5.3 Disease Diagnosis, Control, Monitoring and Surveillance of Aquatic Animals

Aquaculture has always been a major part of the economic strategy adopted by many Southeast Asian countries for reducing poverty in view of its great potentials to fill the gap between supply and demand for fish and fish products especially the role that it has maintained as an important producer of high quality protein for domestic consumption as well as a major generator of export earnings. However, the continuing population growth, the decline in marine fish catch, and the widespread poverty in the rural areas of the region make it imperative that sustainable aquaculture be promoted to ensure food security. In fact, aquaculture in Southeast Asia has grown very rapidly especially during the last two decades, but due to irresponsible introduction of aquatic species that allegedly carried pathogens, a large number of infectious diseases have emerged threatening the sustainability of aquaculture in the region. The occurrence of aquatic diseases has not only led to low production but has also threatened food security and raised alarming environmental concerns (Ogata, 2009). In a brave attempt to address the issues, a regional project on fish disease was implemented at SEAFDEC/AQD in Iloilo, Philippines since 2000 with funding support from the Trust Fund Program of the Government of Japan's Fisheries Agency (JTF). Phases included in the Project are the Development of Fish Disease Inspection Methodologies for Artificially-bred Seeds which focused on the development of diagnostic methods for important viral diseases of aquatic animals in the region and Development of Fish Disease Surveillance System which aimed on the development of surveillance system for diseases of aquatic animals. Also, another phase of the project which is still on-going is the Food Safety of Aquaculture Products. Through this Regional Fish Disease Project, trading of healthy and wholesome aquaculture products has been promoted in the Southeast Asian region (SEAFDEC, 2008a).

5.3.1. Status, Issues and Concerns

Important findings from the Project have been disseminated to the countries in the region through hands-on training and information dissemination. Meanwhile, the countries in the region are also exerting efforts in controlling aquatic diseases to safeguard the quality of their products which are meant not only for domestic consumption but also for the export markets. For its part, SEAFDEC would continue to provide the means in order that the objectives of the countries are attained and to ensure that the requirements for safety and quality of the customers especially the international markets are being complied with. However, this would depend much on the available resources at SEAFDEC.

Development of Diagnostic Methods for Important Viral Diseases of Aquatic Animals

Through the SEAFDEC Regional Fish Disease Project, diagnostic methods have been developed to ensure healthy and wholesome trading of aquaculture products in the Southeast Asian region. Generally, there are 3 levels of diagnostics: Level I, which provides the foundation and is the basis of higher diagnostic levels. It includes production site observations, record-keeping and health management; Level II includes the specialization of parasitology, histopathology, bacteriology and mycology; and Level III includes advanced specialization like immunology and molecular techniques (Bontad-Reantaso *et al*., 2001). The SEAFDEC Regional Fish Disease Project focused more on Level III diagnostics. As a matter of fact, the implementation of the Project was also an opportune time to prevent the spread and control of an emerging viral disease of common carps known as koi herpesvirus (KHV) which almost devastated carp production in the region. The timely efforts of SEAFDEC to address such concern had ensured the sustainability of carp culture, a major economic livelihood in many Southeast Asian countries.

The main activities of the Project aimed to address the concerns related to the reported viral diseases including emerging ones in cultured shrimp and fish in Southeast Asia, such as the white spot syndrome virus (WSSV), monodon baculovirus (MBV) of the black tiger shrimp (*Penaeus monodon*), the taura syndrome virus (TSV) and infectious myonecrosis virus (IMNV) of the whiteleg shrimp (*Penaeus vannamei*) (Nagazawa, 2004). WSSV was in fact one of the root causes of the devastation of the shrimp culture industry that brought acute economic slow-down in Southeast Asia in the 1990s and even until now. This epizootic probably began in China then subsequently spread to Japan, Taiwan and the rest of Asia. Outbreak will cause a high and rapid mortality which may reach 100% within 10 days from the onset of clinical signs. Host range extends widely into other marine and freshwater crustacean species, including annelids, copepods and even aquatic insect larvae. This persistence in wild crustacean species in the vicinity of shrimp farms may make the disease difficult to eradicate from affected aquaculture areas. Through the Project, Level III diagnostic method such as the polymerase chain reaction (PCR) was optimized and standardized for WSSV (de la Peña *et al*., 2007). MBV is exemplified by problems related to infection that is usually encountered in hatchery and grow-out operations because its outbreak can slow the growth of the cultured animals. Level III diagnostic methods have also been optimized and standardized for MBV and hepatopancreatic parvovirus (HPV) in shrimp (Catap *et al*., 2003; Catap and de la Peña, 2005; de la Peña *et al*., 2008). TSV was first recognized in Ecuador in early 1990s where the disease caused heavy losses with a very high cumulative mortality rate of affected cultured *P. vannamei*. It was not reported in Asia until after introduction of *P. vannamei* in Taiwan in the late 1990s and was subsequently reported from most Asian countries where *P. vannamei* were imported for aquaculture. IMNV is considered as an emerging viral disease and its outbreak was initially documented in Brazilian *P. vannamei* farms in 2002. The virus caused low but steady mortality leading to accumulated losses up to 70%. In mid-2006, IMNV outbreak was reported in Indonesia (Flegel, 2009; Taukhid and Nur'aini, 2009). The legalization of the importation of *P. vannamei* in several Asian countries including the Philippines for aquaculture hastened the efforts for the establishment of Level III diagnostic methods such as RT-PCR for both TSV and IMNV. These diagnostic methods are very useful in the pre- and post-border screening of imported stocks.

In marine fish, well known viral diseases that severely affect the aquaculture industry in the region are the viral nervous necrosis (VNN) and iridovirus and also the koi herpesvirus (KHV) for the freshwater fish. VNN is considered as one of the most devastating diseases of marine fish. Larvae and juveniles are the most affected stages wherein outbreaks may cause up to 100% mortality. Iridovirus may also cause infections in many marine fish such as red seabream and groupers wherein mortalities may reach 60% among fingerlings and market-sized fish. Methods to detect, prevent and control VNN infection in marine fish hatchery have also been developed and established (Pakingking *et al*., 2009 and 2010; de la Peña, 2010). Level III diagnostics such as PCR was also optimized and standardized for iridovirus.

The first outbreak of the viral disease in koi and common carp (*Cyprinus carpio*) known as the koi herpesvirus disease (KHVD) was reported to have caused mortalities in carps in Indonesia in early 2002 and in Japan in 2003. With potential threats of spreading in other Southeast Asian countries, SEAFDEC through the Regional Fish Disease Project initiated strategies for the prevention and control of the KHVD. Kanazawa (2005) cited that in 2003, the losses incurred by Indonesia due to the KHVD was more than US$ 15 million, and considering that common carp is an important source of protein in the rural areas in Southeast Asia, it has become necessary for AQD to conduct studies on KHVD taking into account its high virulence and devastating impact on the freshwater aquaculture sector. Lio-Po *et al*. (2009) cited that the results of the studies on KHVD conducted at AQD that targeted five Asian countries had provided basic data on the status of the disease in the region and led to the prevention of the transboundary movement of KHVD in Southeast Asia. In addition, husbandry techniques (*e.g.* use of live bacteria or probiotics and "green water" culture system) to control the luminous vibrosis caused by *Vibrio* spp. such as *Vibrio harveyi*, a common bacterial disease that has also heavily affected shrimp aquaculture in the Southeast Asian region, were also developed as alternatives for chemotherapy (de Castro-Mallare *et al*., 2005). Results from the standardized diagnostic and husbandry methods for disease control have been disseminated to the region through hands-on training and massive information dissemination.

E-learning on Principles of Health Management in Aquaculture

Since 1988, AQD has been conducting classroom-based face-to-face training courses on health management in aquaculture on a regular basis at its main station in Tigbauan, Iloilo, Philippines. Later in the early 2000s, the teacher-student face-to-face setting had been changed into a distance-learning mode, which AQD considered more convenient and practical for a learner to acquire knowledge and skills in health management at his own place and at his own time. This new learning experience via information technology was developed for the AQD AquaHealth Online, which covers up-to-date knowledge on fish and crustacean diseases, the causal organisms and the methods of disease prevention and control (Lavilla-Pitogo and Torres, 2004). Targeting full-time working professionals, AquaHealth Online aims to introduce the principles of health management in aquaculture, and is envisaged that by the end of the course, online participants should be able to recognize diseased shrimps and fish, identify the cause(s) of the diseases, explain how the diseases develop, apply preventive and control measures to lessen the risks posed by the diseases, and use appropriate techniques for the preparation of samples for disease diagnosis. The AquaHealth Online was developed to train a large pool of geographically dispersed participants at minimum costs. Since its first session in 2002, AquaHealth Online has trained more than 150 e-learners not only from Southeast Asia but also from other regions in the world. Based on the feedbacks from the e-learners, AquaHealth Online has proved that a state-of-the-art online course can be as effective as the face-to-face training. However, AquaHealth Online requires that participants should have basic knowledge of written English and competency in using the computers and browsing the Internet.

Fish Disease Surveillance System

The Regional Fish Disease Project also focused on the development of Fish Disease Surveillance System in Southeast Asia to assist its Member Countries in their efforts in fish health management. Both general and targeted surveillance were implemented; thus, a network of the region's resources and facilities for fish health diagnosis has been established while human capacity building has been enhanced. During the implementation of the Project, AQD has continued to refine the diagnostic methods to be able to develop new prevention methods for aquatic animal diseases. More importantly, a surveillance system for important viral diseases for shrimps in the region has been instituted. As a result, the countries have developed a well-coordinated network for the timely and efficient reporting on any outbreak of any aquatic disease in the region as exemplified in the reporting of KHVD which spared the region's freshwater aquaculture sector from total economic collapse. As one of the most significant outcomes of this Project, the countries in the region can now boast of its regionally-recognized reference laboratory for specific aquatic diseases.

In order to review the emerging fish diseases and to keep the region abreast on the advances in pathogenesis, diagnosis, epidemiology, and surveillance of emerging diseases of aquatic animals the International Workshop on Emerging Fish Diseases in Asia was convened by SEAFDEC in December 2007 in Bangkok, Thailand. Attended by more than 70 participants from 17 countries including the Southeast Asian region, the information obtained from the Workshop has largely contributed to the promotion of responsible aquaculture in the region. Moreover, the knowledge gained by Southeast Asian countries on newly emerging aquatic diseases could boost their efforts in preventing the occurrence and spread of any aquatic diseases. Moreover, AQD has also updated information related to fish disease management based on considerable research findings achieved through the implementation of the Project (Lio-Po and Inui, 2010). This would then ensure that aquaculture products from the region are safe and wholesome for human consumption.

Monitoring Residual Chemicals in Aquaculture Products

The expansion of aquaculture farming activities over the years has made the health of the culture animals under constant threat from bioagressors such as viruses, bacteria, parasites and fungi. In an effort to control the occurrence of such bioagressors, many farmers use antibiotics and other chemicals without knowing that some could be toxic to humans and pose danger to the wellness of the environment. Improper use could also induce the development of resistant pathogens in the cultured aquatic species, the human consumers and the environment (Platon *et al*., 2007). Considering that the presence of chemical residues in aquaculture products poses threats to human health, SEAFDEC through the Regional Fish Disease Project has developed and standardized detection methods for residual chemicals such as pesticides and antibiotics in aquaculture products. This is aimed at securing safe and healthy aquaculture products from the Southeast Asian region.

With the cooperation of the Singapore-based SEAFDEC Marine Fisheries Research Department (MFRD), studies have been conducted to develop detection methods of residual antibiotics in aquaculture products. Oxolinic acid (OXA) and tetracycline (TC) are the most extensively used antibiotics in aquaculture and in order to determine the residue levels of OXA and TC in aquaculture products, high performance liquid chromatography methods had been developed (Tan *et al*., 2005). Moreover, a compilation of the methods for chloramphenicol and nitrofuran residue testing were prepared by MFRD and AQD and disseminated to the region's fish disease laboratories (Ruangpan and Tendencia, 2004; Borlongan and Ng, 2004). Furthermore, evaluation methods for residual chemicals in aquaculture products have been established to secure the safety of aquaculture products while the use of antibiotics in the region's aquaculture industry has been closely monitored (Borlongan, 2005; Ruangpan and Pradit, 2005).

5.3.2 Challenges and Future Direction

Recognizing that aquaculture which is an important contributor to food security in the region has been severely threatened, efforts have been made by SEAFDEC in collaboration with the Member Countries towards its sustainable development through the effective control of diseases by developing technology and techniques for disease identification, quick and reliable field-side diagnosis and harmonized diagnostic procedures specifically on Level III diagnostic methods; establishing regional and inter-regional referral systems including designation of reference laboratories; reducing risks of negative environmental impacts, loss of biodiversity, and disease transfer by regulating the introduction and transfer of aquatic organisms; and establishing quality standards and take measures to reduce or eliminate the use of harmful chemicals.

Considering that the occurrence of diseases in aquaculture is attributed to irresponsible management practices that bring about deteriorated culture conditions, some innovations have been adopted by many countries in the region that aimed to prevent disease outbreak. This includes the installation of effluent reservoirs which has been found effective in controlling viral diseases (Platon *et al*., 2007). Also included is the concept of total biosecurity system which comprises the installation of disinfection baths, dedicated paraphernalia per pond, screening of postlarvae for diseases, presence of reservoir ponds, water filtration and treatment for incoming and outgoing water and proactive monitoring of the animals and rearing water during the culture. In addition, strategies have been formulated to control fish diseases in aquaculture systems (Platon *et al*., 2007) as well as address the issues on healthy and wholesome aquaculture (Toledo *et al*., 2011) which should be considered specifically in the further development and refinement of the various methods and techniques for fish disease prevention and control, taking into account the various preventive measures that are now being advanced that could inhibit the use of chemical inputs in aquaculture.

More importantly, AQD would continue to focus its activities in addressing the areas of concern of responsible aquaculture development guided by the priorities especially on the development of responsible aquaculture technologies and practices, responsible use of genetic resources for the purpose of aquaculture, adoption of measures to avoid environmental degradation, and promotion of environmentally sound culture methods and commodities. There is certainty that if uncontrolled, irresponsible practices in aquaculture would continue to threaten food safety and create negative impacts on the ecosystem. It is for this reason that AQD has been promoting the concept of healthy and wholesome aquaculture, which is a holistic approach to fish disease management for food safety and security. This concept also promotes the use of efficient feeds which are cost effective and low-polluting in order to optimize production and healthy famed aquatic animals with the least negative impact to the environment (Toledo *et al*., 2011).

5.4 Development of Sustainable Aquaculture Feeds

Southeast Asia is a major producer of aquaculture products and aquaculture production has been steadily increasing with concomitant increase in the demand for aquafeeds in the region. Fishmeal (FM) and fish derived products (FPs) such as fish oil (FO), fish hydrolysates, fish protein concentrates, fish processing by-products, and fish soluble, are the major components of aquafeeds that would satisfy nutrient requirements and acceptability. However, FM and FPs are not always available and market prices could be unstable. Hence, these have big impacts on aquaculture activity and its sustainability.

Aquaculture feeds with lesser dependence on these feedstuffs are being developed to sustain growth of aquaculture in the Southeast Asian region. Decreasing the levels of FM and FPs in aquafeeds has been the objective of many feed formulators and feed millers. Therefore, research effort should emphasize on determining the lowest levels of FM and FPs in feeds formulated for specific aquaculture species in their stages of growth without loss in efficacy and on protein production. This has been achieved to a certain extent, for example in the compounded feeds for some species using alternative protein sources and nutritional interventions. Improvement and refinement of formulations, however, should be continued together with technologies that make alternative protein sources commercially available and cheap. Moreover, the culture of species with low requirement for FM and FPs such as the low value with high volume aquaculture species should be encouraged and to a certain extent environment regulations should be put in place. In addition, there is a need for greater involvement of governments to expand the market and promote consumer acceptance of low value species.

5.4.1 Use of Fishmeals and Fish-based Products for Aquafeeds

Production from fed aquaculture is 54% of total production in Asia (FAO, 2008). In 2009, the Southeast Asian region which is a major producer of aquaculture products, the volume of production was 12.5 million MT valued at US$ 14.8 billion (FAO, 2010). The amount of raw materials that goes into aquafeed production in the region is significant and the impact is tremendous on non-renewable resources or on the raw materials with limited supply. The collective impact of market forces, research results, and pressures of environmental issues lowered the inclusion levels of FM as a source of high quality protein and minerals as well as that of FO as a source of omega fatty acids, the second most valuable among the FPs in compounded feeds for aquaculture. Global reported data showed that these ingredients are expected to decline from 1995 to 2010 in the levels of FM and FO in compounded feed of milkfish (*Chanos chanos*) from 15% to 3% and 3% to 1%, respectively.

Except for catfish, a similar trend is also reported for shrimps, marine fish and tilapia. The compounded feeds for these species have become less dependent on FM and FO as lesser amounts are used, and are also increasingly efficient as shown by lower average FCR values from 1995 to 2010. The decreased levels of FM and FO in aquafeed imply that there is now less pressure on the manufacture of FM and FO. However, fish production from aquaculture in the Southeast Asian region has increased and more fish farmers are using efficient compounded feeds in aquaculture, increasing the demand for aquafeed production and thus, increasing also the total requirements for FM and FPs. For instance, the volume of aquafeeds used in the culture of milkfish between 1995 and 2007 has more than doubled while that for the other species groups has quadrupled (**Table 59**). In 2010, the estimated volumes of total feeds for the culture of these species also increased. Thus, with increased aquafeed use in aquaculture production in the Southeast Asian region, the demand for FM and FPs will continue to increase.

5.4.2 Issues and Concerns

Aquaculture production in the Southeast Asian region has been increasingly dependent on aquafeeds and this trend will continue as long as resources for the feed poduction are available. However, FM and FPs which are significant