Status of Aquatic Animal Health in the Philippines

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Abstract

The national aquatic animal disease surveillance and reporting system is implemented by the Bureau of Fisheries and Aquatic Resources in coordination with other recognized laboratories. It covers the OIE/NACA listed diseases particularly those that cause major problems in aquaculture. The fisheries laboratories continuously enhance their capabilities to support the surveillance activities, controls on transboundary movement of aquatic animals, and provide services to the fish farmers. Programs are implemented to strengthen the aquatic animal health services in the country. Promotion of Good Aquaculture Practice and implementation of biosecurity measures are being done to prevent disease occurrences. Collaboration with other institutions on aquatic animal health programs are also established. The paper provides the information on the country's status on aquatic animal health management.

Introduction

The Philippine aquaculture sector contributes about fifty three percent of the country's total fisheries production in 2018 (**Figure 1**). Among the major aquaculture species include tilapia, milkfish, shrimp and its production for the last five years is indicated in **Figure 2** (Philippine Fisheries Profile, 2019). In the same year, the Philippines' has contributed about 0.826 million metric tons of fish, crustaceans and mollusks, equivalent to 1.01 % share to the total global aquaculture production of 82.095 million metric tons, valued over 1.887 billion dollars (FAO Statistics).

The continuous aquaculture intensification increases the risk of disease occurrence and its spread. This has been considered as one of the major hindrance in aquaculture production. Recognizing the impact of diseases and other health problems in fish farming, the implementation of good aquaculture practice and biosecurity measures are important to maximize productivity and ensure safe and quality aquaculture product.

This paper provides the current status of the significant aquatic animal diseases in the Philippines and the programs initiated to control and prevent diseases.

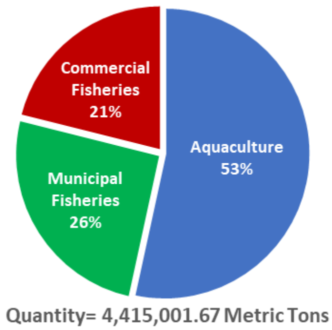

Figure 1. Philippine Fisheries Production CY 2018. Philippine Fisheries Profile, 2019

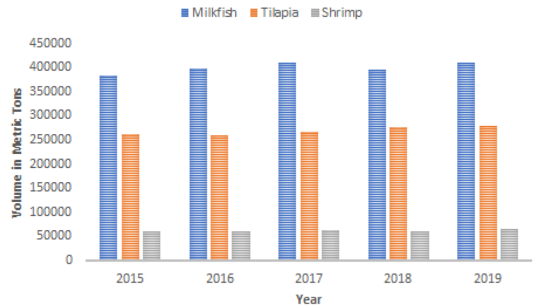

Figure 2. Production data of milkfish, tilapia and shrimp from 2015-2019.

Surveillance system for aquatic animal diseases

Aquatic animal disease surveillance is being conducted by the Bureau of Fisheries and Aquatic Resources. The surveillance activities include those diseases listed in the OIE/NACA. Passive surveillance is implemented at the national level, where reports from the regional fisheries laboratories, and other recognized laboratories are collated at the NFLD for reporting to the OIE/NACA Quarterly Aquatic Animal Disease through the Fisheries Inspection and Quarantine Division. The disease surveillance and reporting system is described in **Figure 3.**

The Department of Agriculture provided the national list of Notifiable Diseases, based on the OIE listed diseases (DA, 2018). The regulations and policies for the controls on transboundary movement of aquatic animals, health certification, biosecurity, disease monitoring, and farm registration geared towards prevention of entry and spread of diseases through issuances of Fisheries Administrative/ Office Orders.

The Philippine National Standards on Code of Good Aquaculture Practices were developed by the Bureau of Agriculture and Fisheries Standards through participative and consultative process with the concerned government agencies and stakeholders. These are basis for the implementation of farm registration scheme for shrimp and fish, on farm inspection and sampling for laboratory analysis. Disease cards regarding significant diseases in aquaculture are being distributed for awareness of the fish farmers. The BFAR central and regional fisheries laboratories and fisheries inspection and quarantine offices involved in the implementation of aquatic animal health management in the country are shown in **Figure 4**.

The laboratory capabilities of the NFLD and regional fisheries laboratories involved in the implementation of aquatic animal health management programs are indicated in **Table 1**. The NFLD as the central laboratory is accredited with PNS ISO/IEC 17025:2017 by the Philippine Accreditation Bureau of the Department of Trade and Industry. The scope of its accreditation includes chemical (residues in fish and fishery products) and biological (microbiological analysis of fish and fishery products and molecular diagnostics) testing, that include the detection of shrimp diseases using conventional PCR.

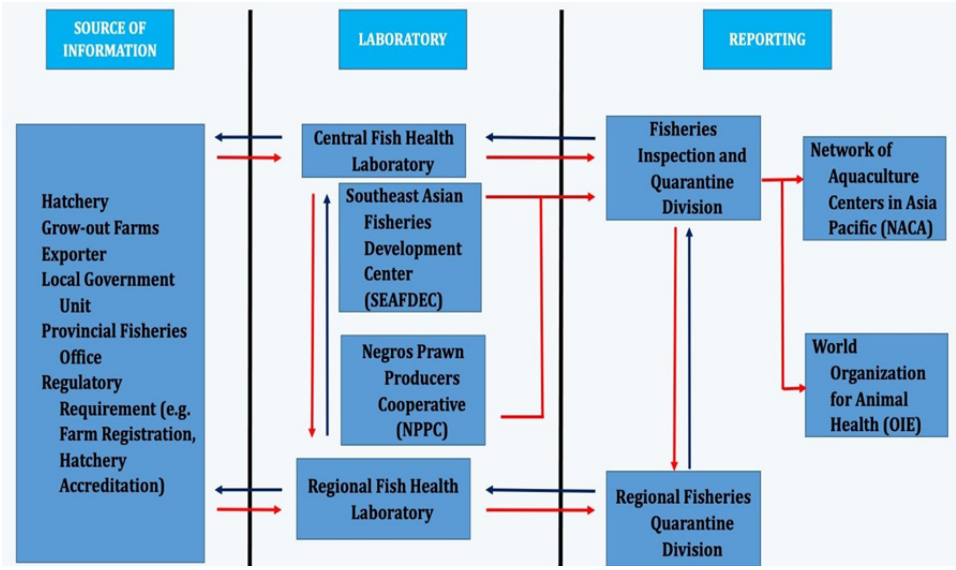

Figure 3. Aquatic animal disease surveillance and reporting system of the Philippines

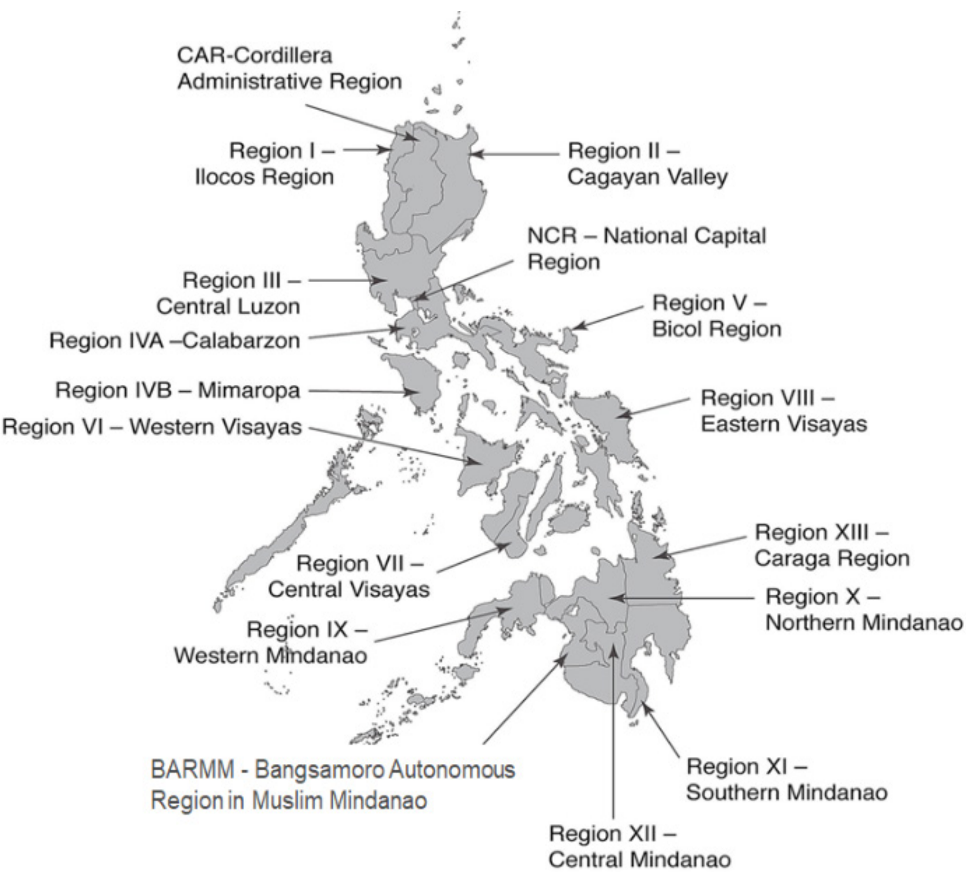

Figure 4. BFAR Central and Regional Fisheries Offices location

The NFLD together with regional fisheries laboratories III and VII participates in the Asia Pacific Laboratory Proficiency Testing for Aquatic Animal Diseases organized by the Australian National Government-Department of Agriculture and Water Resources. The NFLD and the regional fisheries laboratories conducts planning and reporting for a harmonized implementation of programs on aquatic animal health.

The regional fisheries laboratories capabilities depend on the needs of the industry within their areas of their jurisdiction. Regional Fisheries Laboratory VI and VII are also accredited with PNS ISO/IEC 17025:2017 for microbiological and chemical analysis for fish and fishery products. All of the regional fisheries laboratories implement quality management system based on the ISO 17025 standard. They are audited by the NFLD once a year to assess the implementation of various national programs on aquatic animal health including laboratory activities.

Table 1. BFAR laboratories and their level of capabilities on aquatic animal disease detection

BFAR Fisheries Laboratory	Level I	Level II	Level III	
			Screening	Confirmatory
NFLD	√	√	√	√*
NCR	√	√	√	-
I	√	√	√	-
II	√	√	√	√
III	√	√	√	√
IV-A	√	√	√	-
MIMAROPA	√	√	√	-
V	√	√	√	-
VI	√	√	√	√*
VII	√	√	√	√*
VIII	√	√	√	-
IX	√	√	√	-
X	√	√	√	-
XI	√	√	√	-
XII	√	√	√	-
XIII	√	√	√	-
CAR	√	√	√	-
CARAGA	√	√	√	√
BARMM	√	√	√	-

Level I - Observation of animal and environment, Gross clinical examination;
Level II - Parasitology, Bacteriology, Histopathology;
Level III - Molecular biology, Immunology (i. Screening - Insulated Isothermal Polymerase Chain Reaction (iiPCR)/ POCKIT or POCKIT microPlus, ii. Confirmatory - Conventional PCR*, Real-time PCR)

Reference: Asia Diagnostic Guide to Aquatic Animal Diseases (eds. Melba G. Bondad-Reantaso, Sharon E. McGladdery, Iain East and Rohana P. Subasinghe). FAO Fisheries Technical Paper 402-2. Rome* PNS/IEC ISO 17025:2017 Accredited

Aquatic animal diseases

Diseases in shrimp

White Spot Disease (WSD)

WSD is considered as one of the major diseases of shrimp that causes massive mortalities. In the Philippines, WSD in *Penaeus monodon* was first detected from surveillance activities and reported to the Network of Aquaculture Centres in Asia-Pacific (NACA) in January 1999 (NACA/FAO QAAD, 1999). The disease was also detected in various geographic locations such as Agusan del Norte, Bataan, Batangas, Bulacan, Camarines Norte, Cebu, Negros Occidental, Oriental Mindoro, Quezon, Sarangani Province and Zamboanga del Sur in January to May of the same year (Tapay *et. al.*, 2000).

Mass mortalities due to WSD have been experienced in major shrimp producing areas in the country since 2002 affecting shrimps of about 60–90 days of culture. The disease caused 80 to 95 % mortality in intensive culture systems, while 30 to 70 % in extensive culture systems (de la Pena *et al*., 2007). At present, WSD are now detected by BFAR laboratories at post-larvae up to adult stages without seasonal pattern. High mortalities are observed in some cases and emergency harvest of stocks are being done in harvestable sizes whenever possible.

Mixed infection with other shrimp diseases can be observed in some cases. Result of WSSV surveillance of BFAR from 2015–2019 is shown in **Figure 5**.

WSD can cause rapid mass mortality, lethargy, cessation of feeding and moribund animals are observed floating at the edge of the pond. Grossly, infected animals commonly exhibit loosened carapace, reddish to pinkish discoloration of the body and appendage and white calcium deposits embedded in the shell. Histopathological examination shows inclusion bodies and hypertrophied nuclei in cuticular epithelium and gills. A reported case of WSSV infection with clinical signs and histopathogical examination is shown in **Figures 6** and **7**.

Acute hepatopancreatic necrosis disease (AHPND)

AHPND was first detected in the Philippines in *Penaeus vannamei* and *Penaeus monodon* in the provinces of Bataan, Bulacan and Pampanga in Central Luzon 2014 (NACA/FAO QAAD, 2014; Dabu *et al*., 2015; de la Peña *et al*., 2015). Species affected are *Penaeus vannamei*, *P. monodon*, *P. merguiensis*, and *P. indicus*. The disease can affect all stages of the culture period (Apostol-Albaladejo, 2016). Mortalities occur within 0–35 days and as early as 10 days of stocking shrimp postlarvae or juveniles. However, the disease is also observed to occur as late as 46–96 after stocking (de la Peña *et al*., 2015). Among the clinical signs observed include inappetence, empty hepatopancreas and stomach, rubbery textured hepatopancreas, in some cases with white feces, and rapid mortality. **Figures 8** and **9** shows a shrimp with pale hepatopancreas, and histopathological examination of hepatopancreas with sloughing epithelial tubules, respectively

Shrimps infected with AHPND manifests several degrees of pathological changes in the hepatopancreas such as loosening and minimal degradation of tubule epithelial cells in acute phase. In early phase of infection, there is sloughing around the tubule leading to greater space, and at the terminal stage of infection, others manifest enlargement of the nuclei and presence of bacterial colonies may be observed in

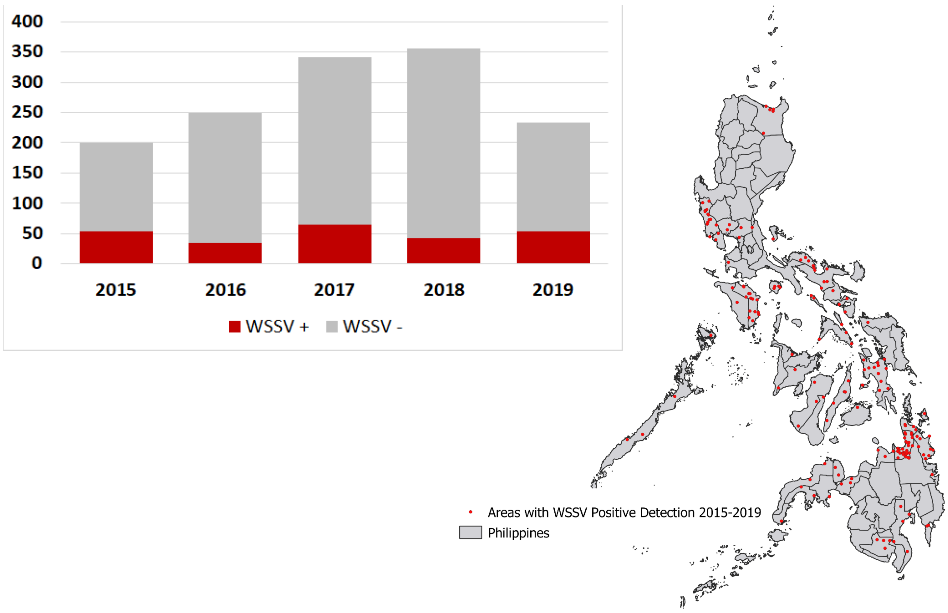

Figure 5. Graph and map showing WSSV detection from surveillance activities (2015-2019)

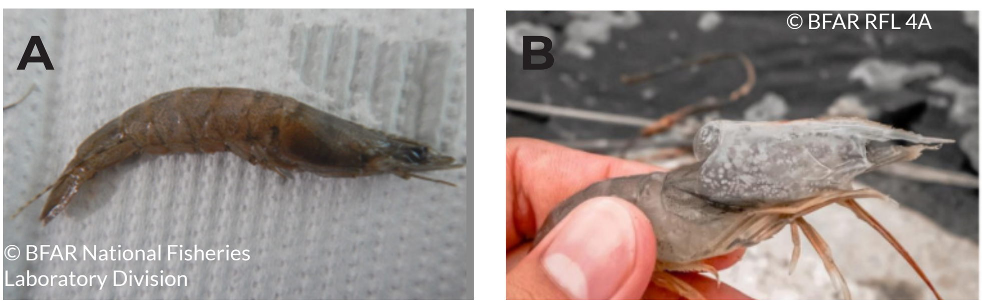

Figure 6. Shrimp with signs of WSSV infection, a) reddish discoloration of the body ; b) calcium deposits in carapace.

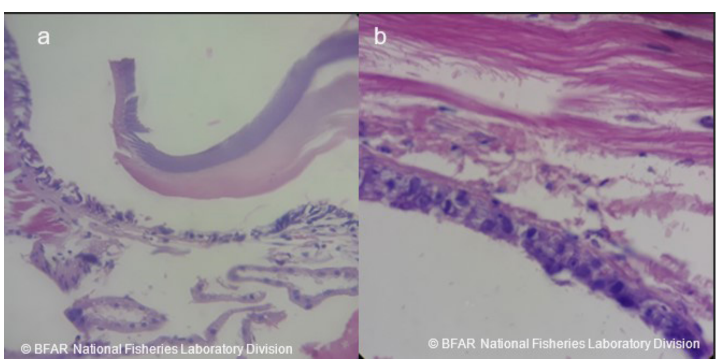

Figure 7. Histopathological examination of *P. vannamei* showing **a)** disintegration of epithelial lining of the mouth (H&E staining- 400x), and **b)** presence of intranuclear inclusion bodies and nuclear pyknosis (H&E staining- 1000x).

hepatopancreas tubule epithelial cells (Dabu *et al*., 2015).

The BFAR surveillance activities for AHPND from 2015–2019 is shown in **Figure 10.** Based on the results of the surveillance, the BFAR laboratories detected the disease on a wide range of shrimp culture stages from post-larvae to adult. Detection by the laboratory did not provide any seasonal pattern on its occurrence. However, mortalities are more common at post-larvae to juvenile stage. Currently, infection by AHPND can be observed to be associated with other diseases such as IHHNV, WSSV and EHP.

Hepatopancreatic microsporidiosis caused by Enterocytozoon hepatopenaei (HPM-EHP)

HPM-EHP is an emerging disease of shrimp caused by a fungal microsporidian parasite that infects the hepatopancreas. In the Philippines, EHP was detected in various shrimp species including *P. vannamei*, *P. monodon*, *Penaeus indicus* and *Penaeus merguensis.* It was first detected in *P. vannamei* from Cebu by the BFAR laboratory in 2016 (NACA/FAO QAAD, 2016).

The disease signs include growth retardation, uneven sizes and some may

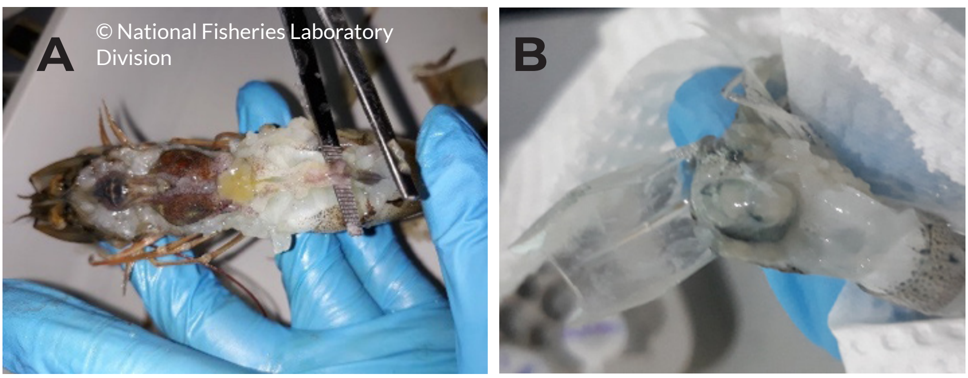

Figure 8. Comparison of shrimp with (a) normal hepatopancreas (b) pale hepatopancreas with AHPND

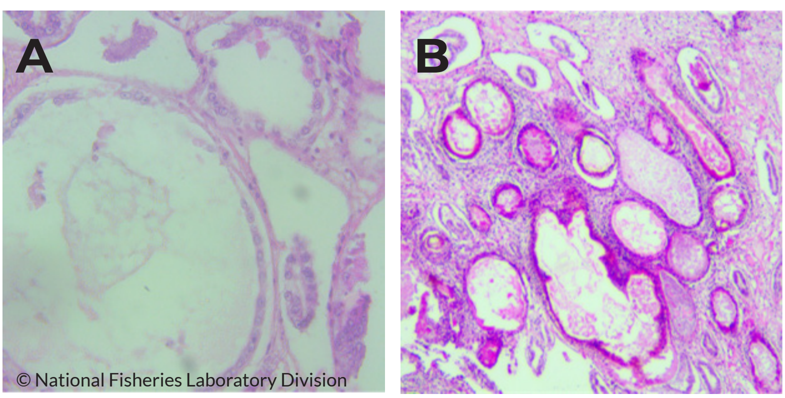

Figure 9. Histopathological examination of *P. vannamei* with AHPND showing **a)** rounding and sloughing off of hepatopancreas tubule epithelial cells and **b)** inflammation of hepatopancreas (H&E staining-1000x)

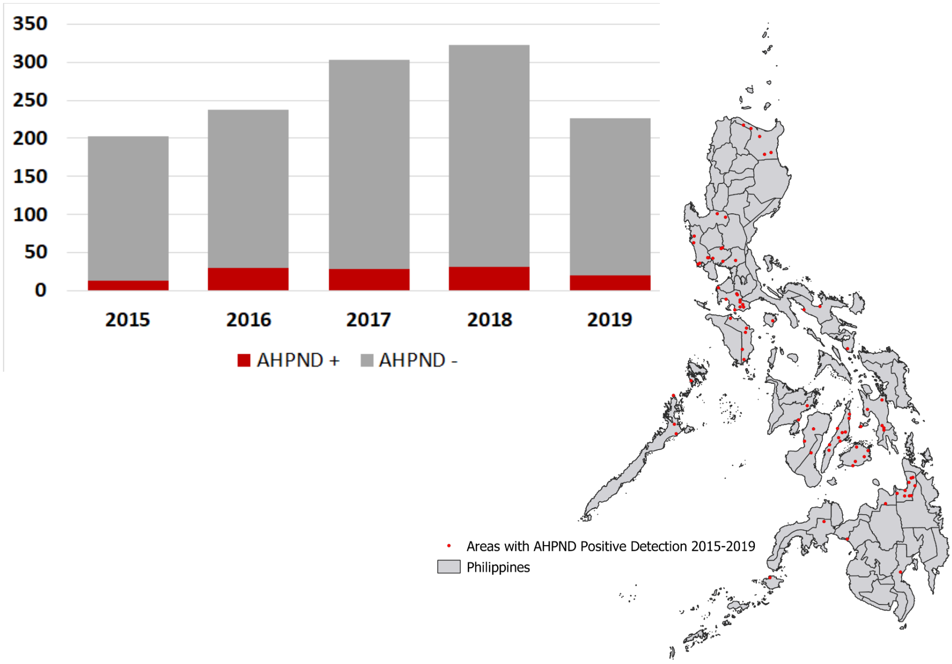

Figure 10. Graph shows the number of farms with detection of AHPND and total number of farms monitored from 2015-2019. The Map shows location and distribution of the disease in the Philippines

exhibit soft body/segment. No significant mortalities were observed in EHP infected animals even in co-infection cases with IHHNV. Mortalities are experienced in mixed infection with WSD and AHPND. Pitogo (2016) provided recommended disinfection measures to minimize EHP from maturation facilities, hatcheries, and grow-out farms using hydrated lime or hydrochloric acid before stocking and implementing quality control in post-larvae selection. A reported case of mixed EHP and AHPND infection is shown in **Figure 11**. The surveillance activity of BFAR on EHP from 2016–2019 is presented in **Figure 12.**

Other shrimp diseases

Other diseases of shrimp in the Philippines include infection with Infectious Hypodermal and Hematopoietic Necrosis Virus (IHHNV), Baculovirosis and Yellow-Head Disease. IHHNV affects all life stages of several species such as *P. vannamei*, *P. monodon*, *P. stylirostris*, *P. merguiensis* and *P. indicus*. It was first reported in March 2006, on postlarvae *Penaeus vannamei* from Zambales conducted by SEAFDEC-AQD (NACA/FAO QAAD, 2006). Common disease signs may include cannibalism, poor hatching of eggs and poor survival of larvae and PL, irregular growth rate and deformities.

Monodon Baculovirus (MBV), is the first diagnosed viral disease in the Philippines in 1989–1990 in all 12 shrimp producing provinces. All life stages of *P. monodon* are affected. Spherical, eosinophilic occlusion bodies fill up enlarged nuclei of hepatopancreatic cells and are discharged into the lumen under microscope. Elimination of fecal contamination of spawned eggs and larvae by thoroughly washing nauplii or eggs with formalin, iodophors and clean sea water.

Figure 11. Shrimp with mixed infection of EHP and AHPND shows uneven sizes with reddish discoloration

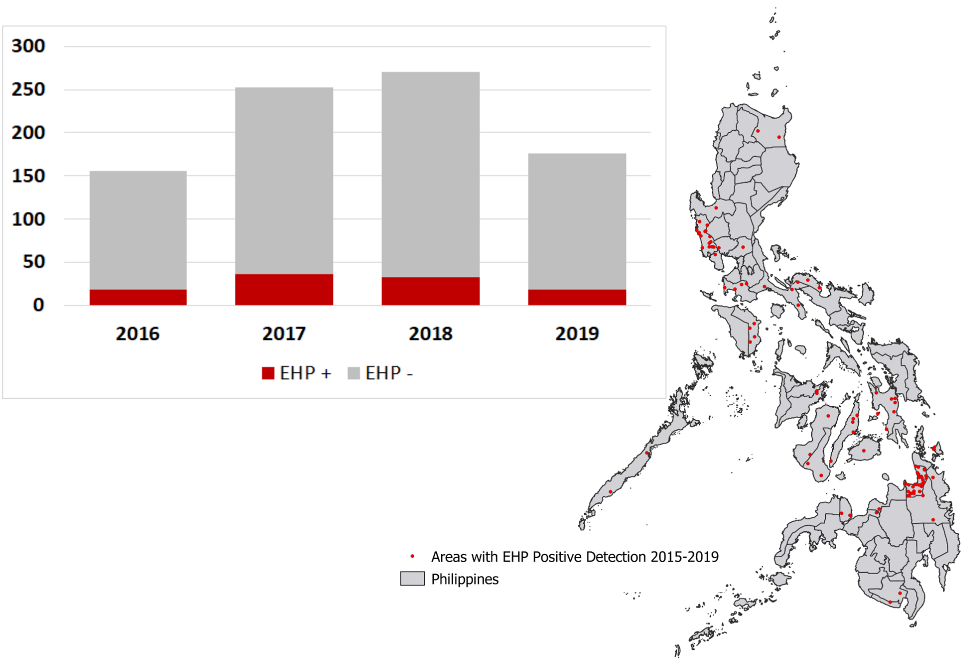

Figure 12. Graph demonstrating the number of samples and detection of EHP in shrimp. The map shows the areas with detection of EHP (2016-2019)

Yellow Head Disease caused by yellow head virus (YHV) was detected in 1998 by Albaladejo *et al.* Affected shrimp population was observed to have poor growth performance and with mortalities from 40–80 %. The reported case showed mixed infection with Luminous bacteria and spawner-isolated mortality virus (SMV) in some samples. The last occurrence in the Philippines was reported in July 1999, and have not been detected until the present time. In previous years, the luminous bacteria was a significant problem in shrimp culture. Polyculture system of shrimp with finfish or oyster/mussels can control the growth of luminous bacteria (Tendencia, 2007).

Viral diseases

Tilapia Lake Virus (TiLV)

In the Philippines, Tilapia Lake Virus (TiLV), or Syncytial Hepatitis of Tilapia (SHT), was first detected in tilapia (*Oreochromis niloticus*) in the province of Bulacan in May 2017 and reported to the OIE in the same year. The first occurrence happened in a tilapia nursery farm wherein fingerlings showed daily mortality that reached up to 25 % after 15 days of culture. The infected fish have demonstrated skin erosions and discoloration (darkening), distended abdomen, scale protrusion, exophthalmia, and paleness of the gills. TiLV infection in tilapia fingerlings is shown in **Figure 13**.

Figure 13. Tilapia fry showing distended abdomen and exophthalmia

The disease is observed during summer up to the onset of the rainy seasons from April to June. Some samples tested positive in iiPCR however typical signs of the disease are not apparent. Since its first occurrence, surveillance activity has continued on a national scale (**Figure 14**).

Currently, a collaborative project is being undertaken by the SEAFDEC/AQD Binangonan Freshwater Station with BFAR on detection, quantification, and viability of Tilapia Lake Virus (TiLV) in pond soil and water as influenced by water quality parameters and culture management.

Viral nervous necrosis (VNN)

Viral nervous necrosis (VNN), also known as Viral encephalopathy and retinopathy (VER) causes mass mortalities in marine fishes such seabass (*Lates calcalifer*) larvae and grouper (*Epinephelus coioides)* (de la Pena *et al*., 2008). The disease is caused by Betanodavirus and the infected fish exhibits abnormal swimming behavior, anorexia, lethargy, and some develops skin lesion. The organ most affected for VNN is the brain and optic nerves. In addition, the diseases can be observed in mixed infections with other pathogen

Irido Megalocytivirus

Irido Megalocytivirus is being detected in groupers (*Epinephelus* spp.), in juveniles to grow out stages. Farms positive to the disease experienced massive mortalities. Clinical signs include lethargy, uncoordinated swimming, and distended abdomen. Internal examination showed signs of spleen enlargement and it also affects the kidney.

Koi Herpesvirus

Koi Herpesvirus (KHV) is included in the surveillance activity of BFAR. Up to present time, Philippines is KHV-free country. In 2010, the first case of KHV associated mortality was from illegally imported koi carp bought by a passenger from an ornamental fish show in China, but its origin was unknown. It was confiscated by the Fisheries Quarantine and Inspection Service Officers at the Ninoy Aquino International Airport (NAIA). Five days after confiscation, fish showed symptoms such as necrotic gill filaments, body ulcerations, discolored patches and pale body coloration. The disease was confirmed by PCR analysis (Somga *et al*., 2010). The disease has not been detected locally in surveillance activities of BFAR and conform with the study conducted by Lio-Po *et al*. 2009.

Bacterial diseases

Streptococcosis

Streptococcosis in the Philippines is mainly caused by *Streptococcus agalactiae* and *S. iniae*. These are associated with highly contagious and significant mortalities in tilapia farming, specifically in grow-out cage culture in Taal Lake, Batangas. Locals refer to disease as "hibay" wherein affected fish demonstrate scale loss, fin rot, lethargy, abnormal swimming behavior such as swirling and loss of balance. Terminal stage of the disease presents abdominal distention, exophthalmia, and hemorrhages in the different parts of the body (**Figure 15**). Pathological changes in the internal organs can be observed such as enlargement of liver, spleen, kidney and gallbladder, petechiae and focal necrosis of liver, and hemorrhages in the brain. The moribund fish are fragile and have a foul smelling odor.

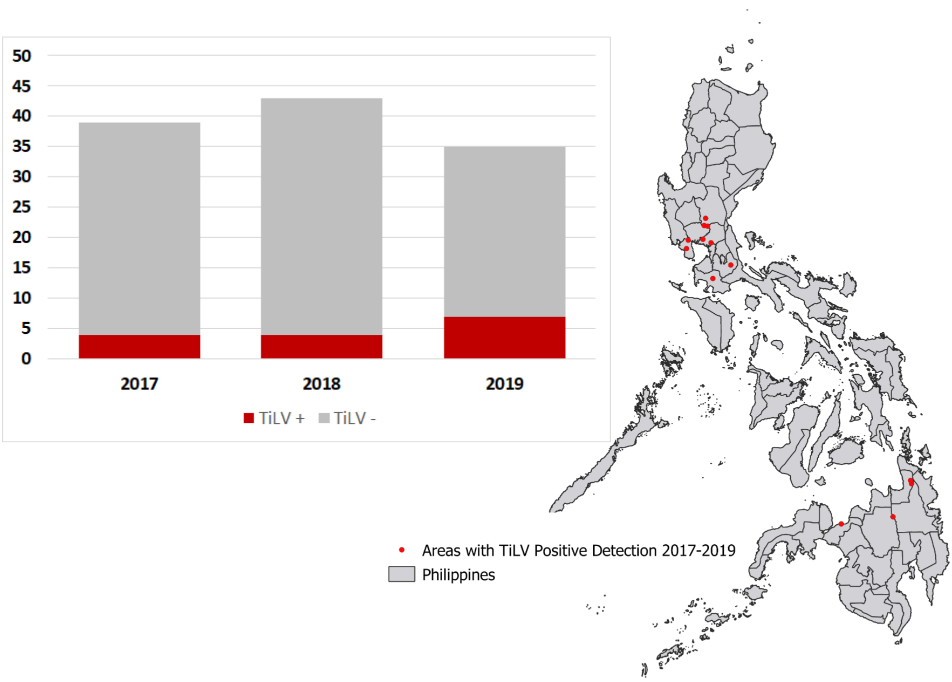

Figure 14. Graph showing positive detection with TiLV from the total number of samples analyzed. The areas with detection of TiLV (2017–2019)

Aeromonas Infection

Aeromonas infections in tilapia, caused by *Aeromonas hydrophila*, are also experienced by farmers as a result of any stressor to the animal such as abrupt changes in the temperature, overstocking, and poor water quality. Clinical signs and patterns of mortality are similar to other common bacterial infections. Pakingking *et al*, (2015) studied the composition of bacterial microbiota in the rearing water, sediment, gills and intestines in tilapia that could cause disease in stressful conditions.

Vibriosis

Vibriosis in marine fish is the most common bacterial infection and most cases are chronic and may affect all fish stocks. The disease is characterized by hemorrhagic ulcers penetrating muscle tissue (**Figure 16**). The affected fish show hemorrhages in fins, tail rot, cloudiness of the eye may occur at the advance stage of the disease. It is also associated with heavy parasite infestation particularly in small fishes.

Nocardiosis

Nocardiosis caused by *Nocardia* spp. has been detected in cage-cultured pompano in at Padre Burgos, Quezon, Philippines. The morbidity rate was about 80–100 % while the mortality rate was estimated at 50–60 %. Clinical signs of the disease were lethargy, emaciation, loss of scales, skin ulcers on the body and whitish to yellowish green, irregularly shaped masses at the base of the gill filaments. Internally, nodules in the liver, spleen and kidney were seen (**Figure 17**). Histopathological examination showed multiple granulomas in the kidney, liver, spleen and muscle.

Figure 15. Tilapia samples taken from affected population with bugling eyeball and distended abdomen

Figure 16. Grouper with clinical signs of bacterial infection.

Epizootic Ulcerative Syndrome (EUS)

Epizootic Ulcerative Syndrome (EUS) caused by *Aphanomyces invadans* first confirmed occurrence in the Philippines was in late 1985 to early 1986 at Laguna Lake affecting bottom dwelling species like snakehead (*Ophicephalus striatus*), catfish

(*Clarias batrachus*), gouramy (*Trichogaster pectoralis*), goby (*Glossobius giurus*), crucian carp (*Carassius carassius*), Manila sea catfish (*Arius manillensis*), and silvery theraponid (*Therapon plumbius*) (Llobera and Gacutan, 1987). The last report of EUS was in October 2002 in African sharptooth catfish from Sta. Barbara, Iloilo. It is only in January to April 2019 that the disease is reported to have re-occurred in gobies (*Awaous* spp.) in San Juan river, Abra. The disease usually occurs during cold months causing shallow to deep ulcerations from the different parts of the body. Risk factors for EUS infection includes low-water temperature, low alkalinity, low hardness and chloride, fluctuating pH and heavy rainfall (Bondad-Reantaso *et al*., 1992). Histopathology reveals muscle degeneration and necrosis with fungal hyphae and mycotic granuloma formation using grocott's methenamine silver stain (**Figure 18**). EUS is difficult to control as most cases occur in wild populations.

Microsporidiosis

Microsporidiosis is caused by microsporidians, *Glugea* spp. and *Pleistophora* spp.,(Nagasawa and Lacierda 2004). Reported cases of microsporidiosis were seen in groupers (*Epinephelus* spp. and *Cromileptes* spp.). Clinical signs include abdominal swelling, and presence of dark brown cyst-like formed in fat tissues and internal organs (**Figure 19**). It affects nursery and grow-out stages. Mortality rate in affected stocks is variable.

Figure 17. a) pompano showing loss of scales, emaciation and skin ulcers (red arrow), **b)** pompano gills with irregularly shaped masses at the base of gill filaments, **c)** liver with nodules, and **d)** pleen with nodules

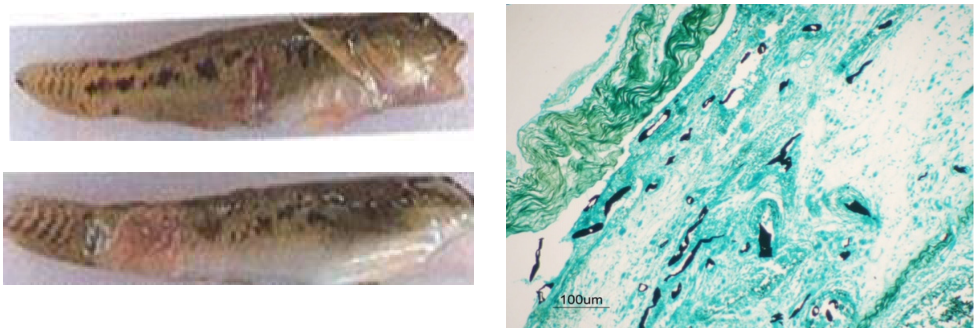

Figure 18. Goby infected with EUS, and histopathological examination of muscle tissue showed presence of fungal hyphae (Grocott's Methenamine silver stain, 10X)

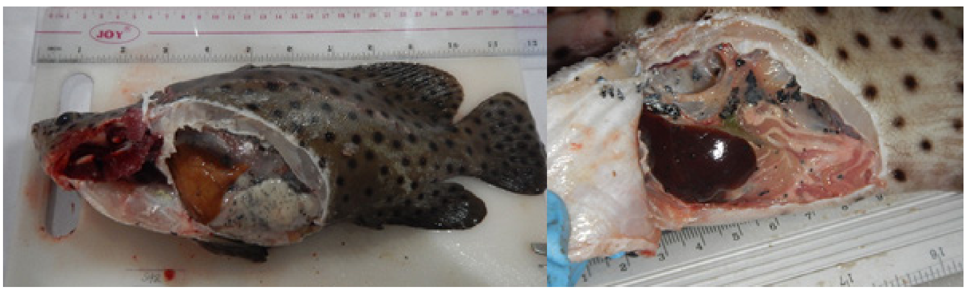

Figure 19. Panther Grouper infected with microsporidiosis

Common parasites in finfish

Common protozoan parasites in freshwater fishes include *Trichodina* spp. and *Ichthyopthirius multifiliis.* These are the most prevalent parasites in fish (Natividad *et al*., 1986; Bondad-Reantaso and Arthur, 1989). The BFAR laboratory commonly detects *Trichodina* parasites in eels, carp, and tilapia fry and fingerlings intended for local movement and export. On the other hand, *Ichthyopthirius multifiliis* or "White Spot Disease '' is detected in tilapia imported from other countries (**Figure 20**). These parasites can cause discomfort, skin and gill damage, respiratory distress, and predisposes fish to opportunistic organisms.

Other parasites commonly detected in fishes are the skin fluke, *Dactylogyrus* spp. and gill fluke, *Gyrodactylus* spp. (**Figure 21**). Some of the signs and symptoms of infestation in fish include swollen and pale gills, loss of scale and a change in color in areas where the parasites are attached and lethargy (Cruz-Lacierda, 2010). The gill epithelium may be severely damaged affecting normal respiration. Heavy infestations may cause high mortalities. Most commonly affected are at fingerlings stage.

Disease control measures

There are several good aquaculture practices recommended for disease control and prevention (PNS, 2014). The GaqP covers elements on food safety, animal health and welfare, environmental integrity and social aspects. Specific farm management practices against significant diseases in shrimp are also available for the stakeholders such as acute hepatopancreatic necrosis disease

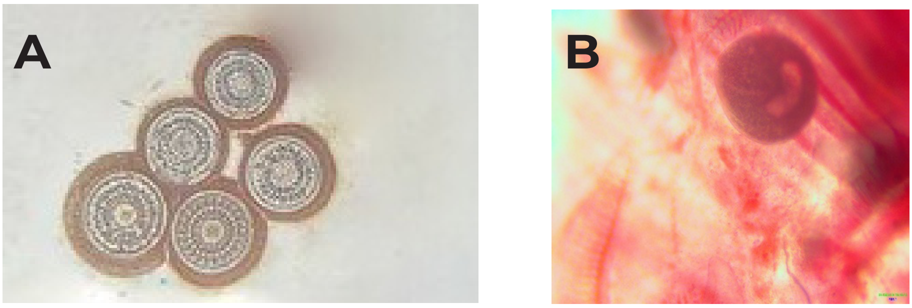

Figure 20. a) *Trichodina* spp. isolated from tilapia fingerling samples, and **b)** *Ichthyopthirius multifiliis* isolated from grass carp (10X)

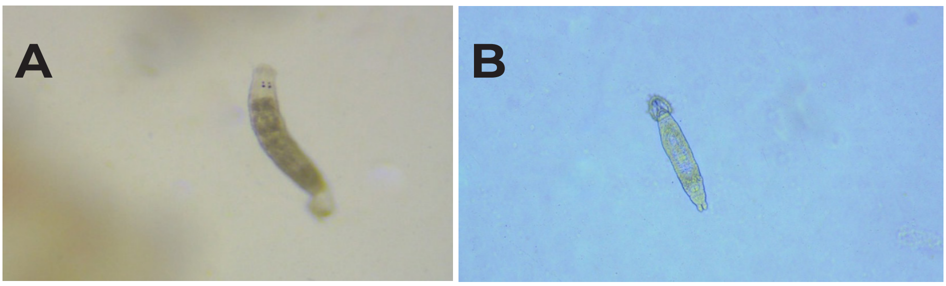

Figure 21. (a) Skin fluke and, **(b)** gill fluke isolated from tilapia (40X)

(Usero and Apostol-Albaladejo, 2015). The DOST-PCAARD also published handbooks on the Philippine Recommends of different aquatic animal species such as tilapia and milkfish. The handbooks described techniques and provide valuable information in the management and disease control measures in every stage of the rearing process. There are also disease recognition cards for significant diseases by BFAR which also provides various disease control measures.

Cooperation on the aquatic animal health management programs

The aquatic animal health services of the Philippines were evaluated by the OIE experts using the OIE Aquatic PVS Tool on 3–18 Feb. 2013. It was aimed to identify strength and weakness of the aquatic animal health services in compliance with the criteria set out in the OIE aquatic animal health code in particular quality of aquatic animal health services. It includes assessment of the human, physical and financial resources, capabilities, interaction with interested parties and access to markets. Recommendations on how to improve the aquatic animal health services were provided (Somga *et al.*, 2015). In 18–28 Jan. 2016, another OIE experts mission conducted Gap Analysis in the implementation of priority programs on aquatic animal health services, to determine the level of performance and gaps that needs to be strengthened. Short to medium term plan of activities were developed to achieve the goals set in improving aquatic animal health services. Continuous strengthening of aquatic animal health services is being done.

There are also several projects being implemented by BFAR on aquatic animal health in collaboration with other international organization such as the

Food and Agriculture Organization (FAO), World Organization for Animal Health Office (OIE), Network of Aquaculture Center in the Asia Pacific (NACA), Southeast Asian Fisheries Development Center (SEAFDEC), and other research institutes.

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