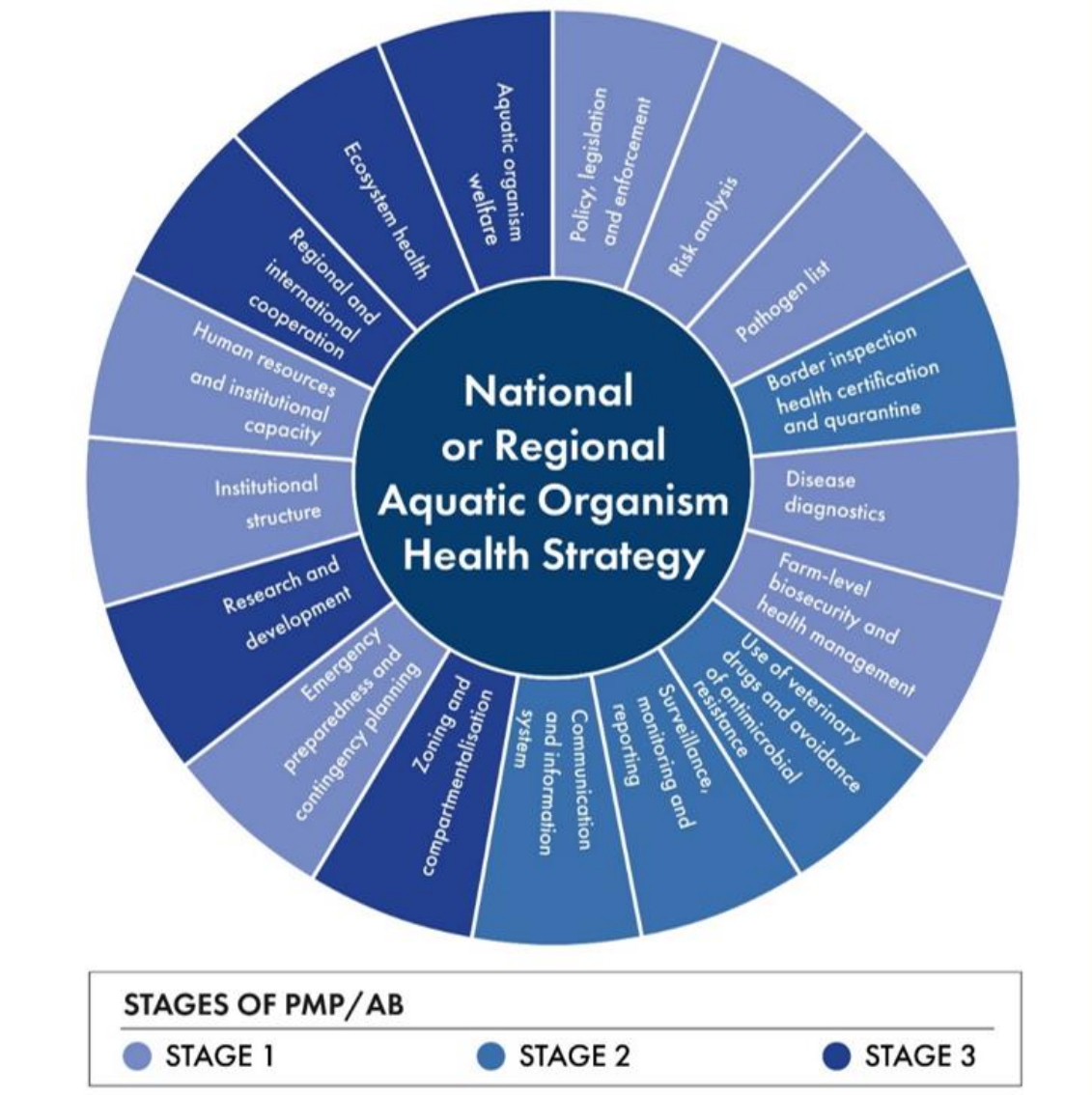
Regional Aquatic Organism Health Strategy (RAOHS) using a Progressive Management Pathway for Improving Aquaculture Biosecurity (PMP/AB) developed

(March 15-17, 2023)

The FAO/NACA regional workshop for the development of the NACA Regional Aquatic Organism Health Strategy (RAOHS) was successfully implemented from 15-17 March 2023 (Phuket, Thailand) with 41 delegates from 15 NACA and FAO member countries (Australia, Bangladesh, Cambodia, China, India, Indonesia, Iran (via Zoom), Malaysia, Maldives, Nepal, Pakistan (via zoom), the Philippines, Sri Lanka, Thailand, Vietnam), the Pacific Community (SPC) and FAO/NACA Project Team participating.

Its development followed a systematic process, with support through the FAO project GCP/GLO/352/NOR Component 3: Progressive Management Pathway for Improving Aquaculture Biosecurity (PMP/AB), funded by the Norwegian Agency for Development Cooperation- (Norad). The RAOHS will assist NACA Members in developing and harmonising their approaches to aquatic organism (plant and animal) health and aquatic biosecurity through understanding and implementing the PMP/AB. The PMP/AB provides a risk-based approach to aquaculture biosecurity that is founded on value chain analysis (VCA) to assess, prevent and manage pathogen risks to aquaculture. The NACA RAOHS was adopted by the 32nd NACA Governing Council Meeting (GCM 32), held in Chiang Mai, Thailand during 7–9 August, 2023. The RAOHS contains 17

Programmes addressing the following broad thematic areas as reflected in various stages of the PMP/AB, as seen from the below figure;



The purpose of the RAOHS for NACA is:

"To support the improvement and harmonisation of regional aquatic organism health and biosecurity by encouraging and assisting NACA Members to implement a risk-based, progressive and collaborative Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB). This includes the adoption of the value chain and risk-based approaches towards protecting aquatic organism health in aquaculture production sectors and the natural environment".

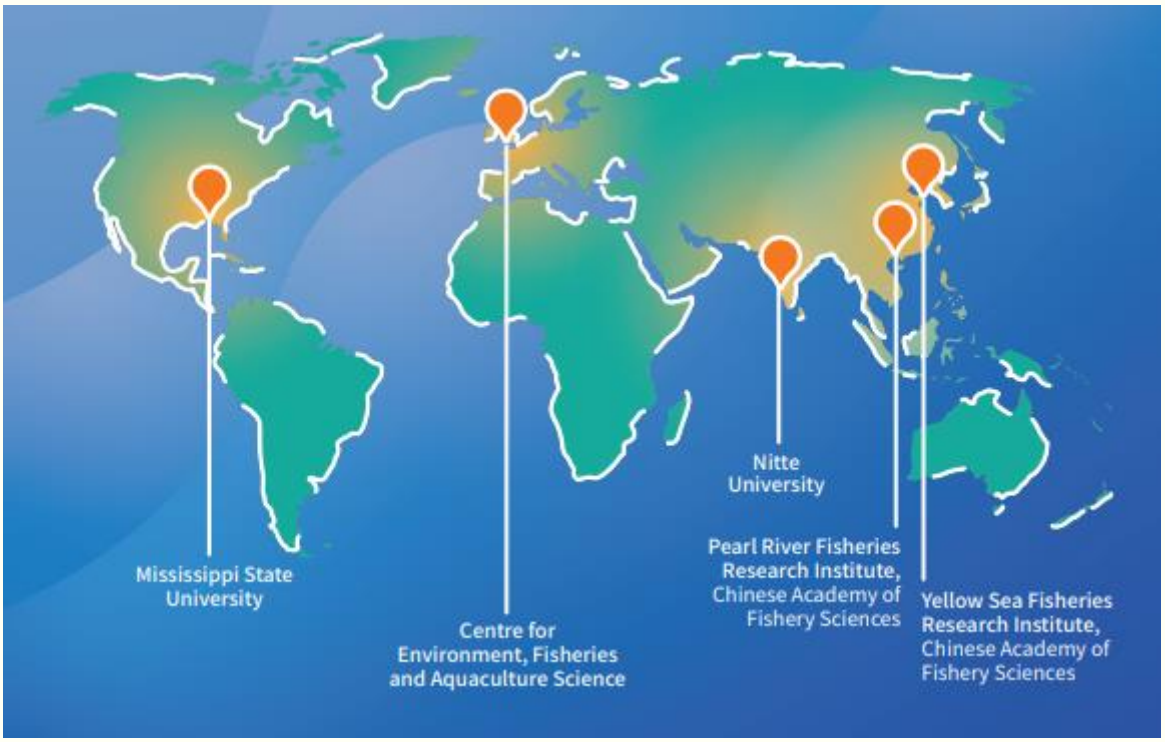
To support the implementation of the RAOHS, an Asia PMP/AB Regional Technical Working Group was established and formally convened on 31 August 2023 following a Call for Expression of Interest (CEI, released on 1 June 2023) for membership. The key officers of the RTWG are, Chair: Dr. Muyassar Hamid Abualreesh (Kingdom of Saudi Arabia); Vice-Chair: Dr. Sonia Somga (the Philippines); Secretary: Dr. Andy Shinn (Thailand) and Dr. Jiraporn Jarungsriapisit (Thailand).

Global collaboration: key in the fight against AMR

Recognizing that collaborative scientific research, innovation, education and information sharing are critical to reduce AMR and to support awareness about the risks and the need for prevention measures, such as good biosecurity – through global collaboration - four FAO Reference Centres (RCs) for Antimicrobial Resistance (AMR) and Aquaculture Biosecurity (AB) (https://www.fao.org/documents/card/en/c/CC6625EN) were physically launched in June 2023. These are: the Pearl River Fisheries Research Institute and the Yellow Sea Fisheries Research Institute both of the Chinese Academy of Fishery Science; Nitte University in India; and the Mississippi State University in the United States. We now have five centres including the Centre for Environment, Fisheries and Aquatic Science (CEFAS) in the United Kingdom supporting AMR work in the aquatic sector.

The FAO RCs will support FAO's mandate and would help guide and support FAO Members in: scientific, technical and policy advice, training and collaborative research, expertise on laboratory capacity, global interpretation of AMR data, confirmatory testing of resistant isolates and serotypes and quality control of antimicrobials used in the food and agriculture sector.

FAO Deputy Director-General, Maria Helena Semedo, led the opening ceremony by acknowledging the critical importance of the centres and their potential contribution.



"Working in partnership with the different centres will create excellent synergies to better understand and improve actions in preventing the increase of AMR," Semedo said. "Only by combatting AMR together can we ensure healthy and safe aquatic foods."

At global level, FAO, the World Health Organization, the World Organisation for Animal Health (formerly OIE), and the United Nations Environment Programme under the Quadripartite alliance are working together to tackle AMR from a One Health approach.

FAO is fully committed to support FAO Members, to work with relevant stakeholders and to engage with the different centres to implement the AMR Action Plan in promoting the responsible and reducing the use of antimicrobials in aquaculture.

The FAO Action Plan on AMR 2021-2025 provides guidelines and capacity building tools to assist FAO Members in developing National Action Plans on AMR. The main objectives of FAO Action Plan on AMR 2021-2025 are:

1. increasing stakeholder awareness and engagement
2. strengthening surveillance and research
3. enabling good practices
4. promoting responsible use of antimicrobials
5. strengthening governance and allocating resources sustainably

The FAO Progressive Management Pathway for Antimicrobial Resistance (FAO-PMP-AMR) serves as a guide to help countries put their NAPs into action. The progressive approach enables specific sectors to make step-by-step improvements toward the sustainable use of antimicrobials and management of AMR.

The FAO Progressive Management Pathway for Aquaculture Biosecurity (PMP/AB) (https://www.fao.org/documents/card/en/c/cc6858en) is a four-stage pathway that's is risk-based, progressive and collaborative. It is expected to result to a sustainable: (i) reduction of burden of diseases; (ii) improvement of aquatic health and welfare at farm, national and regional levels; (iii) minimization of global spread of diseases; (iv) optimization of socio-economic benefits from aquaculture; (v) investment opportunities in aquaculture; and (vi) the achievement of One Health goals.

The FAO's Blue Transformation Roadmap 2022-2030 recognizes the importance of aquatic food systems as drivers of employment, economic growth, social development and environmental recovery, which all underpin the SDGs. One of the core components of Blue Transformation aims to increase capacity on aquaculture biosecurity, disease control and health management, prevention of AMR in aquatic food systems through the development of early warning, risk assessment and emergency preparedness related to food safety and aquatic animal health.

Updates on WOAH Asia-Pacific Aquatic Animal Health Network (AP AquaNet)

Aquaculture production is a significant food production sector in the Asia-Pacific region, accounting for approximately 88% of global aquaculture production. With a wide range of species farmed in various production systems, including shrimp, fish, molluscs, and seaweed, the sector has not only contributed significantly to regional food security but has also played a pivotal role in driving

economic development and employment opportunities. China, India, Indonesia, Vietnam, Bangladesh, Thailand, and Myanmar are major aquaculture producers ranking among the top ten producers worldwide.

The emergence of diseases in aquatic animals in the Asia-Pacific region presents a significant challenge to the sustainability of aquaculture and the health of aquatic ecosystems. One pressing issue is the lack of a cohesive collaboration mechanism among international organizations operating in the region. Without effective coordination, it becomes challenging to pool resources, share information, and implement standardized disease management strategies. As a result, emerging diseases may spread more rapidly and unpredictably, threatening both the aquaculture industry and wild aquatic populations. To tackle this issue successfully, a regional collaboration framework was established, which brings together key stakeholders and international organisations, fostering unified responses to the growing threats posed by aquatic animal diseases in the Asia-Pacific region.

The Regional Collaboration Framework serves as an effective mechanism for implementing the Aquatic Animal Health Strategy, addressing regional requirements, and enhancing collaboration. Numerous stakeholders participate in the *Framework*, including the World Organisation for Animal Health (WOAH) Reference Centres in the region, the Aquatic Animal Health Standard Commission, Focal Points of WOAH Members, WOAH Regional Representation for Asia and the Pacific (RRAP), and international partners such as the Network of Aquaculture Centres in Asia-Pacific (NACA), Southeast Asian Fisheries Development Center (SEAFDEC), Food and Agriculture Organization of the United Nations (FAO), and others to be engaged for collaboration. Additionally, outreach efforts will target various partners and institutions, including university research institutions, the private sector, and other donors with a focus on aquatic animal health and objectives aligned with those of this Framework.

Four meetings of the *ad hoc* Steering Committee of the *Framework* have been organized so far with the most recent meeting held in Busan, Republic of Korea on 29 June 2023. Progress and output of the Flagship activities (2020 – 2023) were presented, including projects on (1) aquaculture biosecurity in small-scale farms, (2) evaluation of the existing AHPND diagnostic methods, and (3) regional collaboration to respond to emerging diseases of aquatic animals. Three new Flagship activities were identified at the 4th *ad hoc* Steering Committee meeting: (1) a response exercise to examine regional coordination and response to emerging diseases, (2) assessment of on-farm biosecurity in aquaculture, and (3) improving Aquatic Animal Disease Reporting in Asia and the Pacific. The activities will be led by Experts from different WOAH Reference laboratories, regional partners, WOAH Headquarter, and RRAP. In addition, awareness programme on AMU/AMR in aquaculture will also be conducted to support the implementation of Aquatic Animal Health Strategy. Concept Notes are being developed with the plan of the project implementation in 2024. In addition, the *ad hoc* Steering Committee adopted the name change from the *Regional Collaboration Framework for Aquatic Animal Health for Asia and the Pacific* to *Asia Pacific Aquatic Animal Health Network (AP AquaNet)*.

Contributed by: Dr. Thitiwan Patanasatienkul, WOAH-RRAP, Tokyo, Japan

Training Course on Risk Analysis in the Aquaculture Value Chain

A Training Course on Risk Analysis in the Aquaculture Value Chain, under the auspices of the FAO Project GCP/GLO/352/NOR was successfully held during 3-5 September 2023, Bangkok in collaboration with the Thailand Department of Fisheries (Thai DoF) and the ASEAN Network of Aquatic Animal Health Centres (ANAAHC) led by the Thai DoF. A total of 70 attendees participated (68 in-person), consisting of: ASEAN, FAO and NACA representatives: Brunei (2), Cambodia (2), Ethiopia (3), Iran (1 online), Kingdom of Saudi Arabia (3 self-funded), Lao PDR (2), Malaysia (1 + 1 online), Maldives (1), Myanmar (2), Philippines (2 + 4 self-funded), Sri Lanka (2), Thailand (2 + 21 self-funded), Viet Nam (2), INFOFISH staff (2), NACA staff (3), FAO staff (4), experts (4 in person (Australia, Canada, Norway) + 2 online (India, France). The opening session was welcomed by Mr. Praphan Leepayakhun, Deputy Director-General of the DoF, Thailand.

The 3-day in-person event consisted of four Technical Sessions which delivered 18 expert presentations (pre-recordings, live and virtual) including four Working Group presentations based on six Working Group Exercises.

1) Session 1: Risk analysis in context to understand the importance of diseases in aquaculture, introduce the PMP/AB initiative focussing on its requirements (e.g. NAOHS or RAOHS) and PMP/AB tools (e.g. risk assessment)

2) Session 2: Review of FAO elearning modules

3) Session 3: Results of the survey related to the aquatic organism movements in the ASEAN region

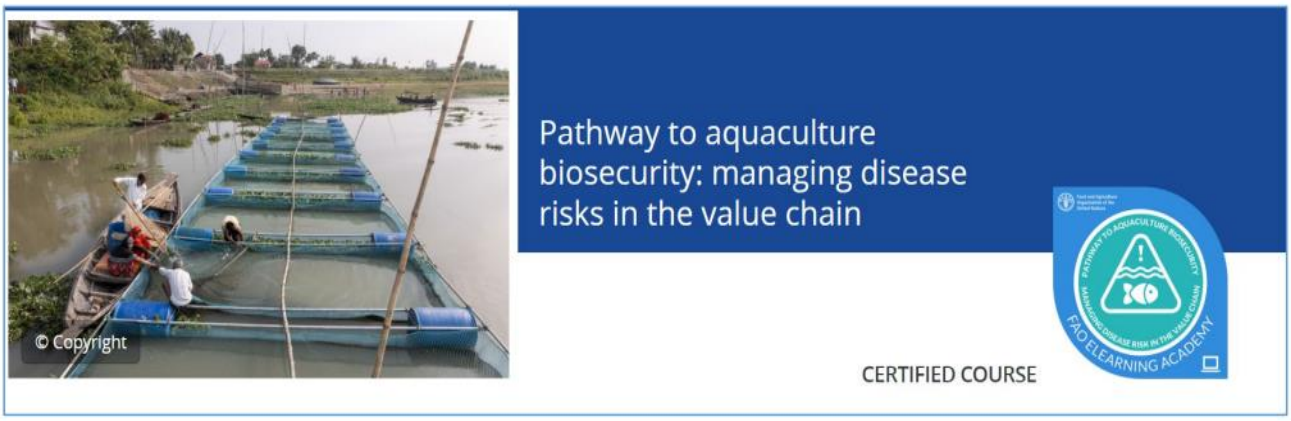
4) Session 4: Risk Analysis Proper, represented by six Working Group Exercises (WGE) corresponding to the six steps in conducting a RA along AVC

WGE 1: Preparing for a value chain risk analysis (definition of a situational analysis)
WGE 2: Hazard identification (preliminary identification, hazard list, pathogen characterization, risk profiling)
WGE 3: Risk factors, risk table and important biosecurity vulnerabilities (definition of the risk hotspots)
WGE 4: Risk assessment: risk pathways analysis and estimate of the likelihood (entry assessment, exposure assessment)
WGE 5: Risk management through the implementation of risk management measures at the critical control points, monitoring and review
WGE 6: Risk communication Participants were divided into four working groups based on the most important commodities in aquaculture:

- Barramundi/Grouper (Group 1)
- Shrimp (Group 2)
- Tilapia (Group 3)
- Ornamentals (Group 4)

WGEs were supported by detailed Guidelines and continuously assisted by all experts throughout the entire process.

Participants completed five elearning lessons/modules and received a digital badge from the FAO elearning Academy (https://elearning.fao.org/course/view.php?id=979), after passing a 75% mark in the final exam prior to attendance to the in-person course.



The five elearning lessons/modules are:

- Introduction to the Progressive Management Pathway for Aquaculture Biosecurity.
- Introduction to risk analysis.
- Import risk analysis.
- Risk analysis along the aquaculture value chain.
- Application of risk analysis along the aquaculture value chain.

3rd International Conference on Aquatic Animal Epidemiology (AquaEpi III) held at ICAR- NBFGR, Lucknow, India

November 29-December 01, 2023

The 3rd International Conference on Aquatic Animal Epidemiology (AquaEpi III) was organised by ICAR-National Bureau of Fish Genetic Resources, Lucknow in collaboration with the International Society of Aquatic Animal Epidemiology (ISAAE), the National Fisheries Development Board, Hyderabad, and the Aquatic Biodiversity Conservation Society, Lucknow during November 29 to December, 01, 2023. A total of 210 delegates including 20 overseas experts participated in the conference. A total of nine technical sessions were conducted, covering diverse topics such as the epidemiology of finfish and shellfish diseases, surveillance and reporting of diseases, one health and aquaculture, biosecurity in aquaculture, and the social and economic impacts of aquatic animal diseases. The sessions featured a total of 50 presentations, including a keynote presentation, 12 invited presentations, and 37 oral presentations. In addition, there were 69 poster presentations. On the side-lines of the conference, a meeting of the ISAAE was organised, during which the Chile was selected to host the AquaEpi IV in 2026. Additionally, Dr. Neeraj Sood, Principal Scientist, ICAR-NBFGR, India and Dr. Saraya Tavornpanich, Coordinator, International Centre for Aquatic Animal Health, Norwegian Veterinary Institute, Norway were nominated as the President and Vice-President of the ISAAE, respectively for the period 2023-2026.

Fish Health Section
Asian Fisheries Society

Japanese Society of Fish Pathology

Greetings from the Japanese Society of Fish Pathology!

The Japanese Society of Fish Pathology (JSFP) was founded in 1966 as a research group, and since then has held conferences twice a year (March and September) to exchange, share, and disseminate latest knowledge on fish diseases. We have also been publishing the academic journal "Fish Pathology" (four times a year). From March 2023, a new executive committee has been constituted with Dr. Motohiko Sano of Tokyo University of Marine Science and Technology as President, Dr. Shinpei Wada of Nippon Veterinary and Life Science University as Vice President, Dr. Goshi Kato of Tokyo University of Marine Science and Technology as General Secretary, and Dr. Osamu Kurata of Nippon Veterinary and Life Science University as Editor-in-Chief for the journal. Please visit our homepage (https://www.fish-pathology.com/english/?l=en_US). We especially welcome submissions to the journal, and even non-members can submit for free. “Fish Pathology” is the oldest journal specializing in fish diseases and an international journal with an impact factor, and it has published 58 volumes by 2023. All issues can be viewed from the browser of J-Stage site (https://www.jstage.jst.go.jp/browse/jsfp/list/-char/en). The Society has not been able to hold in-person conferences in recent years due to COVID-19, but since last year, it has organised in-person conferences, allowing for more active in-person interactions. Many members of JSFP have also participated in the FHS DAA conferences. It is assumed that members of our society will be participating in the next DAA12, and we hope to see you there!

School on Aquatic Animal Epidemiology

December 4-8, 2023

A Training Programme on Aquatic Animal Epidemiology was organized at ICAR-National Bureau of Fish Genetic Resources, Lucknow, India during December 4-8, 2023 involving resource person Professor Kenton L. Morgan, Emeritus Professor of Epidemiology, University of Liverpool, United Kingdom. The training was attended by a total of 24 participants from 11 institutes/organizations. The topics covered in the School included types of epidemiological investigations; designing a questionnaire; sensitivity, specificity and predictive values of screening tests; risk ratio and odds ratio etc. It is expected that the School would help to strengthen capacity to undertake epidemiological investigations in the country.

The importance of lipidomic profiling of penaeid shrimp

Wananit Wimuttisuk
National Center for Genetic Engineering and Biotechnology, Thailand

Lipids are diverse groups of organic compounds that are essential for many cellular and biological processes within living organisms. Lipids are major contributors of energy within cells through the breakdown of free fatty acids to produce ATP. Lipids also serve as precursors of signaling molecules and hormones that are involved in the regulation of growth, reproduction, and immunity in living organisms. Additionally, certain types of lipids, such as sterols and phospholipids, are part of the structural component of cell and organelle membranes. The presence of lipids in the cell membrane not only provides the structural support and membrane fluidity, but also influences the distribution of surface proteins, the activation of transcriptional factors, and the regulation of protein signaling. As a result, even small changes in lipid population can have a major impact to the health of the organism. Therefore, the analysis of lipid composition in the living organism is instrumental to understand changes that occur under different physiological conditions.

Lipidomics, which was termed in 2003, is a newly emerged research discipline that involved a systematic identification of all lipids and their biological roles using a combination of mass spectrometry and multi-variated analysis. Ultra-high performance liquid chromatography analysis allows for the separation of lipid class, while gas chromatography analysis identifies different types of free fatty acids. The information on lipid class is often used in conjunction with the analysis of fatty acids or sterols to determine changes that occurred within the organism. Currently, the majority of lipidomic analyses of aquatic products focuses on fish, while fewer analyses were reported on aquatic crustaceans, such as crab, shrimp, and prawn. Lipidomic analyses were typically performed on aquaculture products to determine (1) the nutritional content in aquaculture products for human consumption, (2) the effects of feed supplementation on the lipid profiles in marine organisms, and (3) changes in lipid profiles due to different physiological, pathological, and rearing conditions.

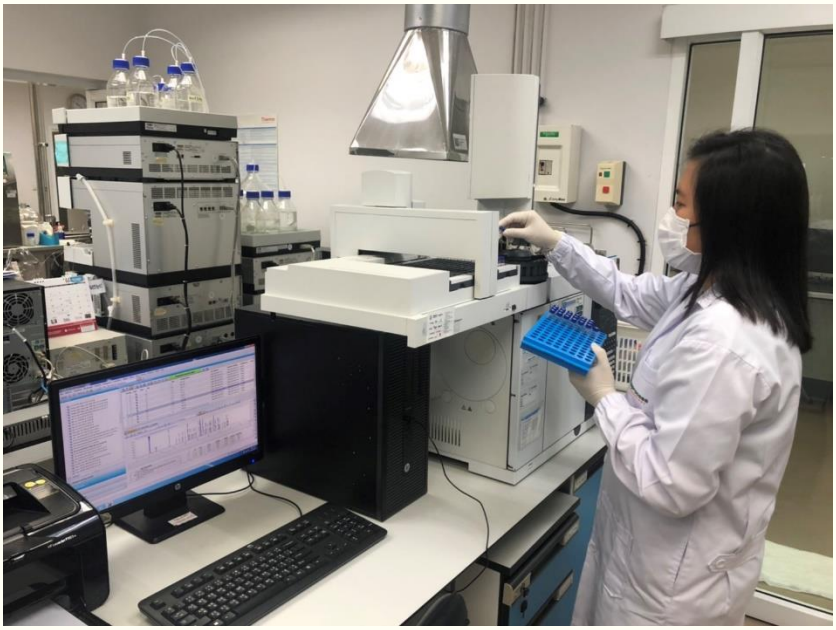
One of the main reasons that lipidomic analysis was crucial for aquaculture products was due to high levels of n-3 polyunsaturated fatty acids (PUFAs), especially eicosapentaenoic acid (EPA, C20:5 n-3) and docosahexaenoic acid (DHA, C22:6 n-3). These n-3 PUFAs provide several health benefits for human consumption by reducing the risk of cardiovascular disease, inflammation, osteoporosis, and autoimmune diseases. To further understand the lipid populations in aquatic organisms, high-throughput lipid analyses were performed, revealing highly complex lipid populations in fish and shellfish. The lipid analysis of three species of marine fish and one species of freshwater fish revealed over 700 molecular species of lipids from 12 major lipid subclasses. Similarly, the lipidomic analysis of shrimp tail muscles identified approximately 600 molecular species from 14 lipid subclasses. Due to the highly complex lipid profiles, it is currently not possible to substitute lipids from other sources to replicate the lipid composition in seafood.

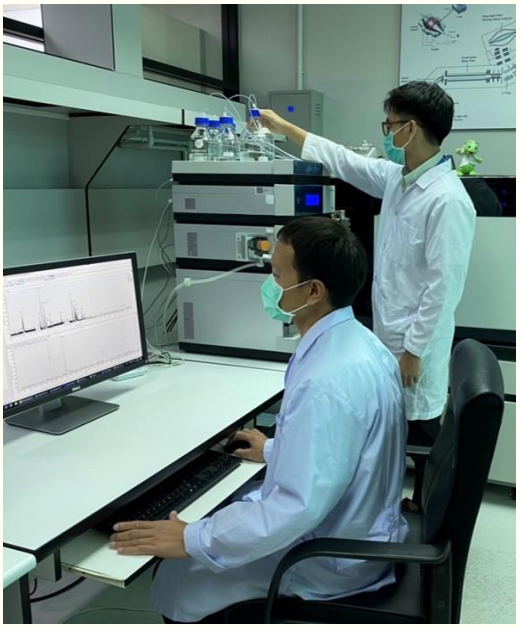
The production of fish and shellfish with high n-3 PUFA content depends on the levels of PUFAs in feed as these organisms lack the ability to synthesize PUFAs due to low enzymatic activities of fatty acid elongase and desaturase. In penaeid shrimp, several research groups focused on feed composition and PUFA supplementation to increase the levels of n-3 PUFAs in shrimp, which improve survival rates, growth, and fecundity in shrimp post-larvae, juveniles, and broodstock, respectively.

Recently, a thraustochytrid *Aurantiochytrium limacinum* BCC52274 was used to enrich artemia to increase the n-3 PUFA content for the Pacific white shrimp Litopenaeus vannamei post-larvae. A. limacinum produces high levels of DHA, docosapentaenoic acid (DPA, C22:5 n-3), and palmitic acid (C16:0), which resulted in increasing levels of all three fatty acids in shrimp post-larvae. Lipidomic analysis revealed that both DHA and DPA were incorporated into the phospholipids or structural lipids, whereas the palmitic acid was accumulated in the acyl glycerol, which is used for energy reserve.

The analysis of lipid composition can be used to determine potential biomarkers for shrimp under different physiological conditions. A study in *L. vannamei* revealed that changes in salinity levels can affect lipid population in shrimp gills and muscles. As the salinity levels decreased from 30% to 3%, the percentage of phosphatidylcholine in gills reduced significantly, while the percentage of triacylglycerol and phosphatidic acid increased. Interestingly, a separate study revealed that the amounts of PUFAs in shallow-water shrimp were higher than those of the deep-water shrimp, possibly because the shallow-water shrimp obtains nutrients from phytoplankton that were rich with n-3 PUFAs. Therefore, the analysis of lipid population in shrimp may indicate the nature of shrimp diets and rearing environments. Moreover, lipidomic analysis can be used to identify biomarkers during pathogenic infection. For example, the GC-MS analysis was performed on shrimp infected with white spot syndrome virus (WSSV), revealing that changes in levels of fatty acids coincided with early and late viral replication phase. Additionally, lipidomic analyses in healthy shrimp, shrimp with latent WSSV infection, and shrimp with dominant WSSV infection revealed that all three groups contained different fatty acid profiles. In shrimp with white feces disease, levels of caprylic acid, pentadecanoic acid, oleic acid, capric acid, lithocholic acid, linoleic acid and myristic acid in their intestines were higher than those of healthy shrimp. The results of these lipid analyses could potentially be used as biomarkers for disease diagnosis as well as in combination with dietary lipid supplementation to alleviate the severity of the disease in these aquatic animals.

Aside from the analysis of lipid class and fatty acids, several research groups also focused on a separate population of lipid derivatives known as eicosanoids, which have potentials as biomarkers for health and diseases in aquaculture products. Eicosanoids are oxygenated derivatives of n-6 and n-3 PUFAs, such as prostaglandins, thromboxanes, leukotrienes, and hydroxy fatty acids. These eicosanoids serve as signaling molecules that regulate various physiological processes, including inflammation, blood clotting, and reproduction. High levels of prostaglandins in ovaries have previously been correlated with successful ovarian maturation in crabs, prawn, and penaeid shrimp. In the male black tiger shrimp *Penaeus monodon*, high levels of PUFAs and eicosanoids in the testis and vas deferens were negatively correlated with total sperm count. Additionally, changes in levels of PUFAs and eicosanoids have been observed in diseased aquatic animals. In *L. vannamei*, levels of eicosanoids in haemolymph increased rapidly after shrimp were infected with WSSV, suggesting that these signaling molecules are involved in pathogenic response in shrimp. The use of n-3 PUFA supplementation during pathogenic infection can reduce the production of prostaglandins, which, in turn, inhibits the pro-inflammatory signaling pathway that was induced by WSSV infection.





identification of lipid biomarkers to determine different stages of health, reproductive maturation, and disease severity, are key for a more sustainable aquaculture in the future.

Selected References

Hsieh Y-C, Chen Y-M, Li C-Y, Chang Y-H, Liang S-Y, Lin S-Y, Lin C-Y, Chang S-H, Wang Y-J, Khoo K-H et al. (2015) To complete its replication cycle, a shrimp virus changes the population of long chain fatty acids during infection via the PI3K-Akt-mTOR-HIF1α pathway. Developmental & Comparative Immunology 53: 85–95.

Huang M, Dong Y, Zhang Y, Chen Q, Xie J, Xu C, Zhao Q and Li E (2019) Growth and Lipidomic Responses of Juvenile Pacific White Shrimp *Litopenaeus vannamei* to Low Salinity. Frontiers in Physiology 10: 1087.

Visudtiphole V, Khudet J, Chaitongsakul P, Plaisen S, Siriwattano J, Laiphrom S, Klaysuban A, Raweeratanapong T, Sittikankaew K, Rattanaphan N et al. (2021) Growth and Lipidomic Analyses of *Penaeus monodon* Larvae Supplemented With *Aurantiochytrium limacinum* BCC52274. Frontiers in Marine Science 8: 771929.

Wimuttisuk W, Tobwor P, Deenarn P, Danwisetkanjana K, Pinkaew D, Kirtikara K and Vichai V (2013) Insights into the prostanoid pathway in the ovary development of the penaeid shrimp *Penaeus monodon*. PLoS ONE 8: e76934.

Wu H, Zhang J, He Y, Zhou J, Yan J and Jiang M (2017) A metabolic study in hepatopancreas of *Litopenaeus vannamei* response to white spot syndrome virus. International Aquatic Research 9: 195–201.

Yotbuntueng P, Jiemsup S, Deenarn P, Tobwor P, Yongkiettrakul S, Vichai V, Pruksatrakul T, Sittikankaew K, Karoonuthaisiri N, Leelatanawit R et al. (2022) Differential distribution of eicosanoids and polyunsaturated fatty acids in the *Penaeus monodon* male reproductive tract and their effects on total sperm counts. PLOS ONE 17: e0275134.

Fish-Borne Bacterial Zoonoses

Dr. Tirawat Rairat
Kasetsart University, Thailand

Historically, fishes were not considered to be important vectors of human diseases as most cases are self-limiting and usually limited to only small number of opportunistic pathogens. Compare to zoonotic bacterial diseases of terrestrial animals, human infection by aquatic bacteria seem to be less important in terms of both prevalence, diversity of pathogens, morbidity, and mortality. Therefore, the majority of fish-borne zoonosis cases were probably go unreported. However, as aquaculture activity is intensifying during the recent decade, it is likely to increase the chance of human exposure to pathogenic bacteria from fish origin especially for workers in aquaculture sector as well as seafood consumers. Immunocompromised individuals (e.g. HIV/AIDS patients or people who take immunosuppressive drug) are most susceptible and may develop severe illness and death even if infected by relatively innocuous microbe.

In general, aquatic bacterial pathogens can infect human by 2 main routes, i.e. direct contact (through abrasions, cuts, or open wound in the skin) and/or consumption of uncooked fish meat. The principal pathogens acquired topically include *Streptococcus iniae*, *Vibrio vulnificus*, and *Mycobacterium marinum*, while *Clostridium botulinum* and *Plesiomonas shigelloides* infect human by oral route. *Edwardsiella tarda* and *Aeromanas hydrophila* infections can be either via oral or topical route. Both *E. tarda* and *A. hydrophila* are ubiquitous in aquatic environment (predominantly freshwater) and can infect a broad host range (but not always cause diseases) including fishes, amphibians, reptiles, and mammals. It should be noted that not all fish-borne zoonotic bacteria are common pathogens of the fish hosts. Some microbes are commensal organisms such as *C. botulinum*, *Erysipelothrix rhusiopathiae*, and *P. shigelloides*; others may be merely contaminants from the environment and thus not considered as true fish-borne bacteria, e.g., *Salmonella* spp., *Escherichia coli*, *Listeria monocytogenes*, and *Staphylococcus aureus*. Conversely, despite being important fish pathogens and phylogenetically related to some deadly pathogenic bacteria of human, the zoonotic potential of *Yersinia ruckeri*, *Pseudomonas fluorescens*, and *Francisella orientalis* are very unlikely. Other than aquatic bacteria, fish-borne zoonotic viruses, fungi, and ectoparasites (but not endoparasitic nematodes, trematodes, and cestodes) have never been reported in the literature. Consequently, there is very low or no risk of zoonotic infection from these pathogens.

Of all bacterial zoonoses reported from fish, only *S. iniae*, *Mycobacterium* spp., *C. botulinum*, and *V. vulnificus* are well-supported by epidemiological studies as well as molecular evidences, namely infections in fishes and humans are caused by the same strains/serotypes (Gauthier, 2015), whereas such information of other fish-borne bacteria are either lacking or questionable even though some of them can actually causes serious infection in human.

It is generally accepted that the normal bacterial flora of fish reflect those of aquatic environment where they live. Some potential pathogens may be isolated from clinically healthy fish, but unlikely to cause severe disease unless the fish host become stressed. Because most of the pathogenic bacteria are part of their natural habitat, it is impossible to completely eradicate them from the fish or water.

As most of the fish-borne zoonotic bacteria are transmitted by ingestion of uncooked fish and/or direct contact through open wound on the skin, it is conceivable that the best preventive methods are avoid consuming uncooked fish and avoid handling fish with bare hands. Aquaculture farmers, aquarium hobbyists, and seafood processors should always wear protective gloves while working with fish and should thoroughly clean their hands with soap after finished the work. Any open wound that accidentally occur during the work should be thoroughly washed with a plenty of normal saline solution or clean water before applied antiseptic agent such as alcohol, povidone-iodine, or topical antibiotics. Immunocompromised people are at the greatest risk of the zoonotic diseases and should avoid contacting fish as much as possible.

In summary, fish can be a natural host of various microbial pathogens, yet a few of them can be transmitted to human and causing diseases. Among all potential zoonotic bacteria from fish origin, only *S. iniae*, *Mycobacterium* spp., *C. botulinum*, and *V. vulnificus* are considered as true fish-borne zoonotic agents. Other bacteria like *S. agalactiae*, *L. garvieae*, *E. rhusiopathiae*, *N. asteroides*, *A. hydrophila*, *V. cholera*, *V. parahaemolyticus*, *V. alginlyticus*, *P. damselae* subsp. *damselae*, *E. tarda*, and *P. shigelloides* are usually classified as zoonotic bacteria, but further studies are needed to confirm this status, preferably by molecular techniques. Although fish-borne bacteria can cause lethal infections in some cases, such events are relatively rare and mostly restrict to immunocompromised individuals. The majority of them only cause mild symptoms or even asymptomatic.

References

Boylan, S. 2011. Zoonoses associated with fish. *Vet Clin North Am Exot Anim Pract* 14 (3): 427-438.

Gauthier, D. T. 2015. Bacterial zoonoses of fishes: a review and appraisal of evidence for linkages between fish and human infections. *Vet J* 203(1): 27-35.

Greenlees, K. J., J. Machado, T. Bell, and S. F. Sundlof. 1998. Food borne microbial pathogens of cultured aquatic species. *Vet Clin North Am Food Anim Pract* 14(1): 101-112.

Haenen, O. L., J. J. Evans, and F. Berthe. 2013. Bacterial infections from aquatic species: potential for and prevention of contact zoonoses. *Rev Sci Tech* 32(2): 497-507.

Lowry, T., and S. A. Smith. 2007. Aquatic zoonoses associated with food, bait, ornamental, and tropical fish. *J Am Vet Med Assoc* 231(6): 876-880.

Novotny, L., L. Dvorska, A. Lorencova, V. Beran, and I. Pavlik. 2004. Fish: a potential source of bacterial pathogens for human beings. A review. *Vet Med - Czech* 49(9): 343-358.

Rowe, H. M., J. H. Withey, and M. N. Neely. 2014. Zebrafish as a model for zoonotic aquatic pathogens. *Dev Comp Immunol* 46(1): 96-107.

Ziarati, M., M. J. Zorriehzahra, F. Hassantabar, Z. Mehrabi, M. Dhawan, K. Sharun, T. B. Emran, K. Dhama, W. Chaicumpa, and S. Shamsi. 2022. Zoonotic diseases of fish and their prevention and control. *Vet Q* 42(1): 95-118.

Recent publications

Tilapia health: quo vadis?

This Special Issue on Tilapia health: quo vadis is a compilation of a Letter and eight review papers delivered during a virtual International Technical Seminar of the same title held in December 2021. The eight review papers are: (1) From Africa to the world- the journey of Nile tilapia, (2) The future of intensive tilapia production and the circular economy without effluents: bio floc technology, recirculation aquaculture systems, Bio-RAS, Partitioned aquaculture systems, and integrated multitrophic aquaculture, (3) How value addition by utilization of tilapia processing by-products can improve human nutrition and livelihood, (4) Strategies to enhance tilapia immunity to improve their health in aquaculture, (5) Improving tilapia biosecurity through a value chain approach, (6) A global review of problematic and pathogenic parasites of farmed tilapia, (7) Bacterial diseases of tilapia, their zoonotic potential, and risk of antimicrobial resistance (AMR), and (8) From the basics to emerging diagnostic technologies: What is on the horizon for tilapia disease diagnostics?

This virtual event was organized by the Food and Agriculture Organization of the United Nations (FAO) and INFOFISH to review the status of tilapia health, prevention and cure; such concerns increased as tilapia farming becomes more widespread. The event brought together 1700 participants from over 100 countries. It was supported by two FAO projects, namely: GCP/RAF/510/MUL Enhancing capacity/risk reduction of emerging Tilapia Lake Virus (TiLV) to African tilapia aquaculture and TCP/INT/3707 Strengthening biosecurity (policy and farm-level) governance to deal with TiLV.

Wang B, Thompson KD, Wongkahart E, Yamkasem J, Bondad-Reantaso MG, Tattiyapong P, Jian J, Surachetpong W. 2023. Strategies to enhance tilapia immunity to improve their health in aquaculture. Rev Aquac. 2023; 15(Suppl. 1): 41-56. doi:10.1111/raq.12731 https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12731

MacKinnon B, Debnath PP, Bondad-Reantaso MG, Fridman S, Bin H, Nekouei O. 2023. Improving tilapia biosecurity through a value chain approach. Rev Aquac. 15 (Suppl. 1): 57-91. doi:10.1111/raq.12776 https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12776

Shinn AP, Avenant-Oldewage A, Bondad-Reantaso MG, et al. 2023. A global review of problematic and pathogenic parasites of farmed tilapia. Rev Aquac. 15 (Suppl. 1): 92-153. doi:10.1111/raq.12742 https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12742

Haenen OLM, Dong HT, Hoai TD, Crumlish M, Iddya Karunasagar I, Barkham T, Chen SL, Zadoks R, Kiermeier A, Wang B, Gamarro E, Takeuchi M, Noor Amal Azmai M, Fouz B, Pakingking Jr. R, Wei Wei Z, Bondad-Reantaso MG. 2023. Bacterial diseases of tilapia, their zoonotic potential and risk of antimicrobial resistance. Rev Aquac. 15 (Suppl. 1): 154-185. doi:10.1111/raq.12743 https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12743

Dong HT, Chaijarasphong T, Barnes AC, Delamare-Debouteville J, Lee P, Senapin S, Mohan CV, Tang K, McGladdery S, Bondad-Reantaso MG. 2023. From the basics to emerging diagnostic technologies: What is on the horizon for tilapia disease diagnostics? Rev Aquac 15 (Suppl. 1): 186-212. doi:10.1111/raq.12734 https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12734

Other relevant publications:

Caputo A, Bondad-Reantaso MG, Karunasagar I, Hao B, Gaunt P, Verer-Jeffreys D, Fridman S, Dorado-Garcia A. Antimicrobial resistance in aquaculture: A global analysis of literature and national action plans. Rev Aquac, 15(2): 568-578. doi:10.1111/raq.12741578 https://onlinelibrary.wiley.com/doi/10.1111/raq.12741

Bondad-Reantaso MG, MacKinnon B, Karunasagar I, Fridman S, Alday-Sanz V, Brun E, Groumellec L, Li A, Surachetpong W, Karunasagar I, Hao B, Dall'Occo A, Urbani R, Caputo A. 2023. Review of alternatives to antibiotic use in aquaculture. *Rev Aquac* 1-31. doi:10.1111/raq.12786 https://onlinelibrary.wiley.com/doi/full/10.1111/raq.12786

Deekshit VK, Maiti B, Krishna Kumar B, Kotian A, Pinto G, Bondad-Reantaso MG, Karunasagar I, Karunasagar I. 2023. Kumar AK, Antimicrobial resistance in fish pathogens and alternative risk mitigation strategies. *Rev Aquac* 15(1): 261-273. doi:10.1111/raq.12715 https://onlinelibrary.wiley.com/doi/abs/10.1111/raq.12715

Cottier-Cook EJ, Cabarubias JP, Brakel J, Brodie J, Buschmann A, Campbell I, Critchley AT, Hewitt CL, Huang J, Hirtado A, Kambey C, Lim PE, Liu T, Mateo JP.,Msuya FF, Qi Z, Shaxson L, Stentiford GD, Bondad-Reantaso MG. 2022. A new Progressive Management Pathway for improving seaweed biosecurity. *Nat Commun* 13: 7401. https://doi.org/10.1038/s41467-022-34783-8 https://www.nature.com/articles/s41467-022-34783-8

FHS-AFS Executive Committee (2022-2025)

The editorial team expresses its sincere thanks to all the members who have contributed to the eNewsletter. The next issue of eNewsletter is being planned in January 2025. All the members are requested to share important news or other information that would be useful for the members of FHS.

eNewsletter Editorial Team