



SEAFDEC/AQD  
**HIGHLIGHTS**  
**2020**



**ANNUAL REPORT**  
Southeast Asian Fisheries Development Center  
AQUACULTURE DEPARTMENT

## HIGHLIGHT

# Aquafeed project shows promise to improve income of farmers

To help lower the price of fish amidst volatile food prices across the country, the Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC/AQD) is coming up with a new fish feed formulation that is cost-efficient and eco-friendly.

Using byproducts of ethanol production, rendered animal protein, and processed copra meal, a scientist at SEAFDEC/AQD formulated fish feed that performed better than commercially available feeds as proven in pond trials.

The SEAFDEC/AQD-formulated diet is cheaper as it only costs about P28 per kilogram to produce, while the average cost of a commercial feed is about P34 to 36 per kilogram.

“We came up with this feed formulation to lower the price of feeds which account for more than 50 to 60 percent of the total production cost in aquaculture,” said Dr. Roger Edward Mamauag, a scientist at SEAFDEC/AQD and head of its Technology Verification and Extension Division.

The field trials were done in 2020 at SEAFDEC/AQD’s Dumangas Brackishwater Station (DBS) in Iloilo as part of a collaborative project between SEAFDEC/AQD, the National Fisheries Research and Development Institute (NFRDI), and the Bureau of Fisheries and Aquatic Resources (BFAR).

### Cheaper ingredients

Dr. Mamauag used cheaper and locally available protein ingredients such as distiller’s dried grain soluble, poultry by-product meal, and protein enhanced copra meal as a substitute to the usual fishmeal, which is an expensive, imported, and unsustainable fish-based ingredient.

“SEAFDEC/AQD’s goal is to lessen our dependence on fishmeal as a protein ingredient in feeds since it is expensive and unsustainable to harvest fish from the oceans to feed the fish in the farms,” said Dan Baliao, chief of SEAFDEC/AQD.

With the move to veer away from fishmeal dependence, the field trials showed that the new formulation was more efficient than the commercial diet. It had a lower feed conversion ratio, that is, less feeds were needed to produce a volume of tilapia.

The tilapia that we fed with our diet gained about 730 percent of its own weight after 90 days, while the tilapia fed with a commercial diet only gained about 680 percent,” said Dr. Mamauag.

### Costs can still go down

“The cost of the feeds that we developed will still go down if produced on a commercial scale. That is why we are doing these field trials to check the effectiveness of the feeds before giving the formulation to private feed manufacturers for adoption,” added Dr. Mamauag.



Pond aides of SEAFDEC/AQD harvest tilapia produced from a project on the field testing of cost-effective aquaculture feed



Tilapia, weighing an average of 270 grams apiece, harvested from a project on the field testing of cost-effective aquaculture feeds at the Dumangas Brackishwater Station

# MESSAGE OF THE CHIEF



The first quarter of 2020 was busy as usual. Our researchers were working on over 46 research projects approved for the year, while trainings, workshops, lectures, meetings, and seminars were organized and done to the benefit of our stakeholders.

In late March, the government imposed lockdowns and quarantine measures due to the COVID-19 pandemic. Then, we became busy “unusual” as we had to rework and reprogram our strategies and programs to adapt to a new normal.

Thankfully, our information channels were quarantine-proof. Our training program was reconceptualized and the development of new online training courses were fast-tracked and offered in new interactive platforms. The primary recipients of our new online training courses were the personnel of the National Fisheries Research and

Development Institute (NFRDI) and the Bureau of Fisheries and Aquatic Resources (BFAR) whom we expect to pass on their knowledge and skills to the grassroots.

Production of new information materials was also intensified and dissemination was facilitated through social media and the SEAFDEC/AQD Institutional Repository. The demand for our information materials by remote learners was demonstrated by the remarkable 900% increase in unique visitors this year to our repository which served 773,000 stakeholders.

As our way of helping alleviate the disruptions in the local aquaculture value chain, we made sure our hatcheries ramped up the production and delivery of seeds to nearby provinces wherever logistics was workable. Fish farmers who visited our station asking for technical assistance were also gladly accommodated. Still as part of our desire to prop up the local aquaculture industry, new broodstock and hatchery facilities are currently under construction at our Tigbauan Main Station, with a projected completion in the first quarter of 2021

Also despite the disruptions, our ongoing collaborative projects with the NFRDI and BFAR bore much fruit this year. Foremost among these, the field-testing of our cost-efficient feeds both at our

Dumangas Brackishwater Station and in BFAR’s facility in Muñoz, Nueva Ecija returned very encouraging results. Tilapia feeds we formulated performed better in terms of fish growth, and were more affordable than commercial pellets. Similar results gained from earlier field-tests for milkfish in Guimaras, Eastern Samar, and La Union boost our confidence that our formulation will be ready for commercial adoption very soon.

While there is still no clear end in sight to the COVID-19 pandemic, our stakeholders can count on SEAFDEC/AQD that we are not waiting for this disruption to pass. There will always be disruptions, and as a research and development organization, we are committed to lead in the face of unknowns and in the midst of uncertainties. Our partners may rest assured that we continue to work tirelessly to fulfill our mandates of undertaking research, developing human resources, and disseminating and exchanging information in aquaculture.

**Dan D. Baliao**

Chief, SEAFDEC/AQD

# CONTENTS

Message of the Chief	1	REGIONAL PROGRAMS	
Research & Development Programs in 2020	3	Fish Health & Sustainable Aquaculture	39
Priority Programs	7	Training & Information	47
DEPARTMENTAL PROGRAMS		Production & Services	55
Quality Seed for Sustainable Aquaculture	13	Human Resources & Finance	61
Healthy & Wholesome Aquaculture	21	Collaboration in 2020	71
Maintaining Environmental Integrity	29	Heads of Offices	72
Meeting Social & Economic Challenges	35		
Adapting to Climate Change	37		

## SEAFDEC/AQD HIGHLIGHTS 2020

ISSN 1655-5228

Published and printed by:  
Southeast Asian Fisheries Development Center  
Aquaculture Department  
Tigbauan, Iloilo, Philippines



Copyright © 2021 Southeast Asian Fisheries Development Center, Aquaculture Department

Some rights reserved. This work is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc-sa/3.0/igo/>.



This license requires that reusers of the material give credit to the licensor, the Aquaculture Department of the Southeast Asian Fisheries Development Center. Reusers may distribute, remix, adapt, and build upon the material in any medium or format, for noncommercial purposes only and not in any way that suggests the licensor endorses the reuser. If others modify or adapt the material, they must license the modified material under identical terms.

### ACKNOWLEDGMENTS

Contributors: Program leaders, study leaders, section heads, office and laboratory staff

Technical review: LD de la Peña, EC Amar, JP Altamirano, JJD Huervana, REP Mamauag, ND Salayo, EA Tendencia, program leaders, study leaders

Editing and layout: RD Dianala

# 2020 RESEARCH & DEVELOPMENT PROGRAMS

## PRIORITY PROGRAMS OF SEAFDEC/AQD

Project Title
<b>Fry Sufficiency Program</b>
<b>Development of Cost Efficient Feeds</b>
<b><i>Oplan Balik Sugpo</i> (Operation Black Tiger Shrimp Revival)</b>
<b>Joint Mission For Accelerated Nationwide Technology Transfer Program (JMANTTP II)</b>
<b>Manpower Development</b>

## THEMATIC PROGRAMS

Study Title	Main Proponent	Collaborating Partners
<b>Quality Seed for Sustainable Aquaculture</b>		
1	Development of technique for sustainable mass production of harpacticoid copepods for marine and crustacean larviculture	MAE Mandario
2	Use of biofloc system to improve water quality, growth performance and disease resistance of <i>Penaeus monodon</i> and <i>Penaeus indicus</i> juveniles reared in tanks	EGE Superio
3	Optimization of electrolytic flocculator for paste production of important locally available microalgae in aquaculture	AV Franco
4	Use of algal paste in the larval rearing of mangrove crab <i>Scylla serrata</i>	JJDC Huervana

Study Title		Main Proponent	Collaborating Partners
5	Utilization of artificial illumination in floating net cages on the nursery culture of pompano <i>Trachinotus blochii</i> : effects on growth and survival of pompano and its added economic value	MIC Legaspi (JLQ Laranja)	
6	Verification studies on breeding and seed production of giant and hybrid groupers ( <i>Epinephelus</i> spp.)	PA Palma	
7	Optimizing the survival of micropagated seaweed <i>Kappaphycus alvarezii</i> through acclimation in tank-based nursery systems	HS Pitogo	
8	Economic viability of tank-based polychaete culture technology	MAE Mandario	
9	Development of a modified continuous culture system for the mass production of <i>Nanochlorum</i> sp. and <i>Brachionus rotundiformis</i>	MR de la Pena	
10	Optimizing hatchery production of early juveniles sandfish <i>Holothuria scabra</i>	JP Altamirano	
11	Verification of the effectiveness of SEAFDEC/AQD broodstock diets in improving reproductive performance in the tropical abalone, <i>Haliotis asinina</i>	JB Biñas	
12	Sea-based nursery cage production of farmed eucheumatoids	JP Faisan Jr.	
13	Production of farmed eucheumatoids by micropropagation in the land-based nursery	HS Pitogo	
14	Seed production of mangrove crab ( <i>Scylla serrata</i> ) with refinements on the feeding frequency	JJDC Huervana	
15	Seed production of donkey's ear abalone, <i>Haliotis asinina</i> juveniles	RM Piloton (DD Catedral) (NC Bayona)	
<b>Healthy and Wholesome Aquaculture</b>			
16	Production techniques for culture of silver therapon ( <i>Leiopotherapon plumbeus</i> ) in tanks and cages	FA Aya	
17	Evaluation of DSM formulated feeds with phytase and carbohydrases	RE Mamauag	
18	Grow-out culture of abalone comparing the use of <i>Gracilariopsis heteroclada</i> and SEAFDEC formulated diet as feeds	MJHL Ramos	
19	Test of refined formulated feed for the grow-out culture of mangrove crab, <i>Scylla serrata</i> (Forsskal) in land based tanks	MB Teruel	
20	Spray dried hemoglobin powder meal as an alternative protein source in <i>Trachinotus blochii</i> , pompano diets	RE Mamauag	
21	Nutritional interventions to improve reproductive performance of Indian white prawn, <i>Penaeus indicus</i> (H. Milde Edwards, 1837) (Dissertation)	SS Avanceña	DOST / UPV
22	Field testing of low cost aquaculture feed for milkfish and tilapia in ponds and cages	RE Mamauag	NFRDI

Study Title		Main Proponent	Collaborating Partners
23	Evaluation of unfermented, fermented and live green macroalgae <i>Chaetomorpha</i> sp. as food source for farmed <i>Penaeus monodon</i> and low-trophic level finfish	JB Biñas	
24	Quantitative amino acid requirements of pompano, <i>Trachinotus blochii</i> : Requirements for leucine, isoleucine and histidine	RE Mamauag (RMA Cabrera)	
25	Detection, control and treatment of persistent and emerging pathogens affecting pond cultured Asian catfish ( <i>Clarias macrocephalus</i> )	RV Pakingking Jr.	
26	Detection, quantification, and viability of Tilapia Lake Virus (TiLV) in pond soil and water as influenced by water quality parameters and culture management	DJC Logronio	
27	Efficacy of different therapeutants against <i>Caligus</i> sp. infestation in tropical fish under laboratory conditions	GE Pagador	
28	Safeguarding the future of the seaweed industry of the Philippines: Disease and pest detection (WP1)	J Faisan/ Juliet Brodie (I) J Faisan/ MRJ Luhan (II) AQ Hurtado/ MRJ Luhan/ J Faisan (III)	UKRI (previously RCUK) GCRF GlobalSeaweedSTAR
29	Field verification of the vaccination regimen in cage-cultured marine fish species (pompano, snapper, grouper) broodfish in Igang Marine Station as a practical strategy to prevent the vertical transmission of nervous necrosis virus during seed production	RV Pakingking Jr.	
30	Demonstration of grow out techniques of commercially-viable shrimp species ( <i>P. monodon</i> , <i>P. vannamei</i> , <i>P. indicus</i> ) using SEAFDEC/AQD formulated diet and commercial feed.	RE Mamauag	
31	Hatchery production and semi-intensive pond culture of <i>Penaeus indicus</i>	EGE Superio (SS Avanceña)	
<b>Maintaining Environmental Integrity Through Responsible Aquaculture</b>			
32	Strategic feeding of milkfish ( <i>Chanos chanos</i> ) for efficient marine cage culture production	PA Palma	
33	Increasing technical skills supporting community-based sea cucumber production in Vietnam and the Philippines	JP Altamirano	ACIAR
34	Development of optimal fish-prawn co-culture schemes in tanks and lake-based cages for increased farm production: I. Use of genetically improved seedstock II. Evaluation of sustainable lake based tilapia-freshwater prawn farming innovations	MRR Eguia	
35	Grow-out culture of abalone in pipes	MJHL Ramos	
36	Polychaete culture in raceway ponds	VR Alava	
<b>Meeting Social and Economic Challenges in Aquaculture</b>			
37	Assessment and development of community-based sea cucumber ( <i>Holothuria scabra</i> ) farming livelihood for fishing communities	RJG Castel	ACIAR

Study Title	Main Proponent	Collaborating Partners	
<b>Attaining Sustainable Aquaculture through Cost-Effective Culture Systems and Prompt and Effective Aquatic Animal Health Management</b>			
38	Surveillance and epidemiology of EHP ( <i>Enterocytozoon hepatopenaei</i> ) in Philippines	GE Pagador	GOJ-TF
39	Application of integrated approaches in the management of viral and other emerging diseases in brackishwater ponds	EC Amar	GOJ-TF
40	Generation and application of optimized procedures in disease control and management against emerging shrimp and fish diseases in Southeast Asia	LD de la Peña	GOJ-TF
41	Ecosystem approach to a responsible/sustainable farming for small scale farmers that are into extensive mono or polyculture of shrimp	EA Tendencia	GOJ-TF
42	<i>In vitro</i> and on farm investigation of organisms, chemicals, and methods to prevent or mitigate the effect of important shrimp diseases	EA Tendencia	GOJ-TF
43	Promoting alternative feeds for sustainable production of freshwater aquaculture species	FA Aya	GOJ-TF
44	Developing community-based sustainable aquaculture livelihood strategies in Laguna lake	ND Salayo	GOJ-TF

## SPECIAL PROJECTS

45	Joint Mission for Accelerated Nationwide Technology Transfer Program for Aquaculture (JMANTTP-II) (Hatchery and grow-out technology for selected finfish, crustacean, mollusc and seaweeds)	DD Baliao	BFAR
46	Demonstration and verification of sustainable and efficient aquaculture techniques by combination of multiple organisms	R Nambu (ND Salayo) (M Kodama)	JIRCAS

### Abbreviations used

ACIAR	Australian Centre for International Agricultural Research
BFAR	Bureau of Fisheries and Aquatic Resources
DOST	Department of Science and Technology
GCRF	Global Challenge Research Fund
GOJ-TF	Government of Japan - Trust Fund
JIRCAS	Japan International Research Center for Agricultural Sciences
NFRDI	National Fisheries Research and Development Institute
UKRI	UK Research and Innovation
UPV	University of the Philippines Visayas



# SEAFDEC/AQD PRIORITY PROGRAMS

To support the priorities of the Department's host government, SEAFDEC/AQD pursued thrusts that are implemented in collaboration with Philippine government agencies.

Fry Sufficiency Program

Development of Cost Effective Feeds

Oplan Balik Sugpo

Joint Mission for Accelerated Nationwide  
Technology Transfer II

Manpower Development



# Thrust 1 Fry Sufficiency Program

The Philippines has been highly reliant on milkfish fry imports to meet the large annual fry requirements of about 2.5 billion fry. The flagship program of the current SEAFDEC/AQD administration aims to address the reliance on imports by improving the quantity of milkfish fry produced locally to meet the country's demand.

In accordance with a 2018 Memorandum of Agreement (MOA) between the Philippine Bureau of Fisheries and Aquatic Resources (BFAR) and SEAFDEC/AQD, proposed areas of multi-species hatcheries legislated during the 16<sup>th</sup> and 17<sup>th</sup> Philippine Congress were evaluated. SEAFDEC/AQD's role in the program is to provide technical assistance by performing suitability surveys of the proposed sites; conduct field trials of low-cost feeds; establish a feed mill in the site; and conduct trainings for manpower development.

Once constructed, the hatcheries will serve as central and satellite milkfish hatcheries providing for the seed requirements of grow-out facilities in their respective regions. Each marine hatchery is capable of producing 25 million milkfish fry annually. Even though the facilities are designed for milkfish, they are also capable of accommodating other species.

Aside from production, the hatchery facilities will also serve as training and demonstration facilities for private groups that plan on putting up hatcheries. The facilities may also accommodate students for internship and on-the-job training. Resident technicians may provide hands-on trainings on various aspects of hatchery operations.



Construction of new milkfish broodstock tanks at the Tigbauan Main Station as of December 2020. Four new units of 500-ton broodstock tanks will host at least 320 new milkfish breeders to beef up SEAFDEC/AQD's capacity to produce eggs and larvae.

## Feasibility study of legislated multi-species hatcheries

In 2020, continued preparation of feasibility studies was done on legislated areas with feasible sites presented. Unfortunately, continued site assessments for places with no feasible sites provided were largely hampered due to travel restrictions and COVID-19 lockdowns. Site selection surveys and construction site visits were halted. SEAFDEC/AQD continued work on the feasibility studies for two sites located in the municipality of Surigao City in Surigao del Norte (RA 10825) and the municipality of Hinatuan in Surigao del Sur (RA 10944).

As of December 2020, SEAFDEC/AQD has already completed six (6) feasibility studies and submitted them to their respective BFAR regional offices and local

government units (LGUs). One site, the one in Lingig, Surigao del Sur (RA 10787), has already started construction and is 46% away from completion. Meanwhile, the site in Del Carmen, Surigao del Norte (RA 10825) is waiting for its Environmental Compliance Certificate (ECC) before construction can begin. The construction in Jabonga, Agusan del Norte (RA 10813), the only multi-species freshwater hatchery proposed, has been paused as the contractor was asking for additional budget to solve the embankment issues within the site. However, the BFAR regional office and the LGU have yet to release the supplementary funding.

Site evaluations and engineering layout preparations for the remaining legislated areas with no suitable sites presented will be temporarily put on hold until COVID-19 restrictions allow. Meanwhile, the feasibility studies for Surigao City,

Surigao del Norte, and Hinatuan, Surigao del Sur are expected to be finished by the early part of 2021.

Bidding for the multi-species marine hatcheries in Perez, Quezon (RA 10945) and Sultan Naga Dimaporo, Lanao del Norte (RA 10860) under the supervision of their respective LGUs shall commence. If successful, construction of the said facilities may also start in 2021.

The construction of the multi-species marine hatchery in Lingig, Surigao del Sur will be finished in 2021 and the hatchery in Del Carmen, Surigao del Norte is also expected to start its construc-

tion around the first half of 2021 once it secures its ECC. After necessary evaluations and other requirements for the eventual operation are finished, the first run of the hatchery may already begin.

### **Profiling of operating/abandoned/non-operating hatcheries**

Staff from SEAFDEC/AQD conducted the profiling of abandoned, operating, or non-operating hatcheries in the first district of Iloilo. Nine hatcheries in the first district of Iloilo are operating and are culturing tilapia, *Litopenaeus vanna-*

*mei*, *Penaeus monodon*, milkfish, and seabass. On the other hand, twelve hatcheries were listed as abandoned or non-operating due to sickness or death of owner, bankruptcy, or lack of finances to continue operation. Most abandoned hatcheries cultured *Penaeus monodon* when there was a high demand for the commodity.

To date, there is an ongoing rehabilitation and construction of multi-species hatcheries in Northern Iloilo Polytechnic State College (NIPSC), Concepcion, Iloilo and Batan, Aklan. The profiling of hatcheries was done to serve as baseline information with regards

## **Turning up the heat to meet the milkfish fry shortage**

DESPITE being widely regarded as the unofficial national fish of the Philippines, about half of the milkfish on Filipino tables are born in hatcheries in Indonesia and Taiwan. This is the result of a perennial shortage of fry that are seeded into fishponds, net cages and pens where they continue to grow to marketable sizes.

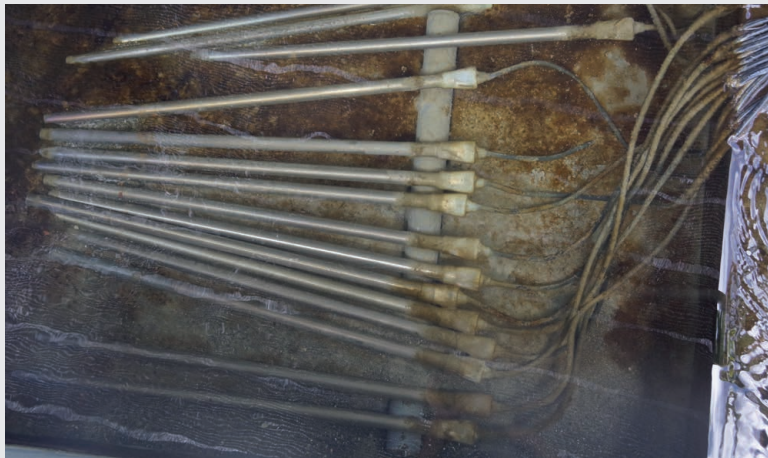
SEAFDEC/AQD, alongside the Philippine Department of Agriculture – Bureau of Fisheries and Aquatic Resources (DA- BFAR), has been finding ways to lift the country into milkfish fry sufficiency. Data from the SEAFDEC/AQD hatchery in previous years show that the breeders only spawned between March and October when the weather, and consequently the water, is warmer.

From November to February, the hatchery was essentially unproductive due to lower water temperature.

To improve the annual production of the hatchery, SEAFDEC/AQD raised the temperature in the water system of a breeding tank to at least 29 °C while in another breeding tank, water was left unheated at a colder temperature of 26 °C.

From December 2019 to February 2020, during otherwise zero-production-months, a total of 23 million good eggs were collected from the heated tank that contained 76 breeders. From these, almost 13 million normal larvae were hatched, whereas in the case of the unheated tank, no spawning occurred.

In anticipation of expanded production, SEAFDEC/AQD's milkfish hatchery is currently being expanded to accommodate more tanks for breeders and fry.



Fifteen 3-kW water heaters were installed in SEAFDEC/AQD's milkfish broodstock tank water system to encourage spawning even during normally off-season months.

to the rehabilitation of non-operational hatcheries in the area.

The profiled operating, abandoned, or non-operating hatcheries will be assessed based on the stability of the tanks, the accessibility of the area, ownership rights, etc. Some of these abandoned or non-operating hatcheries will be repaired and improved to be among the legislated hatcheries in their respective areas. The repair and improvement or rehabilitation of these hatcheries is under the collaboration of SEAFDEC/AQD, BFAR, and the private sector.



The hatchery at the Northern Iloilo Polytechnic State College (NIPSC) in Concepcion, Iloilo that is being subject to rehabilitation in coordination with BFAR.

## ***Thrust 2*** Development of Cost-Efficient Feeds

Alternative sources of protein have been sought to replace fish meal in aquaculture feeds. The use of fishmeal in feeds has been regarded as an unsustainable practice, and finding suitable substitutes is seen to lessen aquaculture's impact on the environment and reduce costs, especially if alternative ingredients are locally available. Numerous studies have been undertaken to examine the effects of fish meal replacement by another source of protein such as animal byproducts or plant-based protein.

In collaboration with the Philippine National Fisheries Research and Development Institute (NFRDI), SEAFDEC/AQD aims to identify and utilize cost-effective feed ingredients which can be used as an alternative to fish meal.

Distiller's dried grains with solubles (byproducts of ethanol production), poultry by-product



Launching of the Field Testing of Cost-Effective Aquaculture Feed for Tilapia in Brackishwater Ponds on 4 Sep. 2020 at SEAFDEC/AQD's Dumangas Brackishwater Station

meal, and protein enhanced copra meal were used to substitute for fishmeal to come up with a SEAFDEC/AQD-formulated diet that costs only about PHP 28/kg to produce, compared to commercial feed that are about PHP 34/kg to PHP 36/kg (see highlight story on inside front cover).

Field trials for tilapia culture in ponds were done at the Dumangas

Brackishwater Station for a culture period of 90 days at a stocking density of 2 ind/m<sup>2</sup>. Tilapia fed the SEAFDEC/AQD diet achieved a 726.45% weight gain, while those fed a commercial diet gained 676.81%. As for feed conversion ratio (FCR), the SEAFDEC/AQD diet gained a more favorable 1.09 FCR while the commercial diet yielded 1.21 FCR. Parallel field testing in

Muñoz, Nueva Ecija yielded similar results. Other field tests were also done at SEAFDEC/AQD's Igang Marine Station in Guimaras; Guiuan Marine Fisheries Development Center – BFAR 8, Guiuan, Eastern Samar; and BFAR 1 Regional Mariculture Technology Demonstration Center, Sto. Rosario, La Union for milkfish reared in sea cages.

## **Thrust 3 Oplan Balik Sugpo**

Production of tiger shrimp (*Penaeus monodon*) suffered a drastic decline back in the late 1990s. The Oplan Balik Sugpo program, launched in 2017, aims to revive the tiger shrimp production in the Philippines and provide farmers with good quality fry for grow-out culture.

To support this program, the shrimp hatchery complex was equipped with its own spawner/broodstock facility for pathogen detection of newly-arrived spawners. The shrimp hatchery often utilizes spawners from the wild wherein they are being processed and analyzed before and after spawning to determine the presence of pathogens. After spawning, when tests result positive, nauplii are chlorinated and discarded. Nauplii that are negative of the disease are stocked in modules containing tanks for larval rearing until they reach the postlarvae stage where they are being harvested. The hatchery is equipped with several larval rearing tanks divided into two modules to allow resting of the other module after stocking. It also has several filtration systems to ensure good water quality for the stocks. Seawater from the source will first pass through the sand



Postlarvae being inspected prior to harvest at the SEAFDEC/AQD tiger shrimp hatchery

filter before it reaches the reservoir. From the reservoir, it will pass through the rapid sand filter, then through the UV sterilizer before it will reach the larval rearing tank with the filter bag. Fry harvesting is done when they reach the PL 20 stage.

The shrimp hatchery produced disease-free fry that were stocked in brackishwater ponds at the Dumangas Brackishwater Station (DBS) in May 2020. The newly installed shower room and waiting

area inside the shrimp hatchery is a part of the strict implementation of biosecurity inside the hatchery premises. Around 2.2 million disease-free shrimp post-larvae were harvested in 2020.

The hatchery is seen to continue its production of disease-free fry with the strict biosecurity protocols and acquisition of SPF spawners.

## Thrust 4

### JMANTTP II: Joint Mission for Accelerated Nationwide Technology Transfer Program

To realize the vision of SEAFDEC/AQD, the JMANTTP II program was designed to intensify the techno-transfer of mature aquaculture technologies to stakeholders in collaboration with the Bureau of Fisheries and Aquatic Resources (BFAR).

Despite the COVID-19 pandemic which necessitated travel restrictions, SEAFDEC/AQD conducted an on-site training course on freshwater aquaculture in Zarraga, Iloilo from 1 to 3 July 2020. About 50 fishpond owners, farmers, and operators from different municipalities in Iloilo participated in the training course. The 3-day training involved a series of lectures on freshwater commodities (e.g., catfish, giant freshwater prawn, and tilapia) and other special topics and simulation activities. Proper health protocols (e.g., physical distancing, use of face masks) were strictly ob-



Demonstration on the procedure for catfish induced spawning during the On-site Training Course on Freshwater Aquaculture held in Zarraga, Iloilo Province

served during the training.

Extension work and technology transfer of aquaculture technologies developed at SEAFDEC/AQD shall continue in 2021. Potential

areas that require such seminars, hands-on workshops, trainings will be identified by BFAR.

## Thrust 5 Manpower Development

This program is geared towards building a critical pool of expertise in aquaculture through the intensive training of fisheries graduates in seed production as well as grow-out using different culture systems. Graduates of the rigorous and in-depth training are meant to be deployed to projects of SEAFDEC/AQD or be recommended to various government or non-government offices and the private business sector.

Sixteen graduates from different fisheries schools in Western Visayas were trained during the Training Course on Manpower

Development for Shrimp, Marine Fish, and Tilapia Aquaculture to enhance their capabilities and broaden their perspectives and experiences in terms of aquaculture. They were trained on shrimp and multi-species marine fish hatchery operations, and cage and brackish-water pond culture operations.

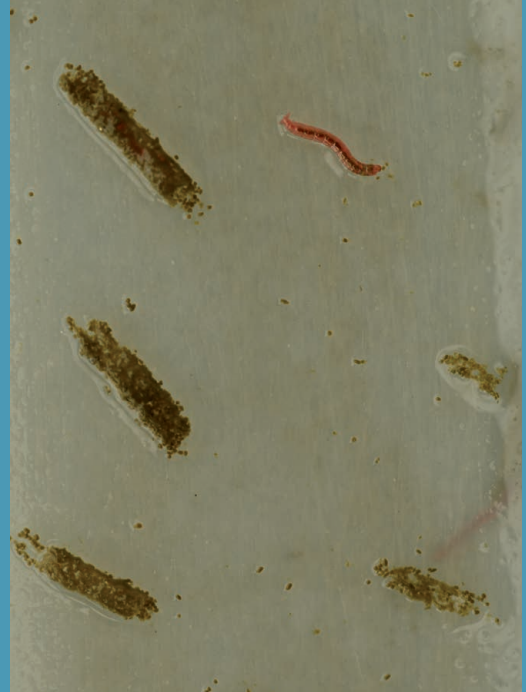
After three months of training, they were employed by SEAFDEC/AQD and assigned to different areas and hatcheries at the Tigbauan Main Station such as the Marine Fish Hatchery, Shrimp Hatchery, Mangrove Crab Hatchery, Integrat-

ed Fish Broodstock and Hatchery Complex, Freshwater Hatchery, and Training and Information Division.

Since the construction of some legislated hatcheries is still ongoing, there is a plan to conduct another training course to produce another batch of trainees. This time, fisheries graduates from different fisheries schools, mostly in the Mindanao area, are the target individuals to be trained and to be deployed to the legislated hatcheries near their area once they are completed.

# QUALITY SEED FOR SUSTAINABLE AQUACULTURE

A sustainable supply of good quality seedstock is key to a successful aquaculture enterprise. Quality seeds require efficient husbandry techniques and suitable farm conditions. With the intensification of aquaculture and environmental challenges from climate change, genetic quality and culture management are equally important in ensuring a steady production.



## Grouper

This year's efforts to improve grouper aquaculture through breeding and seed production of giant and hybrid groupers are now in the verification stage. This study focuses on inducing early gonadal development in captive groupers through an alternative mode of hormone administration. Hormones used for inducing breeders to spawn are typically injected. In this study, recombinant gonadotropin-releasing hormone (GnRH) in yeast was incorporated in artificial diets and fed to juvenile groupers. Results showed that through this mode, gonad development was effectively advanced, and protocols for the preservation of grouper spermatozoa were developed. Fertilization trials and rearing of resulting larvae to verify larval quality are yet to be conducted.

The study also aims to hybridize the preserved sperm of giant grouper (*Epinephelus lanceolatus*) with the ova of tiger grouper (*Epinephelus fuscoguttatus*) to produce fast-growing hybrids. Due to the travel restrictions caused by the COVID-19 pandemic, access to the giant grouper breeders based in SEAFDEC/AQD's Igang Marine Station in Guimaras became limited. The project will resume performing experiments to achieve all the objectives upon access to additional broodstock.

## Abalone

A study was conducted to verify the effectiveness of two SEAFDEC/AQD-developed broodstock diets in improving the reproductive performance of tropical abalone (*Haliotis asinina*). Diet 1 (37% protein; 3,381 kcal/kg energy) and Diet 2 (42% protein; 3,542 kcal/kg energy) were compared against a control diet of seaweeds (18% protein; 2,146 kcal/kg energy).

**Table 1.** Abalone fertilization, hatching, and settlement rates (10, 20, and 30 days post-stocking) of eggs and larvae produced by breeders fed seaweed and two formulated diets.

Treatment	Fertilization Rate (%)	Hatching Rate (%)	Settlement Rate (%)		
			10 days	20 days	30 days
Control, Seaweed	81.6±1.1 <sup>b</sup>	39.6±17.6 <sup>a</sup>	2.3±0.20	1.3±0.0 <sup>a</sup>	1.2±0.89
Diet 1	74.2±3.0 <sup>a</sup>	67.5±9.4 <sup>ab</sup>	1.7±0.45	1.7±0.44 <sup>ab</sup>	1.8±0.22
Diet 2	7.2±3.2 <sup>a</sup>	71.1±10.8 <sup>b</sup>	2.5±0.76	2.6±1.0 <sup>b</sup>	2.5±0.8

**Table 2.** Abalone hatchery production in 2020

Larvae	Juvenile Production	Survival Rate
2,022,000	67,500	3.36%

Results showed that regardless of the feeding treatment, all abalone breeders followed a 30-day spawning cycle. The spawning frequency was higher in abalone fed formulated diets but other reproductive parameters such as spawning rate, days to first spawning, and instantaneous fecundity showed no difference between the formulated diets (treatment) and seaweed (control) groups.

Eggs produced by seaweed-fed breeders had a significantly higher fertilization rate, but the hatching rate was lower than those from breeders fed the formulated diets. Settlement rates 10, 20, and 30 days post-stocking were consistently higher in larvae from Diet 2 breeders, although, except for day 20, the values are not significantly different. Settlement rates of larvae from abalone fed formulated diets were consistent throughout the 30-day monitoring period compared to the declining trend shown by larvae from the seaweed-fed breeders (Table 1).

SEAFDEC/AQD is also conducting a study on the production of abalone juveniles. This study is mainly to showcase the production technology developed by the Department and support other ab-

alone research conducted in-station. In this year's production, the abalone survival rate ranged from 3% to 4% per cropping, as seen in Table 2. A feeding experiment was also conducted aiming to improve the production. Results show that growth of the abalone juveniles fed seaweeds still gave a higher specific growth rate (4.2%) than the juveniles fed the prawn diet (2.8%) and the abalone diet (2.6%).

## Mudworm

Polychaetes are used as natural food either in pure form or in combination with other marine organisms and artificial diets to improve the reproductive performance of crustacean broodstock. The mudworm species being studied at SEAFDEC/AQD is *Marphysa iloiloensis*, named after Iloilo Province in the Philippines, the location of SEAFDEC/AQD's Dumangas Brackishwater Station where the worms were collected before being identified as a new species.

*M. iloiloensis* are being cultured in indoor tanks following a closed-culture system since 2016 to prevent pathogen contamination. Seawater supplied in all culture tanks passes through a series of cartridge filters and a UV steril-



izer. Sediments are disinfected using chlorine and screened for the presence of pathogens before use. Polychaetes were also sampled and screened for shrimp and fish pathogens.

A stocking density experiment was conducted in 2020. Results showed a stocking density of either 500 or 1,000 individuals/m<sup>2</sup> showed the highest polychaete survival (40-48%) with a bodyweight of 0.22 g after five months. Better

survival was also observed when polychaetes were fed at 100 g/m<sup>2</sup> using feeds administered twice or thrice a week. An experiment using the best stocking density, feeding rate, and feeding frequency is ongoing.

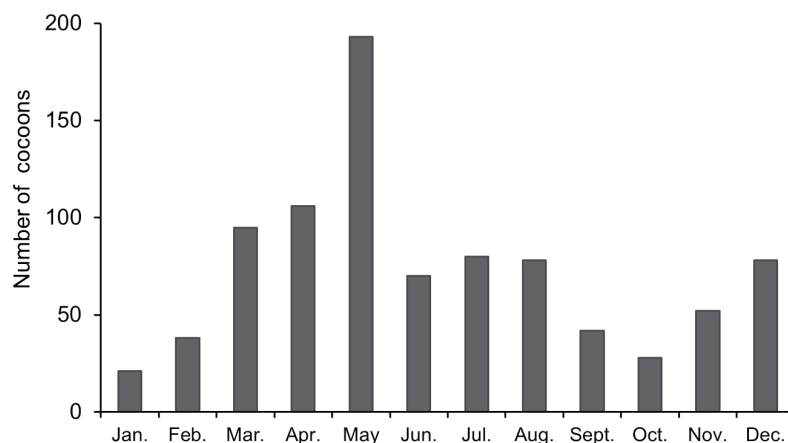
Polychaetes spawned in broodstock tanks every week of each month to produce a total of 881 jelly cocoons (Figure 1). The number of cocoons doubled from 421 (in 2019) to 881 (in 2020). Cocoons

containing fertilized eggs were stocked in the nursery tanks and reared for 15 or 30 days. Thereafter, they are transferred to grow-out sediment tanks until they reach the adult stage. A total of 4.0 kg polychaetes were harvested from a culture area of 18 m<sup>2</sup>. The harvested polychaetes were used as broodstock in the Polychaete Hatchery, and the rest were supplied to other SEAFDEC/AQD researchers. Polychaete production data in 2020 is shown in Table 3.

Polychaete production will continue in 2021, and the cost-and-return analysis of tank-based polychaete culture technology will be investigated. In addition, polychaete jelly cocoons will be collected from the wild and grown in tanks to replace the old breeders. It is important to note that the last collection of jelly cocoons from the wild was in 2016-2017, and spawning has been taking place since then. Thus, it is necessary to replace the old breeders to avoid a deterioration in the performance of the polychaetes used in mass production.



Growth of abalone juveniles fed seaweed still gave a higher specific growth rate than the juveniles fed the prawn diet (2.8%) and the abalone diet (2.6%).



**Figure 1.** Jelly cocoons produced in the Polychaete Hatchery in 2020

**Table 3.** Polychaete production in 2020.

Hatchery	
No. of breeder tanks	6
No. of breeders/tank (1 m <sup>2</sup> )	300–500
Total no. of jelly cocoons	881
No. of fertilized eggs/cocoon	1,500–10,000
Grow-out	
Culture area (m <sup>2</sup> )	18
Survival rate, % (1-day old to adult)	3-5
Body weight (g)	0.20–0.30
Biomass (g/m <sup>2</sup> )	222
Total production (kg)	4.0

## Black tiger and Indian white shrimp

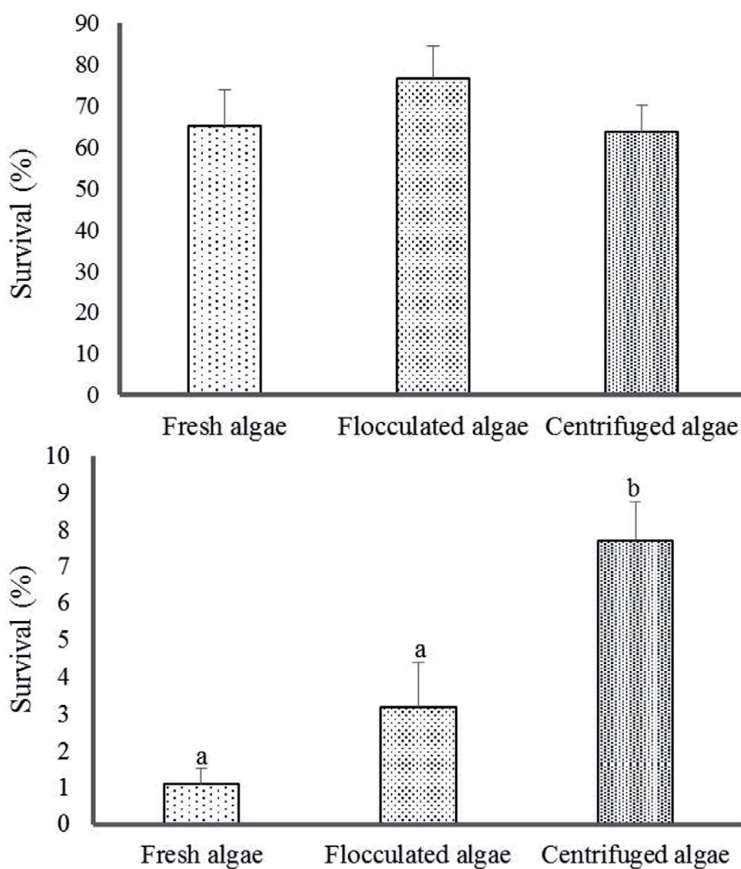
Biofloc-based aquaculture systems have grown because it is bio-secure with zero-water exchange, which means that water quality is improved within the system. This system is also cost-efficient and enhances growth, and boosts the immune system of species being cultured. With this, a SEAFDEC/AQD study was conducted to determine if the adoption of the biofloc system can help improve the quality of the water where shrimp juveniles are reared. This year, an experiment evaluated the effect of biofloc systems using two different carbon sources against clear water culture on the growth and survival of shrimps (*Penaeus monodon* and *Penaeus indicus*). Initial results in Table 4 showed that the growth of *P. indicus* juveniles was better when provided with molasses as carbon sources compared to wheat flour and the control (no carbon source) after 45 days of culture.

## Mangrove crab

Natural food such as green microalgae and rotifers are among the most critical components in the larval rearing of mangrove crab. Maintaining its supply is one of the bottlenecks in the hatchery operation due to many factors such as weather conditions and contamination. Hence, a study using algal paste as an alternative feed for rotifers were conducted in the larval rearing of mangrove crab *Scylla serrata*. This year, crab larvae's performance given rotifers fed with three forms of algae, e.g., fresh or live, flocculated, and centrifuged algal paste, was carried by SEAFDEC/AQD. Figure 2 showed no significant difference in the survival rate of man-

**Table 4.** Mean growth parameters of *Penaeus indicus* in a BFT system.

Growth parameters	Molasses	Wheat Flour	Control
Initial weight (g/shrimp)	0.9	0.9	0.9
Stocking density (pcs/m <sup>3</sup> )	180	180	180
ABW (g/shrimp)	3.01	2.68	2.6
SGR (%/day)	8.62	7.79	7.58
Weight gain (%)	234.44	197.78	188.89



**Figure 2.** Survival (%) (mean  $\pm$  SE) of mangrove crab larvae fed with rotifers given *Tetraselmis* in fresh, flocculated and centrifuged forms until day 4 (A) and from zoea 1 to crab instar (B). Bars with different superscript letters are significantly different ( $P < 0.05$ ).

grove crab larvae at DOC 4 when the three algal forms were compared. However, after DOC 24 (crab instar stage), a significantly high survival rate was observed in centrifuged paste (7.73%) compared to flocculated paste (3.21%) and fresh algae (1.08%). Meanwhile, when

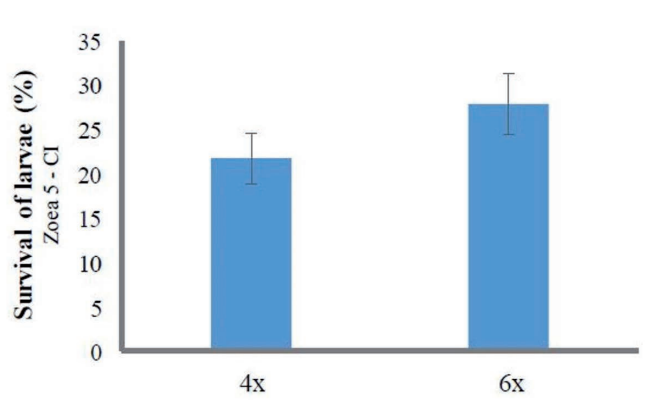
based on growth, results show no significant difference.

Interest in mangrove crab culture is increasing yearly, both locally and internationally. With this, SEAFDEC/AQD continued to develop and improve hatchery technologies to produce crablets. This

would allow the mangrove crab industry to be less dependent on wild-caught seeds or crablets. This year, feeding frequency was refined to improve seed production. Figure 3 showed that the survival rate of zoea 5 to crab instar was higher when fed six times (28%) compared when fed four times (22%). This year, SEAFDEC/AQD's crab hatchery continued to produce crablets to support research and verification studies as well as make good quality seedstocks available for interested stakeholders. Production of crablets increased from 656,200 pieces in 2019 to 817,000 in 2020 despite the COVID-19 pandemic hampering hatchery activities.

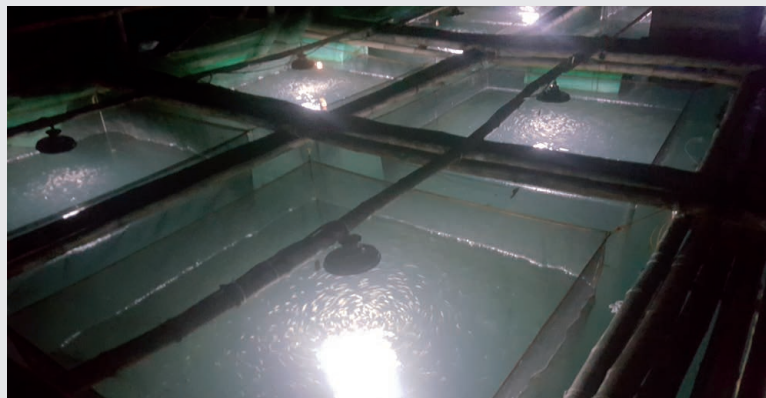
### Pompano

In marine fish, light or illumination was known to affect foraging which subsequently affect its growth and survival. In this study, illumination was used as one factor in the development of alternative and cost-efficient rearing techniques for the nursery culture of pompano (*Trachinotus blochii*) in sea cages. In 2020, results showed that the culture period for pompano in lighted cages and fed 100% of the feed ration was shortened by 15 days. The specific growth rates of pompano fed at 50% and 75% of the feed ration were not significantly different from those in unlit cages fed at 100% of the ration and with pompano in lighted cages and fed 100% of the ration. On the other hand, the feed conversion ratio was noted to be best in lighted cages where pompano was fed at 75% feeding rate. Good growth of pompano in lighted cages could be due to higher zooplankton (calanoid and cyclopoid copepods) ingestion. Figure 4 shows that pompano ingested more zooplanktons in treatments with illuminated cages



**Figure 3.** Mean survival rate (%) of mangrove crab larvae from Zoea 5 to crab instar (CI) at different feeding frequencies.

### Helping young pompano see at night makes them grow faster



POMPANO is a high-value fish grown in cages and in ponds. However, a few challenges, such as the high cost of production, still hamper the widespread farming of pompano.

SEAFDEC/AQD investigated the advantages of lighting up pompano cages at night during the nursery phase. The illumination is supposed to help the young pompano see their natural prey, mostly tiny crustaceans called copepods floating near the surface, allowing the fish to efficiently feed overnight; thus, improving growth and survival.

So far, better growth and higher survival of pompano fry were observed during a year-long experiment using artificial lighting as part of the nursery set-up at SEAFDEC/AQD's Igang Marine Station in Guimaras. The provision of artificial lighting at night in nursery cages significantly improved the growth of pompano.

In the series of experiments, pompano that received artificial light achieved higher body weight compared to pompano not provided with lighting. Results also revealed that pompano receiving 25 to 50 percent less artificial feed, but provided with artificial illumination, gained as much weight as fully fed pompano with no illumination.

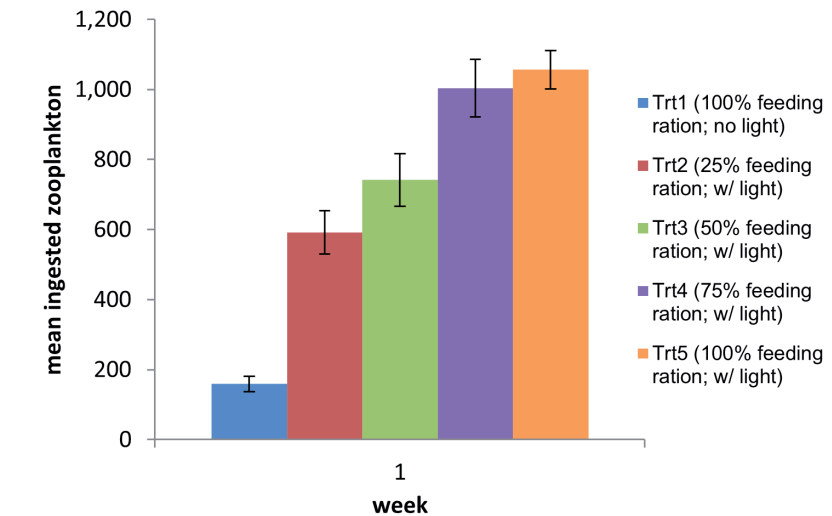
during the earlier weeks of nursery culture. This may conclude that live zooplankton was preferred by pompano in the earlier part of the nursery period.

## Sea cucumber

The SEAFDEC/AQD sea cucumber hatchery was constructed in 2010 with an optimal capacity of 5 million larvae for rearing. Its primary function is to produce early juveniles of sandfish *Holothuria scabra* to cater to various experimental studies of the Department that require sea cucumber seeds. Since 2018, a verification study has been conducted to optimize sea cucumber seed production, targeting a survival rate of at least 5% and a production volume of 20,000 juveniles per spawning batch. The study also seeks to determine factors that affect the unstable production of sandfish year-round.

In 2019 and 2020, the target survival of >5% was achieved by some spawning batches, particularly around April and August. Four batches achieved a production volume target of 20,000 per spawning batch, the highest of which was in June 2019 with 51,713 juveniles and in September 2020 with 45,779. However, many batches are producing juveniles below the target, which resulted in an annual average volume of 13,000 juveniles at a 1.25% average survival rate. The unstable production was attributed to environmental factors since the hatchery is dependent on natural weather conditions. In particular, production was affected by cold temperatures in Jan-Feb; unstable supply of natural larval food around April and Oct; and high precipitation and low salinity in Jul-Sep.

To improve production, an auto-heating system was installed in the hatchery facility to improve



**Figure 4.** Mean ingested zooplankton in five different treatments for 11 weeks of pompano nursery culture.

larval development. Faster larval development was noted in heated tanks (50% doliolaria at 14 days post-hatching) compared to larvae in unheated tanks (50% at 19 days post-hatching). Additional hatchery enhancement included an aeration filter system, and a larger capacity UV water treatment system. Separate studies also explored the use of concentrated microalgae as an alternative to live natural food.

## Harpacticoid copepods

Copepods contain essential nutrients that meet the nutritional requirement of marine fish larvae. Since 2019, SEAFDEC/AQD conducted experiments to determine the optimal culture condition of the harpacticoid copepod *Tigriopus* sp. in tanks. Information on its biology and culture requirements are prerequisites for its sustainable mass production. Last year, the life cycle of *Tigriopus* sp. was successfully monitored and described. For 2020, optimal culture conditions were determined. Results showed that the highest population growth of harpacticoid could be achieved when

cultured at ambient temperature (28–29°C) with a salinity of 33 ppt (Figure 5).

To determine the optimal concentration of biofloc that could increase the population growth of harpacticoids, an experiment was conducted using different biofloc concentrations (10, 20, and 30 ml/L). Harpacticoid population growth in each biofloc concentration increased with the culture days until day 40, and a sharp decrease was observed on day 50 in all biofloc concentrations (Figure 6). In addition, it can be observed that the highest population growth was on day 40 in all biofloc concentrations. On day 40, the highest population growth was at 10 ml/L (202,500 ± 11,087 harpacticoids) followed by 20 ml/L (167,500 ± 8,539 harpacticoids) and lowest at 30 ml/L (97,500 ± 12,500 harpacticoids).

For 2021, a protocol for the large-scale culture of *Tigriopus* sp. in tanks will be established and its suitability for use as live food for the different species of marine fish larvae will be investigated.

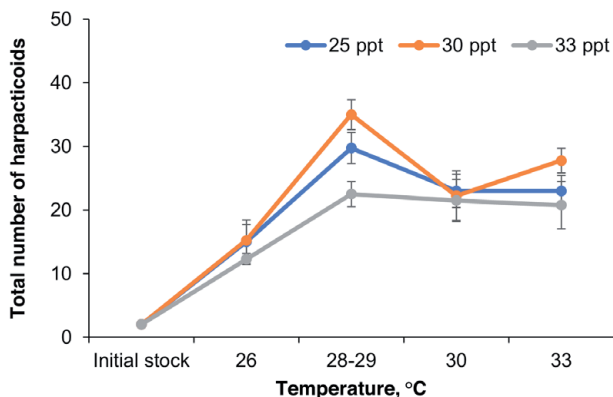
## Seaweed

Diseases and pests hamper the growth of eucheumatoid seaweeds, which result in insufficient production and a lack of quality seedlings available for seaweed farms. SEAFDEC/AQD conducted experiments to produce seaweed seedlings through micropropagation.

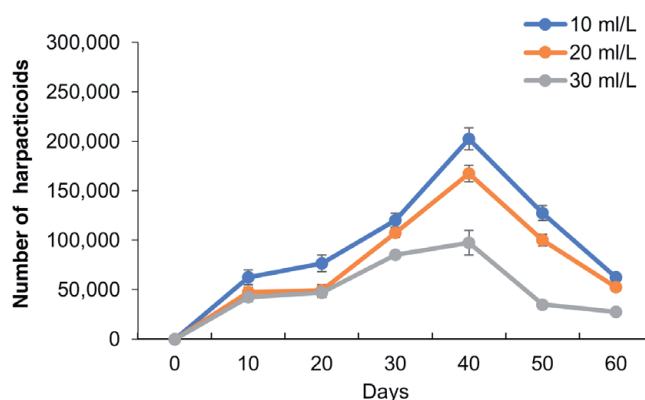
One of the studies aims to produce seaweed micropropagules to support the needs of the sea-based nursery. With the adoption of refined methods, propagule production increased from 4,000 to 7,200 individuals/month. From the start of this year, there were 30 batches (two batches/month) of propagules from the land-based nursery (61,644 *Kappaphycus alvarezii* and 2,449 *Kappaphycus striatus* propagules) that were successfully transferred to the sea-based nursery cages facility at Igang Marine Station in Guimaras. Average survival was 29.0% and 84.0% in *K. striatus* and *K. alvarezii*, respectively. Next year, production is projected to double to 15,000, upon the completion of the seaweeds laboratory expansion.

Tank-acclimated seaweed micropropagules will be produced in a newly approved study. It aims to evaluate if tank acclimation favors better growth and survival over non-acclimatization when the micropropagules are later planted in the open sea. Preparations for the experiment is ongoing and will continue in 2021.

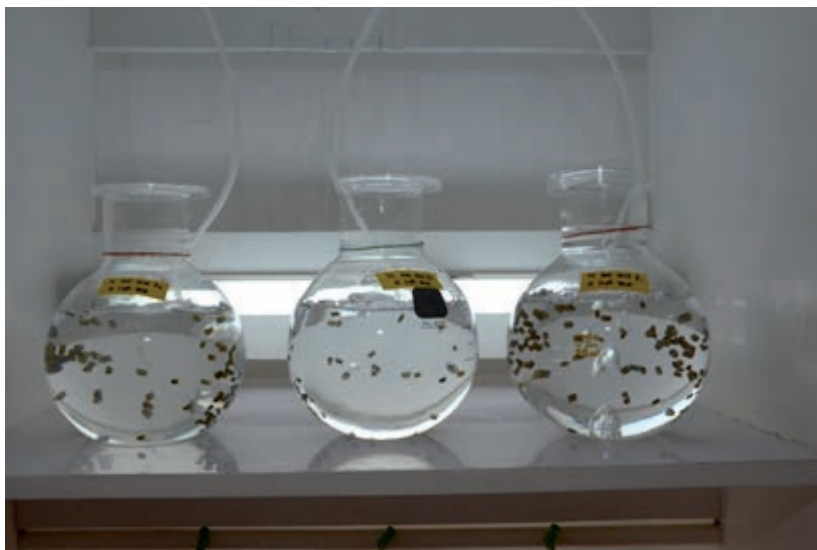
SEAFDEC/AQD is also conducting a study for the sea-based production of seaweeds. It aims to increase the production of seaweed propagules by improving the survival rate in expanded sea-based nursery cages. Production was ongoing this year. Results showed that the study produced an initial *K. alvarezii* and *K. striatus* propagule count of 33,054 with 7,555 survivals in two months, which



**Figure 5.** Population growth of copepods under different temperature-salinity combinations. Each point is presented as mean  $\pm$  SE (n = 4).



**Figure 6.** *Tigriopus* sp. at different biofloc concentrations (10, 20, and 30 ml/L) for 60 days. Each point is presented as a mean  $\pm$  SE (n = 4).



Seaweed propagules production in the SEAFDEC/AQD laboratory

equates to a 22.9% survival rate. This was achieved by using laboratory-produced propagules acclimatized in seawater for 1-2 hours prior to stocking in sea cages with a density of 250 ind/tray.

## Algal paste

The commercially available microalgal paste in the Philippines is expensive and is not affordable for small scale hatcheries. A study is being done to optimize conditions for the production of algal paste through electrolytic flocculation using important and locally available microalgal strains and aquaculture species. Ideal current or power source, electrode materials, and harvest parameters (e.g., biomass and time), will be determined in the experiments.

This year, the study defined the ideal power source, electrode material, and harvest time to produce algal paste using *Chaetoceros calcitrans*, *Tetraselmis tetrahele* and *Nanochlorum* sp. The best number and type of electrode for use in algal paste production are six pieces aluminum and six pieces lead for *C. calcitrans* and *T. tetrahele*. The highest biomass harvested for *C. calcitrans* is 0.646 kg using a 10-volt power source, while for *T. tetrahele* it is 1.7 kg using a 12-volt battery power source as seen in Table 5. Harvest time for *C. calcitrans* is shortest at 15 mins. using a 10-volt power source, while the shortest harvest time for *T. tetrahele* and *Nanochlorum* is 61 mins. and 78 mins., respectively. The paste quality based on metal content and

**Table 5.** Weight of microalgae produced with varying power voltages

Microalgae	Weight	Power used
<i>Chaetoceros calcitrans</i>	0.646 kg	10 volts
<i>Tetraselmis tetrahele</i>	1.7 kg	12 volt

storage conditions has also been determined for the different species, particularly for *C. calcitrans*.

Resuspension of *C. calcitrans* paste can be done in up to six months of storage in the freezer, chiller, or airconditioned rooms. *C. calcitrans* paste stored in the first two months using a chiller developed better lipid content while those stored in the freezer developed high carbohydrates and protein. *T. tetrahele* is best kept using a chiller without preservatives because its resuspension showed a lag phase of three days but peaked after six to eight days. The revival of *T. tetrahele* was not achieved when stored in the freezer.

The study also conducted the feeding of rotifer *Brachionus* with *T. tetrahele* paste, and it achieved the highest count using 6/6 aluminum and steel electrodes at 7-volts. Meanwhile, feeding live *Nanochlorum* sp. to rotifers is still best compared to feeding with *Nanochlorum* sp. paste.

## Larval food

SEAFDEC/AQD conducted a study to develop a modified continuous culture system to improve the mass production of the most commonly used live food for tropical marine hatcheries such as *Nanochlorum* sp. and *Brachionus*

*rotundiformis*. Adaptation of a modified continuous culture system in the hatchery is known to improve culture efficiency. This system will eliminate the tedious scaling-up of algal culture and reduce the number of culture tanks. It is done by continuously feeding the culture system with nutrient medium and exposing the microalgae to continuous lighting using a cool-white fluorescent tube. The algal outflow will be directly fed to *B. rotundiformis*. The study will use a reduced substrate concentration of 50 mg/L nitrate using TMRL culture medium since it promotes optimum growth rate for *Nanochlorum* sp. in batch culture.

Furthermore, the use of a ball valve and brass air controller resulted in a minimal fluctuation of the desired flow rate (inflow of nutrients). A 15% and 30% benchmark turnover rate was identified, resulting in a stable and sustainable algal culture. Moreover, 30 ppm chlorine to treat seawater was observed to minimize the presence of ciliates.

# HEALTHY & WHOLESOME AQUACULTURE

The sustainability of increased aquaculture production is dependent on the provision of adequate and environment-friendly feed and feeding practices. Proper fish health management is equally important to prevent or mitigate losses from diseases.



## Tilapia

Tilapia lake virus (TiLV) is a viral disease that infects tilapia around the world. It causes lesions and ulcers, eye abnormalities, reduced schooling behavior, and mass mortalities. A study was conducted to detect and quantify TiLV in pond soil, water, and fish samples using quantitative reverse transcription PCR (qRT-PCR). This year, the detection and diagnostic protocol for TiLV was optimized. Fish organs were dissected and preserved in 95% ethanol at -20°C for PRC analysis. Phylogenetic analysis of partial genome segment 3 sequences (179 bp) suggests that Group 1 and 3 were closely related to an Egyptian strain.

## Catfish

The occurrence of infectious diseases has by far been a stumbling block that hinders the sustainable production of pond-reared catfish in the Philippines. This study aims to address the current problem of sporadic occurrences of mortalities among hatchery-produced African catfish (*Clarias gariepinus*) in the municipality of Zarraga, Iloilo, through active monitoring and surveillance of the putative causative disease agents. This year, two catfish farms, i.e., Catfish Farm A (commercial scale) and Catfish Farm B (small-scale), were monitored every two weeks over four months. In both catfish farms examined, the levels of

physicochemical water parameters were within acceptable ranges, except for the higher levels of water hardness from one of the deep well sources that supplied water in the hatchery of Catfish Farm A. As shown in Table 6, the presumptive *Vibrio* counts (PVC) in the hatchery water were higher in Catfish Farm A than Catfish Farm B. Moreover, the presumptive *Aeromonas* counts (PAC) quantified in the nursery water, and sediment samples obtained from Catfish Farm A were also apparently higher than those obtained from Catfish Farm B. On the contrary, the PAC quantified in fingerling samples obtained from Catfish Farm A nursery were one log lower than those fingerling samples collected from Catfish Farm B.

**Table 6.** Summary of bacterial counts in the water, sediment, and catfish samples obtained from the hatchery and nursery of Catfish Farm A and Catfish Farm B.

Culture Phase	Sample	Parameter	Catfish Farm A (Commercial Scale)	Catfish Farm B (Small Scale)
Hatchery	Water	Physicochemical parameters	Not significantly different except hardness (CaCO <sub>3</sub> )	Not significantly different
		Presumptive <i>Vibrio</i> Count	≤10 <sup>4</sup> cfu/mL (100% Yellow colonies)	≤10 <sup>3</sup> cfu/mL (100% Yellow colonies)
	Fry	Presumptive <i>Vibrio</i> Count	≤10 <sup>5</sup> cfu/g (100% Yellow colonies)	From undetectable (UD) at 10 <sup>-1</sup> dilution to ≤10 <sup>5</sup> cfu/g (100% Yellow colonies)
Nursery	Water	Physicochemical parameters	Not significantly different except hardness	Not significantly different
		Presumptive <i>Aeromonas</i> Count	≤10 <sup>4</sup> cfu/mL	≤10 <sup>3</sup> cfu/mL
		Presumptive <i>Vibrio</i> Count	UD at 10 <sup>-1</sup> dilution	from UD to ≤10 <sup>2</sup> cfu/mL (100% Yellow colonies)
	Sediment	Presumptive <i>Aeromonas</i> Count	≤10 <sup>5</sup> cfu/g	≤10 <sup>3</sup> cfu/g
		Presumptive <i>Vibrio</i> Count	≤10 <sup>4</sup> cfu/g (100% Yellow colonies)	from UD to ≤10 <sup>3</sup> cfu/g (100% Yellow colonies)
Fingerlings	Presumptive <i>Aeromonas</i> Count	≤10 <sup>5</sup> cfu/g	≤10 <sup>6</sup> cfu/g	

## Marine fish

Outbreaks of viral nervous necrosis (VNN) in Asian sea bass, groupers, and pompano at the larval stages via vertical transmissions of nervous necrosis virus (NNV) from asymptomatic broodfish remain as a major deterrent during seed production at SEAFDEC/AQD. This study primarily aims to verify the practical application of the vaccination regimen as an effective strategy to produce NNV-specific-free eggs coming from immunocompetent (vaccinated) high-value marine broodfish species reared in floating net-cages in Igang Marine Station in Guimaras. This year, several marine fish species at the Igang Marine Station were intraperitoneally (IP) vaccinated with the formalin-inactivated NNV vaccine (pre-inactivation titer: 1,010.5 TCID<sub>50</sub>/fish) from March to July 2020 (Table 7). The annual booster vaccination of these high-value marine fish species enumerated in Table 7 will be conducted in 2021.



Specifically, to elucidate the effectiveness of the vaccination regimen in preventing vertical transmissions of NNV, pompano (*Trachinotus blochii*) broodfish were chosen as experimental fish species. As such, a group of pompano broodfish were IP vaccinated with formalin-inactivated NNV vaccine with a pre-inactivation titer of  $10^{9.2}$  TCID<sub>50</sub>/fish. A group of pompano broodfish were also injected with L-15 medium to serve as a control. Serum samples from both vaccinated and unvaccinated (control) pompano broodfish were collected and examined for NNV-neutralizing antibody titers at different time points post-vaccination. The mean NNV-neutralizing antibody titers quantified in the sera of vaccinated pompano broodfish at one- and two-months post-vaccination were 1:1729 and 1:5042, respectively. On the contrary, NNV-neutralizing antibodies were not detected (<1:40) in the sera of unvaccinated fish.

## Pompano

Spray-dried hemoglobin (SDH) powder meal is a good source of protein. The study will determine the proximate, amino acid, and fatty acid composition of hemoglobin meal as well as assess the digestibility of hemoglobin meal in a carnivorous fish. It will be followed by an efficacy evaluation of the meal used as an ingredient in pompano diets. It will evaluate performance parameters, feed efficiency, and comparative body composition (amino acid, proximate, and fatty acid profile). Due to the poor results gathered in the first runs conducted in October 2019 and January 2020, a second growth experiment run was conducted at the Igang Marine Station in Guimaras. Six test diets were used with the following SDH diet levels: 0, 4, 6, 12, 18, 27 percent. Fish with an initial body weight of 0.85 g were stocked in 1 x 1 x 2 m floating net cages. After 90 days, results (Figure

7) showed that test diet 2 and 3, which has 4% and 6% SDH dietary inclusion, has a higher average body weight (ABW) than others. It also shows that the two same test diets have a lower feed conversion ratio (FCR).

Dietary protein is the most expensive component in feeds, which comprises 70% of intensive fish farming production costs. Therefore, the determination of essential amino acid requirements of fish is necessary to develop a cost-efficient feed. This study aims to determine the leucine, isoleucine, and histidine requirement of pompano. This year, an experiment to assess the leucine requirement was conducted, and results showed that the optimum requirement is 1.61% leucine in the diet. This inclusion level showed optimum weight ( $38.62 \pm 3.08$  g), FCR ( $1.14 \pm 0.07$ ), and survival rate (82.21%), as shown in Table 8. The requirements for the two other essential amino acids will be in the works in 2021.

**Table 7.** High value marine fish species vaccinated with the formalin-inactivated NNV vaccine in 2020.

Fish Species	Total number	Mean body weight (±S.D.)	Date of Vaccination
Pompano ( <i>Trachinotus blochii</i> ) (Vaccinated)	24	1.68 ± 0.46 kg	June 5, 2020
Pompano ( <i>T. blochii</i> ) (Control)	23	1.48 ± 0.21 kg	June 5, 2020
Sea bass ( <i>Lates calcarifer</i> )	13	5.39 ± 1.03 kg	Aug 10, 2020
Hybrid grouper ( <i>Epinephelus</i> sp.)	11	4.50 ± 0.71 kg	Aug 10, 2020
Orange spotted grouper ( <i>E. coioides</i> )	4	1.68 ± 0.67 kg	Aug 10, 2020
Brown marbled grouper ( <i>E. fuscoguttatus</i> )	4	7.20 ± 1.73 kg	Aug 10, 2020
Snapper ( <i>Lutjanus argentimaculatus</i> )	14	2.99 ± 1.62 kg	Sept 11, 2020

## Milkfish

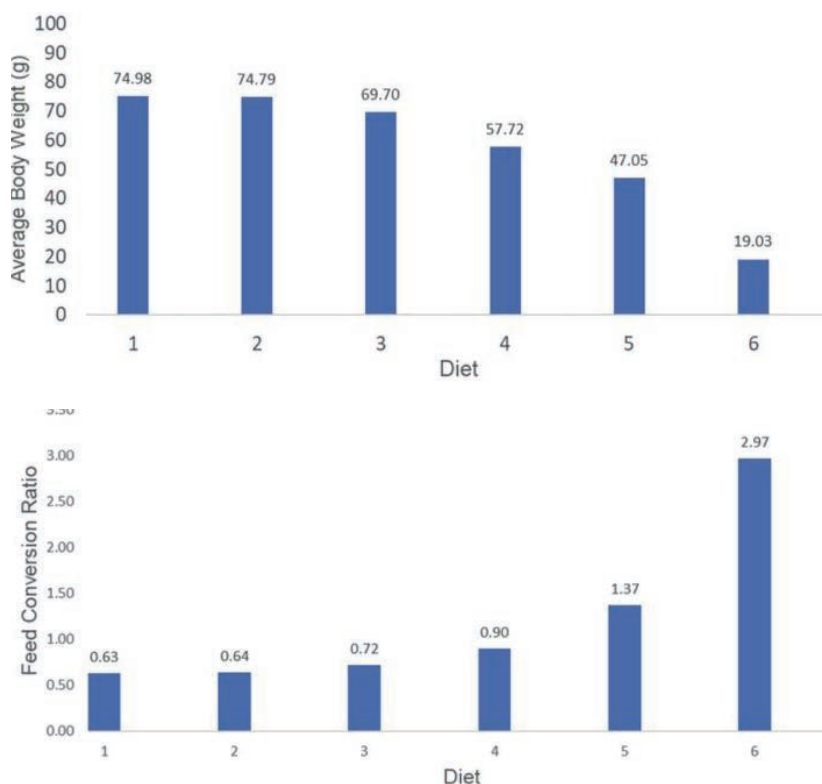
With the increasing interest in using plant protein sources for fish, SEAFDEC/AQD conducted a study to evaluate the efficacy of phytase and carbohydrase feed additive in milkfish diets. Phytase supplementation in fish feed could increase bioavailability of nitrogen which leads to the reduction of feed cost. Meanwhile, carbohydrase enzyme tends to improve digestibility and reduce nutrient excretion. In 2020, experiments were conducted using a floating net cage set-up where milkfish were fed to satiation an estimated 4 times a day. Dietary treatments are shown in Table 9. Partial results (Figure 8) indicated numerical differences which will be subjected to statistical analysis.

**Table 8.** Growth performance of pompano fed different dietary leucine levels.

Parameters	Diet 1 (0)	Diet 2 (0.5)	Diet 3 (1)	Diet 4 (1.5)	Diet 5 (2)	Diet 6 (2.5)
Initial weight (g)	4.87 ± 0.28	4.81 ± 0.19	4.79 ± 0.11	4.82 ± 0.23	4.81 ± 0.34	4.80 ± 0.26
Final weight (g)	29.22 ± 2.18	32.31 ± 2.03	42.98 ± 3.44	38.62 ± 3.08	32.56 ± 2.93	27.19 ± 3.16
FCR	0.88 ± 0.08	0.89 ± 0.07	0.95 ± 0.08	1.14 ± 0.07	1.09 ± 0.06	0.94 ± 0.07
Survival (%)	77	77.77	75.48	82.21	88.84	71.15

**Table 9.** Summary of treatments and components

Treatments	Components
Reference Control	commercial diet (CD)
Positive Control	CD + phytase and carbohydrases, reduce 50% mono calcium phosphate (MCP)
Negative Control	reduce 50% MCP, 10% SBM
Enzyme Control	negative control + phytase and carbohydrases



**Figure 7.** Final average body weight (ABW) and feed conversion ratio (FCR) of pompano-fed with spray-dried hemoglobin (SDH)

## Tiger shrimp

Macroalgae were considered a potential food source for cultured aquatic organisms. The use of *Chaetomorpha* seaweed as a food source, either through inclusion in formulated feeds or by direct feeding through a co-culture system, can potentially benefit cultured shrimps and possibly other farmed aquatic species as well. This study aims to evaluate unfermented, fermented, and live green macroalgae (*Chaetomorpha linum*) as a food source.

Testing several fermentation methods showed the use of koji mold (*Aspergillus oryzae*) is more effective in improving the nutritional value of *Chaetomorpha* meal than lactic acid bacteria (LAB) and yeast. Pre-treatment of fresh *Chaetomorpha* with weak acid also increased its protein and considerably reduced its ash contents.

A 90-day feeding experiment showed shrimps (BW~0.3±0.05 g) given diets with 0%, 6%, and 12% inclusion of unfermented *Chaetomorpha* meal (UCM) have no significant difference in terms of SGR (2.6±0.29 to 3.0±0.16) and % weight gain (1,022±318% to 1,484±225%). However, the optimum level appears to be closer to 6%. Hepatosomatic index (3.9±0.52 to 4.5±0.34) and survival rate (80±22% to 89±8%) were likewise the same in all treat-

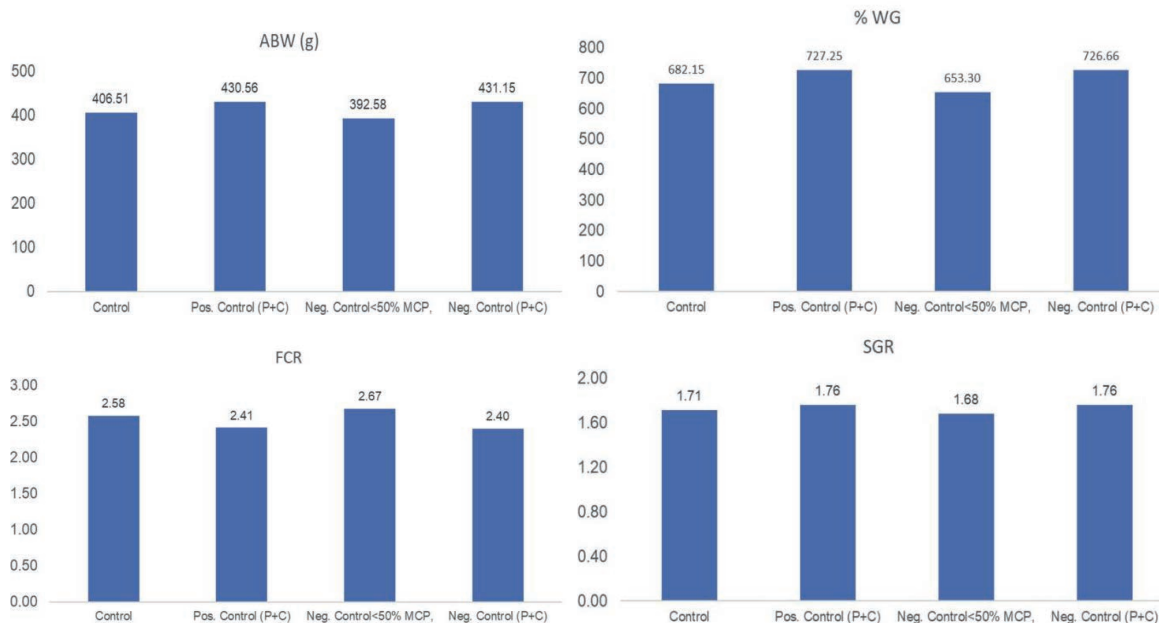


Figure 8. Data showing results of all dietary treatments for milkfish

## ‘Spaghetti’ fed to shrimp in bid to cut aquaculture cost

HUMANS are not the only ones who enjoy eating spaghetti — shrimp can, too.

Researchers are using nutritious green “spaghetti algae” in fish and shrimp feeds as part of a broader move to bring down the cost of expensive aquafeeds which account for over half the expenses of farmers.

*Chaetomorpha linum*, also known as “spaghetti algae” or “green hair algae”, derives its name from its wiry and rigid strands resembling cooked pasta noodles. Its protein content reaches up to 17 percent and it contains health-promoting bioactive compounds. It also grows year-round and can tolerate a wide range of environmental conditions. While growing, spaghetti algae also absorbs excess nutrients from aquaculture wastewater, thereby helping reduce pollution.



Various amounts of the algae were incorporated into aquafeeds, partially substituting soybean and fishmeal which are more expensive imported ingredients. The feeds, containing between zero and 18 percent processed spaghetti algae, were then tested for 90 days on juveniles of tiger shrimp.

The results were promising as shrimp survival and growth were normal with up to 12 percent spaghetti algae in their diet. However, the sweet spot seemed to be at around 6 percent.

SEAFDEC/AQD continues to improve the quality of the spaghetti algae by using lactic acid bacteria, yeast, and fungi to ferment it before including it in feeds. Fermentation improves the nutritional quality of alternative protein sources. The spaghetti algae would also later be tested as a potential feed source for tilapia and milkfish.

ments, even at 18%, the highest inclusion level tested. Meanwhile, feeding trials using diets containing increasing levels of LAB and yeast fermented *Chaetomorpha* meal (LYFCM) resulted in highly variable data. Another run testing the inclusion of fungus-fermented *Chaetomorpha* meal (FFCM) is being conducted.

## Indian white prawn

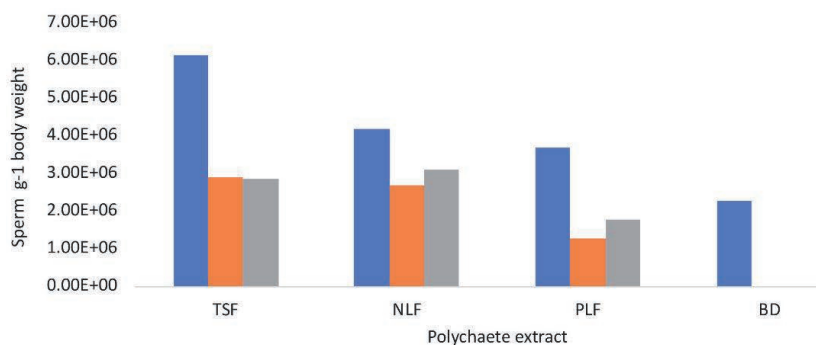
*Penaeus indicus* is an important shrimp species and is indigenous to the Philippines. It is capable of osmoregulation across a wide range of water salinities and has good reproductive performance. In 2020, hatchery production experiments were done to produce a sustain-

able supply of *P. indicus* postlarvae from hatchery-bred broodstock. Male and female broodstock (120 pairs) produced 5,845,594 eggs and 4,230,890 nauplii with 40.5% spawning, 72.4% hatching rate. From that, a 3.3% survival rate was achieved which produced 141,063 postlarvae, as seen in Table 10. The postlarvae were then used in the studies under the Research Division and the excess were given to a collaborator. Fifty pieces of shrimp weighing 100 g each were polycultured with milkfish in a 3,000 m<sup>2</sup> area. The collaborator reported that the shrimps already weigh 6 g after 45 days of culture.

In order to reduce the risk of introducing pathogens to aquacul-

ture production systems, research efforts are directed to closing the life cycle of cultured shrimp species in captivity. SEAFDEC/AQD conducted a study to improve the reproductive performance of *P. indicus* by providing a maturation diet with optimized protein and lipid levels supplemented with polychaete extract vitellogenesis promoting factor. Last year, three dietary treatments were used with varying protein levels (55%, 45%, and 35%) and lipid levels for each protein level (18, 12, and 6). The female shrimp were fed for 45 days. As a result, 45% protein together with 18% lipid (45:18) and 55% protein with 12% lipid (55:12) were determined as the best diet treatments.

This year, the effects of three polychaete extracts namely: total soluble fraction (TSF), polar lipid fraction (PLF) and neutral lipid fraction (NLF), were supplemented to the basal data at three different concentrations (0.25%, 0.5%, 1.0%). Ten dietary treatments with triplicates including basal diet were formulated and fed to adult male *P. indicus* for 21 days. Initial results suggest that lower concentration (0.25%) of total soluble fraction, polar lipid fraction, and neutral lipid fraction extracts from polychaete result in higher sperm counts per body weight in grams (Figure 9).



**Figure 9.** Sperm counts per body weight (g) of male *P. indicus* broodstock fed with polychaete extracts (TSF, NLF, PLF) at three different concentrations (0.25, 0.50, 1.00 %)

**Table 10.** Hatchery production of *Penaeus indicus* from February to August 2020

Month of Culture	Size of broodstock	Eggs	Nauplii	% Spawn	% Remat	Hatching rate (%)	PL	Survival (%)
Feb-March	♀ 12 ± 0.14 ♂ 6.25 ± 0.04	1,270,865	924,697	41	29	73	47,210	5
April -May	No production due to quarantine measures							
June-Aug	♀ 14.60 ± 0.18 ♂ 7.31 ± 0.08	4,574,729	3,306,193	40	37	72	93,853	2.8
<b>Total</b>		<b>5,845,594</b>	<b>4,230,890</b>	<b>40.5</b>	<b>33</b>	<b>72.4</b>	<b>141,063</b>	<b>3.3</b>

## Abalone

Abalone culture is a lucrative business. However, the grow-out culture of abalone in the Philippines is still dependent on *Gracilariopsis heteroclada*, one of the economically-important seaweeds in the country farmed for agar production and human consumption. In 2020, a study tested the feasibility of using a new SEAFDEC-formulated diet for grow-out culture of abalone in tanks and the field. The diet performance will be compared with *G. heteroclada*.

Nine artificial diets were formulated, prepared, and analyzed for moisture content and water stability and were then tested for 2 h, 4 h, and 6 h. The proximate composition of the nine diets are as follows: 26.27% to 32.55% protein; 4.40% to 5.42% fat; and 30.56% to 37.96% NFE, with energy ranging from 278.72 kcal/100 g to 302.77 kcal/100 g. From these nine diets, four were chosen based on nutrient and energy content, cost, and stability rate. In succeeding experiments, the acceptability of the four diets will be tested and actual feeding trials will be done.

## Silver therapon

Silver therapon, *Leiopotherapon plumbeus*, is regarded as one of the most valuable edible native freshwater species in the Philippines. Due to intense fishing pressures, efforts were done to conserve its dwindling natural populations. To alleviate the pressures on the wild populations, SEAFDEC/AQD conducted a study on the domestication of this fish species. Successful developments were achieved in previous years including the establishment of protocols for hormone-induced spawning and rearing of larvae up to juvenile stage in outdoor concrete tanks. Because of these developments, there is now a

**Table 11.** Effect of stocking density on the performance and biometric indices of silver therapon fry reared in tank- and lake-based cages

TANK CAGE NURSERY	Density groups		
	50/m <sup>3</sup>	75/m <sup>3</sup>	100/m <sup>3</sup>
Final weight (g)	2.12	1.93	2.10
Weight gain (%)	1,296	1,098	1,194
Specific growth rate (%/day)	4.17	3.92	4.06
Survival (%)	93.3	90.2	84.0
FCR	2.50	2.55	2.32
Condition factor	1.46	1.50	1.48
Hepatosomatic index (%)	1.47	1.17	1.52
Viscerasomatic index (%)	15.59	17.18	15.86
Gut index (%)	4.88	4.52	5.08

LAKE CAGE NURSERY	Density groups		
	50/m <sup>3</sup>	75/m <sup>3</sup>	100/m <sup>3</sup>
Final weight (g)	1.99	1.85	1.67
Weight gain (%)	716	651	586
Specific growth rate (%/day)	2.99	2.88	2.75
Survival (%)	88.0	83.6	88.7
FCR	3.40	3.53	3.60
Condition factor	1.48	1.52	1.53
Hepatosomatic index (%)	1.17	1.27	1.59
Viscerasomatic index (%)	13.74	15.55	15.07
Gut index (%)	2.02	2.03	2.07

need to establish a reliable nursery and grow-out technique for silver therapon. This year, experiments were conducted to determine the optimal stocking densities for this species in the nursery. Using three stocking densities (50/m<sup>3</sup>; 75/m<sup>3</sup>; and 100/m<sup>3</sup>), performance of early stage silver therapon juveniles reared in tank- and land-based cages were examined. Results in Table 11 showed that early stage silver therapon juveniles stocked at 50-100/m<sup>3</sup> showed comparable growth and survival. Howev-

er, early stage juveniles reared in tank-based cage nursery grew better than those reared in lake-based cage nursery. Experiments on the optimum dietary protein level in grow-out feeds for silver therapon is ongoing.

## *Caligus sp.*

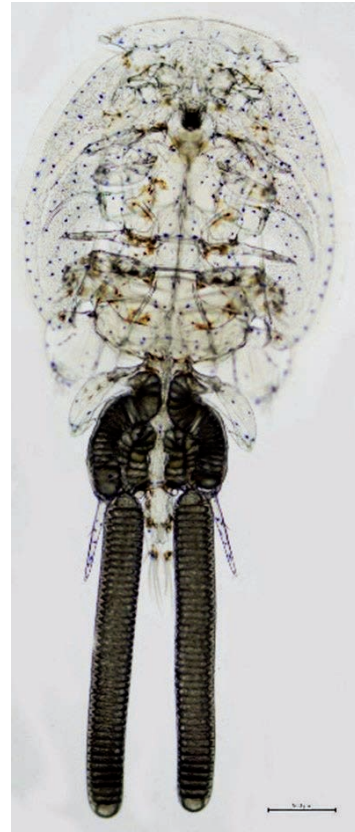
The family Caligidae is the most commonly reported sea lice species of fish reared in brackish and marine waters. The species not only threatens the health of the fish but also has the potential to endan-

ger fish stocks. This study aims to test which concentration dosage of emamectin benzoate (EMB), hydrogen peroxide, and onions is effective versus sea lice. Last year, the life cycle of the *Lepeophtheirus spinifer* (Figure 10) was completed. Laboratory static bioassay were conducted to determine the 96-h  $LC_{50}$  of emamectin benzoate (EMB) on juveniles of snubnose pompano, *T. blochii*. Results showed that the 96-h median lethal concentration ( $LC_{50}$ ) was 0.32 ppm. In addition, results showed that the orally-administered emamectin benzoate (EMB) with a concentration of pompano fed with EMB (1.25, 1.39, 1.53, and 1.67ppm) showed a significant reduction in the prev-

alence and mean intensity of sea lice on 17- and 27-days post-treatment compared to the control.

### Plans for 2021

Studies on the tilapia lake virus, shrimp, and seaweeds will continue their remaining activities in 2021. Meanwhile, a new research will be proposed on the verification control, treatment, and intervention protocols against sea lice. Finally, the vaccination study will end this year as the vaccination of marine fishes will be incorporated as one of the demonstration activities in SEAFDEC/AQD's Igang Marine Station.



**Figure 10.** A female *Lepeophtheirus spinifer*

# MAINTAINING ENVIRONMENTAL INTEGRITY

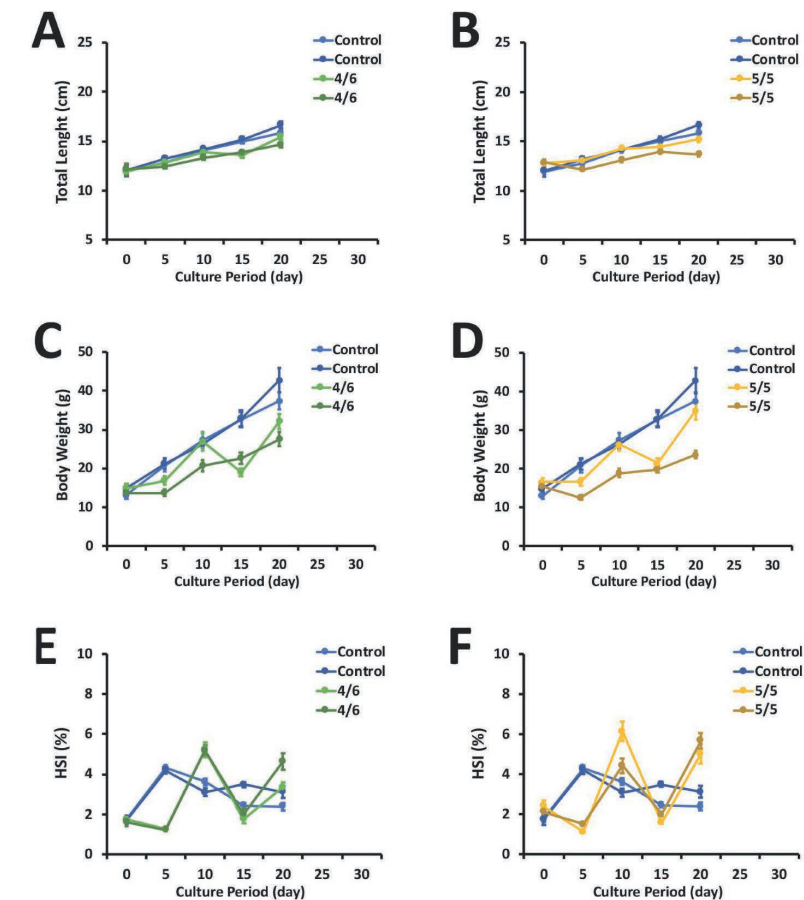
Responsible aquaculture entails the development of environment-friendly technologies and the monitoring of its impacts on biodiversity and the quality of the water and sediments. Propagation of threatened species will also enable the restocking and replenishment of their natural population.



## Milkfish

Aquaculture feeds account for about 70% of the operational expenses in milkfish cage culture. Efforts to improve production efficiency have focused on reducing feed costs as well as optimizing the feeding strategy. SEAFDEC/AQD has been studying compensatory growth (CG) in fish. CG enables rapid growth after a period of food restriction and provides an opportunity to reduce feed input with a comparable harvest. The study seeks to evaluate the compensatory growth response of milkfish, determine the minimum duration of food restriction that primes the CG response in milkfish fingerlings, and assess the minimum duration of refeeding. The study was also set to develop a feeding technique based on optimum starvation-refeeding cycle in a full grow-out culture of milkfish in marine cages. In its first year in 2019, the focus was on determining starvation indicators in milkfish juveniles using body weight loss and hepatosomatic index (HSI) by comparing starved and fed milkfish. Results showed that CG response might be induced after 4-5 days of starvation. Meanwhile, HSI was shown to be fully recovered after four to six days of refeeding.

In 2020, an actual cage culture trial commenced. One treatment was employing two feeding schedules: cycles of 4 days of no feeding followed by 6 days of refeeding (4/6), and cycles of 5 days of food restriction and 5 days of refeeding (5/5). Initial results showed compensation of body weight and length after refeeding. However, it was only sustained up to two cycles (i.e. 20 days) while subsequent cycle of starvation and refeeding showed loss in body weight and length. Figure 11 shows morphometric changes in milkfish finger-



**Figure 11.** Morphometric changes in milkfish fingerlings subjected to various feeding schemes: total length (A), body weight (B), HSI (C). For total length and body weight, each point is a mean of 40 individuals  $\pm$  SEM, while each point in HSI is a mean of 15 individuals  $\pm$  SEM.

lings subjected to various feeding schemes. Subsequent trials will evaluate longer periods of refeeding to ensure full compensation of body weight throughout the period of grow-out culture.

## Sea cucumber

Sea cucumbers have high commercial value in the Chinese markets and are actively being traded in Southeast Asian countries. Overfishing these echinoderms in many parts of the tropics, combined with poor fisheries management, has resulted in a severe decline in wild

stocks. The recent collaborative project funded by the Australian Centre for International Agricultural Research (ACIAR) is developing appropriate hatchery and field culture methods for sandfish in Viet Nam and the Philippines. These studies have improved the knowledge on factors influencing ocean nursery culture and the site selection for sandfish ranching. An aspect of sandfish production being spearheaded by SEAFDEC/AQD is to explore the use of microalgae concentrates as a practical replacement of live feed in the larval rearing of





Sandfish pens for predation experiments at Igang Marine Station in Guimaras

sandfish. So far, commercial products of concentrated *Isochrysis* sp. and a mixed-diatom diet are promising, although larvae fed with live *Chaetoceros calcitrans* showed the best performance. Further studies will explore the larval development performance of locally-produced micro-algae concentrates, including those produced by the SEAFDEC/AQD phyecology laboratory.

Experiments in ocean-based nursery culture of sandfish in floating hapa nets suggest that algal biofilm and temperature positively affect sandfish growth, while wind and rain are negative factors. A study on predation was also conducted, and results showed that medium-sized (15-20 g) sandfish juveniles were observed to avoid predators. In comparison, smaller ones (<5 g) seem to be naïve and can be more prone to predation mortality.

Field experiments on predator-mitigation strategies were also started in 2020 at SEAFDEC/AQD Igang Marine Station (IMS) using sandfish pens. Preliminary results showed that pens with higher nets promoted faster growth and high-

er survival of sandfish than semi-open pens with lower nets, where active effects of predation can be inferred.

### **Tilapia and giant freshwater prawn**

Nile tilapia are easy to rear because farming technologies are well-established. On the other hand, the giant freshwater prawn *Macrobrachium rosenbergii* has also been successfully domesticated, bred, and grown locally, making prawn monoculture, particularly in ponds and lake-based cages, viable. This study aims to jointly produce two commercially-valuable low input species in a sustainable, cost-efficient, and responsible culture system that would provide profitable returns for the small-scale fish farmer. Specifically, the study will look into rearing of a genetically-improved Nile tilapia strain (i-Excel) and a red tilapia hybrid, together with giant freshwater prawn (GFP) in tank-based co-culture systems, and assess optimal tilapia-prawn co-culture schemes in lake-based cages.

In 2020, a five-month trial was conducted in a lake-based set-up. Nile (i-Excel) and red tilapia were stocked in nets within larger cages where GFP was stocked. The experiment had three feeding treatments including: a) tilapia fed floating feeds while prawn are unfed; b) tilapias fed floating pellets and prawns fed sinking shrimp diets; and c) tilapias unfed while prawn are fed sinking shrimp diets.

Results are shown in Table 12. In the data from the first run, mean survival of the GFP was higher in the treatment where both the tilapias and the giant freshwater prawn were fed (62.2%) while red tilapia survived better whether these are fed or unfed (56-81.3%). Average weight gain was the highest for the i-Excel tilapia whether or not they were fed or unfed. It is worth noting that these values have yet to be corrected when the survival data is used as a co-variate in the analysis.

In general, the prawns did not grow well when they were unfed. All the co-culture experiments will continue in 2021 and the economic viability of the various rearing sys-

**Table 12.** Results of the first rearing trial of tilapia and giant freshwater prawn (GFP) in cages at week 20

Treatment	Mean survival (%)			Average weight gain (g)		
	GFP	Red	i-Excel	GFP	Red	i-Excel
Fed tilapia only	50.56	78.67	54.67	28.48	176.04	243.16
Fed both tilapias and GFP	62.20	56.00	45.33	61.03	169.35	272.08
Fed GFP only	42.23	81.30	64.00	75.03	55.00	60.39

tems will be evaluated by the end of the same year.

## Abalone

Due to its high commercial value worldwide, abalone became one of the more important fishery resources. It also became extremely valuable to local fishing communities. SEAFDEC/AQD studied growing abalone in pipes under a three-year project funded by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development of the Department of Science and Technology (DOST-PCAARRD), and it showed promising results.

In partnership with Ayala Corporation, SEAFDEC/AQD verified the effectiveness of this newly-developed grow-out culture technology in a large-scale project in Sicogon Island. From 2018, a total of 7,320 juveniles have been stocked in six batches in the culture site. A total of 3,513 have been harvested in eight occasions until the study was completed last December 2020. Mortalities and missing stocks were caused by two typhoons that directly hit the site in 2019, plus starvation due to intermittent feeding caused by COVID-19 travel restrictions.

## Polychaete

Due to its qualities that enhance reproductive performance, marine worms are incorporated into crus-



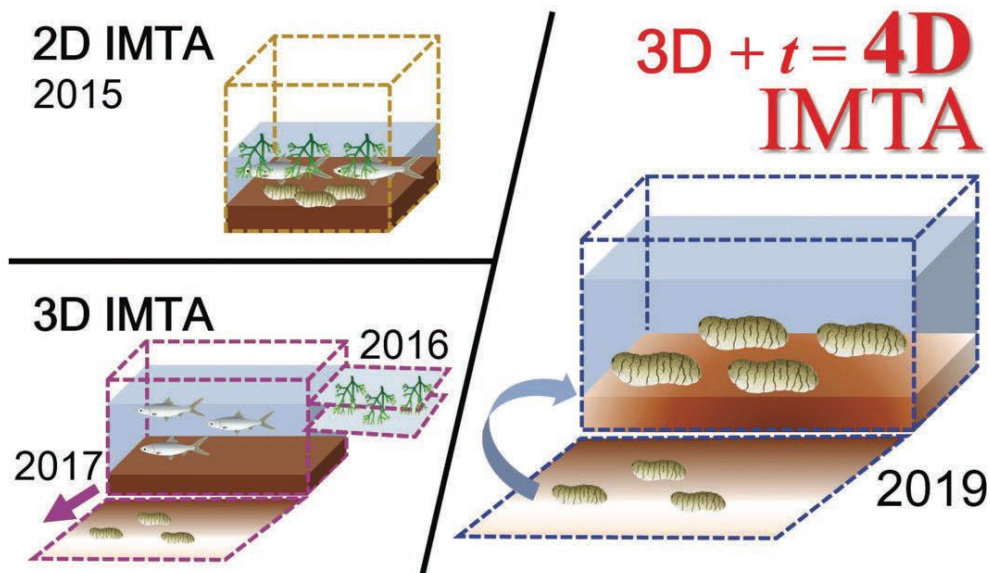
SEAFDEC/AQD staff stocks abalone in the trial area in Sicogon Island.



Newly-harvested live abalone

taceans and fish broodstock maturation diets. As emerging diseases become one of the most pressing issues affecting the aquaculture industry, the production of biosecure polychaetes became a preferable alternative. Thus, a study to verify

methods developed for the culture of *Marphysa* sp. in raceway ponds was conducted. Production results of the study showed that the optimum stocking density is 500 ind/m<sup>2</sup>, biomass is higher (0.56g, 100 g/m<sup>2</sup>) when cultured for four



The evolution of the IMTA pen system used in the project, utilizing milkfish, sandfish, and seaweeds

months, crude protein (64%) is most elevated within four months of culture, and crude fat (10%) is peaked in three months in which 3.2% is polyunsaturated fatty acids. Generally, the study concluded that producing bait-size (<0.4 g) is most profitable with a return of investment of 58%. It would take two months of culture with six-runs per year and a stocking density of 1,000 ind/m<sup>2</sup> in a 100 m<sup>2</sup> area. This approach would yield around 30% survival and be sold for PHP 1 (USD 0.0021) per piece.

### **IMTA: milkfish, sandfish, and seaweeds**

The Japan International Research Center for Agricultural Sciences (JIRCAS) and SEAFDEC/AQD collaboratively explored Integrated Multi-Trophic Aquaculture (IMTA) which is a system of culture that involves different aquatic organisms at various trophic levels. For this project, milkfish was used as the fed species, with sea cucumbers

and seaweeds as extractive species. This approach may potentially allow farmers to maximize aquaculture production while minimizing their environmental impact.

Since 2015, the project explored various IMTA systems and designs, from the traditional 2D IMTA where all species occupy the same water column, to a 3D IMTA where extractive species were located adjacent to the fish pen. In the recent runs in 2019 and 2020, the concept for a four-dimensional (4D-IMTA) system was utilized. This concept involved culturing sandfish in the same milkfish area or pen after the fish has been harvested which means no additional feeding will be done. The remaining organics may be positively utilized by sandfish for enhanced growth, while helping in faster recovery of the sediments during this fallow period. The project was conducted in Barangay Pandaraonan in Guimaras in collaboration with local government unit and fisherfolks.

In the culmination of the proj-

ect, it was found that the traditional 2D IMTA system was problematic because there was not enough space for all commodities. The 3D IMTA worked better, but since the culture duration differed among species, the 4D system was used to allow more time for growth, particularly for the sandfish. However, the experimental and small-scale design of the project resulted in heavy predation for both the seaweeds and sandfish. In effect, there was difficulty in achieving significant bioremediation effects from the current scale of sandfish and seaweed in this open pen system. Nevertheless, the project was able to demonstrate profitable proceeds from the milkfish component. The project also provided useful data in projecting the viability of the IMTA system at scale. At the same time, the project promoted awareness among the partner local community members of the aquaculture and monitoring methodologies of the three species, which they can apply in future ventures.

## Plans for 2021

Studies on the strategic feeding of milkfish, fish-and-prawn-co-culture, IMTA, and community-based sea cucumber production will continue in 2021. Meanwhile, the polychaetes and abalone in pipes study will end in 2020. Projects ending within the year are planned to be translated into information materials, e.g. manuals for dissemination to stakeholders.



Experimental raceway ponds for polychaetes in SEAFDEC/AQD

# MEETING SOCIAL & ECONOMIC CHALLENGES

Securing food and income among stakeholders can be realised through collaboration in implementing social and economic strategies in aquaculture and resource management.



## Community-based sandfish farming

Sandfish, *Holothuria scabra*, is a highly-valued marine product priced for as much as \$1800 per kilogram in China and in Southeast Asian markets. In coastal communities, increasing human population, low catch volume, and low fishing income contributed to the overharvesting of sandfish. Mariculture is considered as one of the solutions to lessen the pressure on wild stocks while striving to meet market demand.

SEAFDEC/AQD conducted a study to assess the capacity of island-based fishing communities to do sandfish farming and develop strategies to increase and sustain the participation of the members. In 2020, a network of collaborators in the Philippines began project preparations. A workshop on qualitative social research methods survey was hosted by the SEAFDEC/AQD team and joined by partners from the University of the Philippines Marine Science Institute (UP-MSI), Guiuan Development Foundation, Inc. (GDFI), and Mindanao State University (MSU) Naawan Campus. Resource persons came from the University of Technology Sydney (UTS).

Formulation of qualitative survey instruments, namely: key informants, traders, and household surveys, formed part of the output of the social methods workshop. The nodes collectively reviewed the Sandfish Mariculture Handbook, showcasing case studies drafted in the second half of 2019.

In the second half of 2020, a memorandum of agreement was finalized with fisherfolk in Molocaboc Island in Sagay City and the local government. For the Western Visayas node, SEAFDEC/AQD completed 41 household social surveys



MOA signing of Molocaboc Sea Ranchers Association (MOSRA) President Rafael Muñoz and Vice President Dennis Abog, witnessed by members Mr. Joebert Muñoz and the late Mr. Mariano Jarina



A workshop on qualitative social research methods survey hosted by SEAFDEC/AQD

of the Molocaboc Sea Ranchers Association (MOSRA) fisherfolks. The survey was done online via Facebook Messenger due to the COVID-19 pandemic. The Eastern Visayas node implemented and completed 60% of its face-to-face interview activities while compliant with prevailing COVID-19 safety measures in Maliwaliw, Guiuan in Samar province. The completed social interviews were consolidated and uploaded in Qualtrics™, an offline data-gathering application that syncs completed surveys in a

database when connected to the internet.

Other nodes will begin the social surveys when the community quarantine mandates are eased.

### Plans for 2021

Community-based studies will continue in 2021. The project is expected to encourage the community to engage in the aquaculture of commercially-viable species through capacity-building.

# ADAPTING TO CLIMATE CHANGE

As patterns of water temperature and salinity in the culture environment shift, there is a need to recognize its effect on the physiological condition of aquaculture species. Studies are needed to simulate possible environmental changes and develop technologies to mitigate problems that may occur.



Climate change is a compounding threat to the sustainability of aquaculture development. Impacts occur due to gradual warming, the increasing acidity of the oceans and associated physical and chemical changes, and frequency, intensity, and location of extreme climatic events. These changes affect the aquaculture organisms in general, the different aquaculture systems and structures, and the various support systems to aquaculture operations. Fish farmers in the region are highly vulnerable since they depend on their aquaculture operations for food and income. Urgent adaptation measures are required in response to the threats to food and livelihood provision due to climatic variations.

Several studies gather information that provide information on the effect of environmental parameters, especially elevated temperatures, on aquatic species. For example in tilapia, growth trials were done during the 2020 dry season. The water temperature recorded at the surface of lake-based cages between April and May reached critically high levels of more than 32 °C and up to 33.2 °C. This was considered a contributory factor to the lower observed survival in the lake-based cages compared to tank-based cages.

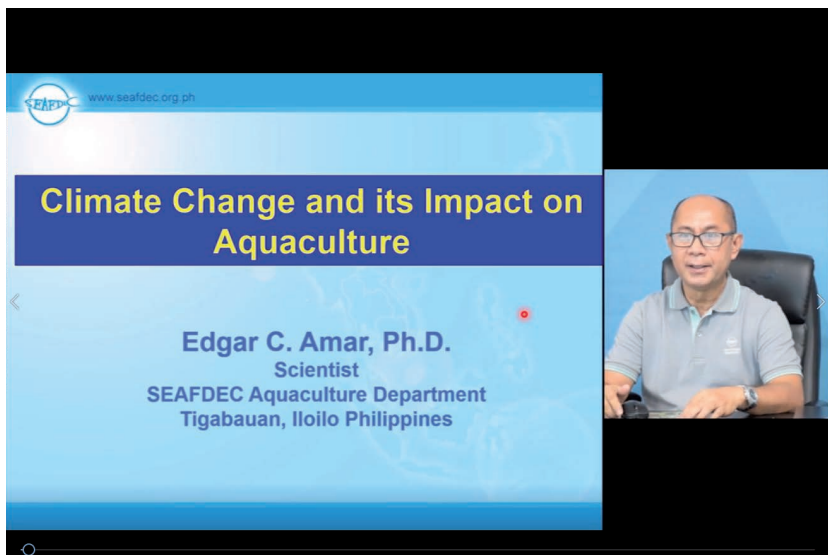
Information on climate change impacts on aquaculture is also incorporated in all SEAFDEC/AQD training courses.

### Plans for 2021

In 2021, AQD will continue to incorporate climate change-resilient practices in studies conducted and training and information materials.



Climate change impacts may include sea level rise which, when compounded with more severe weather events, could severely affect coastal aquaculture facilities. Shown here is a storm surge threatening the seawall of the Tigbauan Main Station of SEAFDEC/AQD.



Climate change impacts may include sea level rise which, when compounded with more severe weather events, could severely affect coastal aquaculture facilities. Shown here is a storm surge threatening the seawall of the Tigbauan Main Station of SEAFDEC/AQD.

The program is expected to generate and integrate scientific information related to the regulation and preparation of the industry, fish farmers,

and other stakeholders to the effects and impacts of climate change.



# REGIONAL PROGRAMS: FISH HEALTH & SUSTAINABLE AQUACULTURE

With support from the Government of Japan, information on aquatic health management continued to be produced through research and disseminated through trainings. Research and capacity-building projects on sustainable aquaculture were likewise pursued.



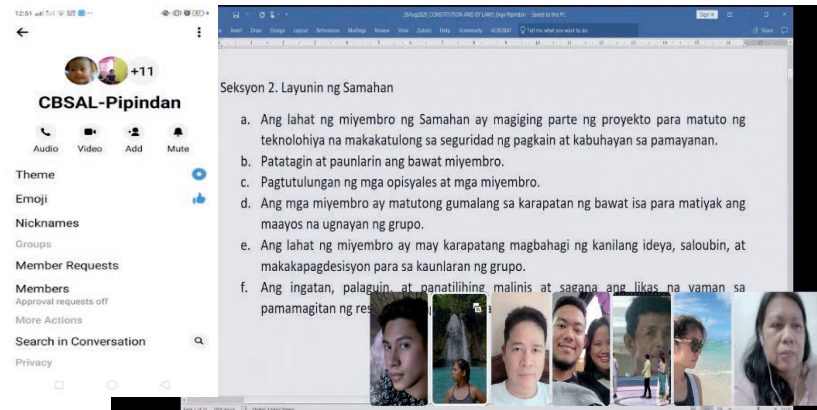
## Community-based hatchery, nursery, grow-out of giant freshwater prawn

This year, the travel and community quarantine restrictions caused by the COVID-19 pandemic challenged the implementation of activities. Virtual meetings and telecommunication methods became the modality to carry-out the activities for the study. SEAFDEC/AQD discussed the nature of the collaboration with the local government unit and fisherfolk stakeholders, initiated the social preparation and community organizing, and drafted the project agreement and the constitution and by-laws of the fisherfolk association. Tri-party collaboration between SEAFDEC/AQD and stakeholders in target Barangay Pipindan in Binangonan, Rizal was forged through online meetings. Thus, rapid site assessment for GFWP hatchery and feasibility study is ongoing.

Next year, this study will validate socioeconomic baseline survey results with stakeholders and train fisherfolks on GFWP hatchery and nursery. Subsequently, the construction and operation of community-based GFWP hatchery and nursery will commence through collaboration with farmers.

## Promoting alternative feeds for freshwater aquaculture

The continuing development of alternative feeds for freshwater species such as tilapia, giant freshwater prawn, and tropical anguillid eels is essential to the viability of aquaculture in light of the increasing cost of ingredients. This year, the effects of feed reduction strategies on tilapia growth performance



Screenshots of online meetings between SEAFDEC/AQD and collaborators in Binangonan, Rizal

in cages and tanks were tested using feeds incorporating fermented okara meal.

Two tilapia growth trials were conducted in tank- and lake-based cage setup during the dry season. The setup used a 2 x 2 factorial design to compare two formulated tilapia feeds (containing bacteria-treated okara meal or BOM and yeast-treated okara meal or YOM) and two feeding strategies (daily and alternate day) with four replicate cages per treatment.

Results showed that the two diets did not significantly affect the performance of Nile tilapia fingerlings after 16 weeks in tank-based cage trials. Furthermore, no significant difference in survival (93.75% to 96.25%) and feed conversion ratio (1.22 to 1.30) were observed in fish fed two diets containing BOM and YOM. However, growth parameters were significantly affected by the two feed management strategies. Meanwhile, survival rate and feed conversion ratio did not show any significant difference in both treatment groups. The interaction between diet and feeding strategy was not significant. Data are presented in Table 13.

In a lake-based cage trial, the two diets had no significant influence on the performance of Nile

tilapia fingerlings after 12 weeks of culture. Mean survival rates and feed conversion ratio were also not significantly different in fish fed the two diets. However, survival rates were much higher in the tank-based cage trials due to high water temperature-related (>32°C) mortality of fish, particularly in April and May. The two feeding strategies had a significant effect on the growth parameters of Nile tilapia in cages. Mean final weight, percent weight gain, specific growth rate, and final yield in groups fed daily were significantly higher than those fed on alternate days. Data are presented in Table 14.

Biometric indices were also measured in this study. Results showed that both diets and feeding strategies did not influence the condition factor and hepatosomatic index of Nile tilapia fingerlings in tank-based cage trials. This suggests that there is no difference in the physiological state of fish in these treatments. However, a significant effect on the fingerlings' viscerosomatic index was detected in groups fed on alternate days. Meanwhile, for lake-based cage trials, significant effects on hepatosomatic and viscerosomatic indices were shown in both diet and feeding strategy. No significant dif-

ference was observed in the fingerlings' condition factor.

In 2021, the second trial will be conducted in the wet season using the same experimental design. The preparation of the economic analysis to determine the most cost-effective feed and feeding strategy for possible adoption by fish farmers will also be included in the activities for next year. Afterwards, alternative feed ingredients (aquatic weeds, black mussel, fish silage, and okara meal) will be evaluated as potential replacements for soybean meal and fishmeal in diets for tilapia in a biofloc-based system.

## Ecosystem approach to responsible and sustainable shrimp farming

To increase the production and competitiveness of small-scale farmers, the mitigation and management of aquatic diseases are essential. One of the ecosystem approaches that help minimize and mitigate diseases, posed by sharing the same water source and having the same inlet and outlet, is aquaculture clustering and zoning. In this approach,

an aquaculture zone consists of one or several clusters of farms, including their water resources. Farms in a cluster are called an aquaculture management area (AMAs). With this, SEAFDEC/AQD started a study to establish aquaculture management plans that can improve the production of small-scale shrimp farmers. In 2020, the identification of aquatic organisms that have the ability to remove nitrogen from the water in a constructed and artificial wetland was conducted. Organisms including *Gracilaria* sp., *Caulerpa* sp., *Salicornia* sp.,

**Table 13.** Growth, survival, yield, and feed conversion ratio of Nile tilapia fingerlings reared in tank-based cage trials

Treatments	FW (g)	WG (g)	SGR (%/day)	Survival (%)	Yield (g/m <sup>3</sup> )	FCR
<b>Diet</b>						
BOM	131.46	687.00	2.08	93.75	3,703.00	1.30
YOM	124.18	648.00	2.05	96.25	3,596.00	1.22
<b>Feeding Strategies</b>						
Daily	182.05 <sup>a</sup>	996.00 <sup>a</sup>	2.14 <sup>a</sup>	94.76	5,209.00 <sup>a</sup>	1.31
Alternative	73.59 <sup>b</sup>	340.00 <sup>b</sup>	2.00 <sup>b</sup>	94.58	2,090.00 <sup>b</sup>	1.21
<b>Two-way ANOVA</b>						
D	NS	NS	NS	NS	NS	NS
FS	<0.0001	<0.0001	<0.01	NS	<0.0001	NS
D x FS	NS	NS	NS	NS	NS	NS

**Table 14.** Growth, survival, yield, and feed conversion ratio of Nile tilapia fingerlings reared in lake-based cage trial

Treatments	FW (g)	WG (g)	SGR (%/day)	Survival (%)	Yield (g/m <sup>3</sup> )	FCR
<b>Diet</b>						
BOM	136.47	535.00	2.27	66.67	2,719.00	1.33
YOM	131.53	513.00	2.21	67.92	2,692.00	1.35
<b>Feeding Strategies</b>						
Daily	157.70 <sup>a</sup>	628.00 <sup>a</sup>	2.45 <sup>a</sup>	68.75	3,249.00 <sup>a</sup>	1.44
Alternative	110.31 <sup>b</sup>	420.00 <sup>b</sup>	2.03 <sup>b</sup>	65.83	2,161.00 <sup>b</sup>	1.24
<b>Two-way ANOVA</b>						
D	NS	NS	NS	NS	NS	NS
FS	<0.0001	<0.0001	<0.0001	NS	<0.0001	NS
D x FS	NS	NS	NS	NS	NS	NS

*Haliotis* sp., *Crassostrea* sp., *Perna* sp., and other species were tested to purify effluent from fish ponds. Water samples were collected before adding nitrogen, a day after the addition of nitrogen, and weekly thereafter. After five weeks, *Caulerpa* and *Holothuria* demonstrated the best ability to remove ammonia, TAN, and phosphate from the environment, followed by *Gracilaria*, *Eucheuma*, *Perna*, and *Kappaphycus*.

These organisms were also evaluated for their ability to grow under brackishwater pond conditions. Pond experiments to identify organisms that can thrive under a brackishwater pond environment is ongoing. Organisms tested include *Caulerpa*, *Eucheuma*, *Gracilaria*, *Kappaphycus*, brown mussel, green mussel, oyster, and sandfish.

After five weeks, *Holothuria* and oyster had the best ability to grow in brackishwater ponds, as shown in their weight increase, followed by *Gracilaria*. All other organisms decreased in weight significantly while brown mussel did not survive. Daily salinity ranged from 23 ppm to 35 ppm and daily temperature ranged between 28.7 °C to 41.1 °C. Overall, the best candidates suitable for the constructed and artificial wetlands are sandfish, oyster, and green algae, as presented in Table 15.

An artificial and constructed wetland for small-scale shrimp culture will be designed based on the organisms identified in the earlier stage of the study. Mesocosms of the designed artificial/constructed wetlands will be made to determine the feasibility of the designs and will be the basis for the pond experiment. Rectangular tanks (30 L capacity) filled with 4 cm sludge will be used for this study.

**Table 15.** Mean nutrient level and mean weight increase of organisms in experimental tanks

Organism	Mean nutrient level (NH <sub>3</sub> , TAN, PO <sub>4</sub> ) in the experimental tank	Mean weight increase (g)
Green algae ( <i>Caulerpa</i> )	0.40	-1,333.30
Red algae 1 ( <i>Gracilaria</i> )	2.37	-366.67
Red algae 2 ( <i>Eucheuma</i> )	2.56	-2,883.30
Red algae 3 ( <i>Kappaphycus</i> )	4.80	-1,166.70
Sandfish ( <i>Holothuria</i> )	0.44	12.20
Mussel ( <i>Mytilus</i> )	6.19	-1,283.30
Brown mussel ( <i>Perna</i> )	3.45	-2,000.00
Oyster ( <i>Crassostrea</i> )	9.93	483.30

## Development of aquaculture techniques for new aquatic species

This project aims to establish seed production and grow-out techniques for the adoption of the local aquaculture industry. The goal is to develop hatchery and grow-out techniques for the following species: kawakawa (*Euthynnus affinis*), shortfin scad (round scad, *Decapterus macrosoma*), flathead lobster (*Thenus orientalis*) and seahorse (*Hippocampus comes*). This year, sources of live fish (round scad and kawakawa) were found in the municipality of Tibiao and Anini-y in Antique Province and Tigbauan in Iloilo Province. So far, 25 live shortfin scad from the wild were transported using 829 L insulated transport tanks with a continuous supply of pure oxygen, conventional aeration, temperature of 26.7 °C, salinity of 33.8 ppt, and dissolved oxygen of 5.75 mg/L. Upon arrival at the Tigbauan Main Station, they were stocked in an 11.5-ton, flow-through rearing tank. The live fish from the wild

was fed with *Gobiuapterus* sp. or locally known as dulong, dried shrimp, and *Acetes* sp. The fish responded well when fed with *Acetes* sp. The full procedure is depicted in Figure 2.

Next year, standardized transport (from the wild to the tank-based facility) and tank-rearing and management protocols for kawakawa and shortfin scad will be established.

## Development of diagnostic procedures for crustacean and fish diseases

Viral and bacterial diseases have caused significant fish and shrimp farming constraints in most Asian countries and worldwide. Prevalence and occurrence of these diseases have contributed to the decrease in aquaculture production. Hence, developing disease diagnostic protocols for unknown and emerging diseases is the most efficient response to address these issues. This study aims to identify

and profile unknown and emerging crustacean and fish diseases in Philippine aquaculture farms. Subsequently, it seeks to develop and optimize bacteriological and molecular protocols, both conventional and real-time PCR, of these diseases. To identify the causative agents, SEAFDEC/AQD conducted onsite assessment and mangrove crab sampling in Capiz Province for disease diagnosis in 2020.

In terms of bacteriological diagnosis, results showed that the average bacterial counts of weak crab samples were highly elevated ( $10^4$ – $10^5$ ) than the apparently healthy crab samples ( $10^2$ – $10^3$ ) in two sampling trips. These high bacterial counts on crab muscle tissue and hemolymph can be traced to low-quality trash fish. Molecular diagnosis showed that all crab samples and *agihis* or live feed for both samplings were negative to seven target pathogens. Meanwhile, histopathology observed a few parasitic plasmodial-like cell inclusions in the gill lamellae, infiltration and colonization of bacteria inside the hepatopancreatic tubules, and sloughing off of the hepatopancreatic tubules in both weak and apparently healthy crab samples. In terms of water quality, the physical appearance of the river water was turbid due to high sediment load. During the sampling, it was also established that both farms were not observing good aquaculture practices (GAqP).

Next year, mass mortalities in aquaculture caused by unknown and emerging crustacean and fish diseases will be monitored. This entails isolation and identification of causative agents and the development and optimization of disease diagnostics protocols.

## Research underway to farm *galunggong*, curb shortage



Live shortfin scad immediately being selected after capture by an otoshi-ami gear in Tibiao, Antique Province

A LONG-TERM solution to the perennial shortage of *galunggong* (shortfin scad or *Decapterus macrosoma*) in the Philippines is finally on the table after a Japan-funded research program set its sight on artificially breeding and farming the fish.

*Galunggong* is considered a staple dish in the Philippines. However, the catch of local fishers has seen a decline over the years, leading to increasing prices and controversial moves to import the fish amid closed fishing seasons imposed with the hopes of helping wild stocks recover.

In 2020, a team led by Deputy Chief Dr. Koh-ichiro Mori, found and procured live *galunggong* from Anini-y and Tibiao in Antique. Local fisherfolk helped catch the fish using a ring net and otoshi-ami, a stationary fish trap locally known as lambaklad.

After collecting broodstock from the wild, the research team transported them to SEAFDEC/AQD's headquarters in Tigbauan and stocked them in tanks for captive maturation. The pioneering activity begins the development of broodstock collection techniques as a first step to domesticate the species.

The research on *galunggong* is under an umbrella program that aims to develop aquaculture technologies on new aquatic species that also includes kawakawa (mackerel tuna or tulingan) and flathead lobster. The main goal of the research program is to close the life cycle of these species in captivity and to develop production techniques for nursery and grow-out.

While the research will take years to complete, it is seen as the long-term solution to the declining supply of *galunggong* from the wild.

## Integrated approaches against viral infections and other emerging diseases in brackishwater ponds

In shrimp culture, the success of the farming operation is highly dependent on growth and survival of the farmed species. This study aims to implement disease management by combining vaccination, immunostimulants and probiotics, antivirals, and Good Aquaculture Practices (GAqP), including biosecurity measures and maintenance of water quality and health status of farmed shrimp. Simulated tank trials (Figure 12) on the combination of two or more approaches against target pathogens as well as pond trials to demonstrate the efficacy of the integrated approaches were proposed under this study. This study also aims to develop guidelines for farm-based disease management specific to the target pathogens. Treatments for the proposed experiments are presented in Table 16.

In 2021, the efficacy of disinfection protocol using 30 ppm chlorine, hydrated lime application, tilling, drying, as well as the use of WSSV-screened postlarvae as analyzed by conventional PCR and quantitative Real-Time PCR (qRT-PCR) will be assessed. Shrimp with low viral load detectable only by qRT-PCR will be subjected to hypoxic stress to see if the viral load will increase to a level capable of causing mortality.

## Crab farm mortalities linked to bad feed, water quality



Dissected crab with blackened gills was already showing signs of weakness when collected during a site visit

HIGH mortalities experienced by crab farmers in Capiz Province, Philippines were linked to poor quality trash fish fed to the crabs and the high turbidity of the river where water is sourced.

An investigation was launched in 2020 by SEAFDEC/AQD after a farmer in the province reported finding dead crabs since 2019, with a mortality rate reaching as much as 40 percent. The farmer said similar observations were noted in nearby farms and even in other towns. Mortalities were observed regardless of life stage, with dead crabs being described as lightweight and with thin muscles.

The diagnostic team dissected the crabs and found gills that were black or brown, instead of pale in color, which is characteristic of crabs exposed to poor environmental conditions such as high organic load or heavy siltation. Fouling organisms or particles clog the gills of the crab and impair water movement, which may lead to respiratory stress or suffocation.

Clinical laboratory results revealed that apparently weak crabs harbored high amounts of bacteria compared to those that appeared healthy. The prevalence of bacteria was linked to low-quality trash fish given as feed which reportedly reeked of foul odor in some instances. Molecular diagnosis through polymerase chain reaction showed that crabs were negative of seven common pathogens that affect crustaceans.

Farmers were advised to source good quality trash fish or to grow tilapia within the farm to use as fresh feed. The use of a reservoir or settlement pond to reduce water turbidity was also recommended.

## Epidemiology, distribution, occurrence, and prevalence of EHP

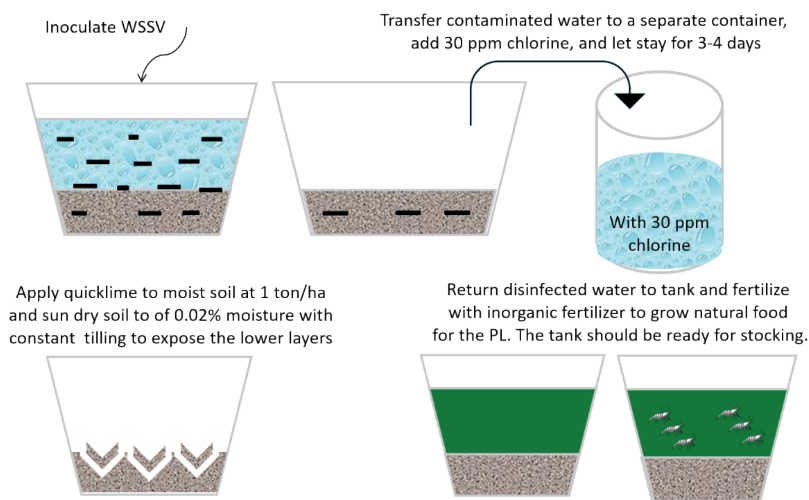
*Enterocytozoon hepatopenaei* (EHP) is an obligate intracellular microsporidian parasite that infects the tubules of the hepatopancreas of shrimps, which impairs the ability of the animals to gain nutrition from feeds. Even if it does not cause mortality, it is still a big concern for shrimp farmers. This study aims to survey the epidemiological information, distribution, occurrence, and prevalence of EHP. Diagnosis, detection and confirmation of EHP infecting shrimps using wet mount preparation, histology and molecular diagnostic tools will be conducted. The study will also describe and learn the transmission mechanism of EHP in shrimp. SEAFDEC/AQD aims to disseminate guidelines and management measures against EHP.

Whiteleg shrimp (*Penaeus vannamei*) were collected in 2020 from a grow-out farm in Zarraga, Iloilo, to analyze EHP by wet mount, PCR, and histology. As preliminary results of the present study, nested PCR and wet mount analysis showed that all shrimp samples were negative of EHP.

In 2021, active surveillance, distribution, occurrence, and prevalence of EHP in the Philippines will continue. Diagnostic methods will be conducted, including squash preparation of EHP, histopathology, PCR, and onsite hybridization.

**Table 16.** Treatments for the experimental setup

Treatment	
T1	SPF PLs + disinfected pond soil and water + other BMs & BMPs (3 replicates)
T2	SPF PLs + non-disinfected pond soil and water + other BMs & BMPs (3 replicates)
T3	non-SPF PLs + disinfected pond soil and water + other BMs & BMPs (3 replicates)
T4	non-SPF PLs + non-disinfected pond soil and water + other BMs & BMPs (3 replicates)



**Figure 12.** Procedure showing the simulated tank trials

## In vitro and in hatchery investigation of organisms, chemicals and methods against shrimp diseases

In the past decades, black tiger shrimp production has decreased due to diseases causing mortalities and affecting growth. This study aims to investigate organisms, disinfectants and chemicals, and methods that can be used to

prevent the vertical and horizontal transmission of shrimp diseases at the hatchery phase. Under this study, verification of the Acute Hepatopancreatic Necrosis Disease (APHND) prevention method in the grow-out phase, devised in previous years, will be conducted. Results of the study will be used in writing recommendations and guidelines on how to prevent shrimp disease transmission at the hatchery phase. Although studies have been done on egg disinfect-

tion, these disinfectants' efficiency in eliminating recent pathogens have not been verified.

The investigation of therapeutants and processes that can disinfect *Peneaus monodon* fertilized egg, nauplii, and postlarvae is still pending. Meanwhile, the verification of the APHND prevention method identified in the previous phase is ongoing.

The investigation of therapeutants and processes that can disinfect shrimps' egg, nauplii, and postlarvae will continue in 2021.

## **Capacity enhancement on sustainable aquaculture and aquatic animal health management**

Since its establishment, SEAFDEC/AQD is mandated to encourage human resource development through research and extension, so capacity enhancement activities are always incorporated in the activities. This project aims to capacitate participants from the ASEAN member-countries with technical knowledge and skills on new approaches

on aquaculture nutrition, feeds, and feeding strategies, through distance learning – a cost-friendly yet convenient tool for e-learners. The target clients include fisheries officers, researchers, fish farmers, farm managers and technicians, feed manufacturers, and college students.

Due to the pandemic, SEAFDEC/AQD strengthened its online learning strategies. A 13-week Aquaculture Nutrition Online (ANOL) course with nine revised and updated modules was offered from September to December 2020 using a new Canvas learning platform. Participants tested the new platform a week before courses started. Participants from member countries (Brunei Darussalam, Cambodia, Indonesia, Myanmar, Philippines, and Singapore) were accepted and registered to attend the online courses.

As for the distance learning course on the Principles of Health Management in Aquaculture (AquaHealth Online) – which aims to disseminate knowledge, skills, and new approaches in fish health management, and increase capacity to manage aquatic animal

diseases among stakeholders in ASEAN-member countries – it was proposed to be conducted using the Canvas platform as well. The 15-week online course has 14 modules and expected participants from member countries such as Brunei, Cambodia, Philippines, and Viet Nam. Meanwhile, station-based and onsite training courses on nutrition and feed development were ultimately postponed until the COVID-19 situation improves.

The training course for Marine Fish Hatchery conducted by SEAFDEC/AQD under this program aims to provide participants with the knowledge and skills on broodstock management, spawning, and larval rearing of marine fish species such as milkfish, sea bass, groupers, mangrove red snapper, rabbitfish, and pompano. Unfortunately, due to travel restrictions and health protocols imposed by the government, the course has been postponed until further notice. An online training course is being proposed with revised curricula and shortened duration as an alternative to the station-based program.



# TRAINING & INFORMATION

The COVID-19 pandemic became an opportunity to further expand the digital dissemination of aquaculture information. Virtual training courses and their digital content were developed. The strategic use of social media was further enhanced and frequent press releases dramatically improved SEAFDEC/AQD's dissemination of science-based aquaculture information, despite restrictions on travel and gatherings.

**SEAFDEC/AQD INSTITUTIONAL REPOSITORY**

SEAFDEC/AQD Institutional Repository Home

**DSpace @ SEAFDEC/AQD**

Southeast Asian Fisheries Development Center, Aquaculture Department Institutional repository for scholarly and research information of the department. This is to enable the digital dissemination of publications for free and online. The repository uses DSpace, an open source software.

**SEAFDEC AOD**

**SEAFDEC/AQD**  
Southeast Asian Fisheries Development Center / Aquaculture Department

SEAFDEC DEPARTMENTS:  
 Secretariat  
 Training Department (DT)  
 Marine Fisheries Research Department (MFRD)  
 Marine Fishery Resources Development and Management Department (MFRMD)  
 Inland Fishery Resources Development and Management Department (IFRMD)

**ANNOUNCEMENTS**  
 [Job Vacancy] Researcher needed  
 [Job Vacancy] Associate researcher needed  
 Guidelines on LAMP Sample Acceptance and Rejection of Test Reports in view of COVID-19 Pandemic  
 COVID-19 Full/Work Temporary Closure  
 2020 Training  
 Updated phone numbers of Manila Office and the various departments.

**MORE NEWS**  
 SEAFDEC/AQD librarian is 2020 PRC Outstanding Professional Awardee

**SEAFDEC turns up the heat to meet bangus fry shortage**

**Over P3-million shrimp harvested from a hectare**

**SEAFDEC/Aquaculture Department**  
 @seafdec.aqd · Educational Research Center

**Regional Technical Guidelines on Early Warning System for Aquatic Animal Health Emergencies**

**TILAPIA CULTURE THE BASICS**  
 Maria Rosaria S. Rosales-Espino  
 Raul F. Espino  
 Roberto V. Parlaghiging, Jr.

**Biology and Hatchery Rearing of the Silver Tilapia *Leptochanna plumbeus***  
 Primit A. Ego  
 Luis Maria S. Garcia

**NEW SPECIES OF SOIL-CLEANING WORM**  
 A new species of mudworm, known to collect and hatch after Iloilo collected and hatched.  
 Now called Marphy as ulod-ulod, were associate researcher (SEAFDEC).  
 Mandarino said she SEAFDEC's fishpond Polychaete Hatcher adult size.  
 The new species was (WoRMS) in Septem mudworms with he and his team.  
 [read more via link]

**New species of soil-cleaning worm named after Iloilo - SEAFDEC/AQD** [Learn More](#)

1.4K 41 Comments 895 Shares

# Training Program

The COVID-19 pandemic revolutionized SEAFDEC/AQD's training program by accelerating the need for, and the adoption of, an online training platform.

While two in-person training sessions were conducted in the first part of 2020, the rest were indefinitely postponed, beginning March, due to COVID-19 restrictions on travel and physical gatherings. Training courses resumed in July after an online

learning management system was set up and new digital training materials were prepared. Recorded video lectures and video tours and demonstrations were produced and made available to online trainees. Meanwhile, both asynchronous and live discussions supplemented the training videos. A total of six online training sessions were conducted for 2020.

A total of 292 trainees availed of the eight training ses-

sions in 2020, both online and in-person. A bulk of the participants were personnel from different local government units in the Philippines who took part in a series of online trainings on milkfish culture and management.

Nine interns and 40 on-the-job trainees were also accommodated in SEAFDEC/AQD facilities before COVID-19 restrictions took effect.

Course, date, venue	Total participants (Male/Female)	Countries represented by participants
<b>Training Course on Research Methodologies &amp; Technical Writing</b> 28–30 January (TMS, Tigbauan, Iloilo)	22 (20 F, 2 M)	Philippines
<b>Training Workshop on Effective Presentation Skills</b> 16–17 July (TMS, Tigbauan, Iloilo)	29 (22F, 7M)	Philippines
<b>FishKwela: Online Training Course on Milkfish &amp; Mangrove Crab Hatchery Technologies (Batch 1)</b> 1–4 September (Online)	25 (12F, 13M)	Philippines
<b>FishKwela: Online Training Course on Milkfish &amp; Mangrove Crab Hatchery Technologies (Batch 2)</b> 14–17 September (Online)	23 (6F, 17M)	Philippines
<b>Distance Learning Course on Principles of Aquaculture Nutrition (ANOL)</b> 21 September–20 December (Online)	14 (6F, 8M)	Brunei, Cambodia, Indonesia, Myanmar, Philippines, Singapore
<b>Online Training Course on Mangrove Crab Hatchery, Nursery, and Grow-out Operations</b> 20–23 October (Online)	32 (11F, 21M)	Philippines
<b>Online Training Course on Milkfish Culture &amp; Management</b> 1, 3, 8, 10, 15 December (Online)	132 (52F, 80M)	Philippines
<b>Training-Workshop on Effective Presentation Skills</b> 9–11 December (Online; TMS, Tigbauan, Iloilo)	15 (12F, 3M)	Philippines

## 'FishKwela' Online Training for Philippine Extensionists



A step-by-step demonstration on how fish farmers can prepare their own feeds is captured on video for an online training for aquaculture extension workers.

FORTY-EIGHT extension workers, mostly of the Bureau of Fisheries and Aquatic Resources (BFAR) from the different administrative regions, completed the 'FishKwela' Training Course to enhance their skills on the hatchery production of milkfish and mangrove crab.

The training course was the first technology and commodity-based online training course prepared by SEAFDEC/AQD in collaboration with the National Fisheries Research and Development Institute (NFRDI).

With the training hosted on Canvas e-learning platform, participants were given user accounts to access the content dashboard which hosts videos of lectures and practical demonstrations, specially created for the course. The trainees were given guided video tours of SEAFDEC/AQD's integrated milkfish and broodstock hatchery complex, mangrove crab hatchery, and feed mill. Online discussion boards also allowed trainees to consult with technical experts, while online examinations measured the participants' understanding of concepts.

The FishKwela online training course held its first session on 31 Aug. 2020 and its second session from 14 to 17 Sept. 2020.

*The training was very good and informative. I also appreciate that it was recorded so I can repeat parts that I didn't understand.*

**Norhata Dumasil** | Ministry of Agriculture, Fisheries, and Agrarian Reform, Bangsamoro Autonomous Region in Muslim Mindanao, Philippines

*The extended time and days of the training were very convenient to us because we were able to view the video lecture presentations in our free time*

**Riza Pulac** | Bureau of Fisheries and Aquatic Resources, Cordillera Administrative Region, Philippines



Training course offerings were packaged into brochures in 2020 to give inquiring parties an overview of the courses.

# Science Papers in Journals and Proceedings

- Altamirano JP, Noran-Baylon RD. 2020. Nursery culture of sandfish *Holothuria scabra* in sea-based floating hapa nets: Effects of initial stocking density, size grading and net replacement frequency. *Aquaculture* 526: 735379.
- Amar EC, Faisan JP Jr., Gapasin RSJ. 2020. Field efficacy evaluation of a formalin-inactivated white spot syndrome virus (WSSV) vaccine for the preventive management of WSSV infection in shrimp grow-out ponds. *Aquaculture* 531:735907.
- Aya FA, Sayco MJ, Garcia LM. 2021. Optimum stocking density and feeding level for laboratory-reared early-stage silver therapon (*Leiopotherapon plumbeus*) larvae. *Aquaculture Research* 52:935-942.
- Cabalfin JJMC, Lamzon JDH, Serra VRM, Mediodia HP, Catedral DD. 2019. Interaction between *Rhodobacter sphaeroides* and Harmful Algal Bloom (HAB) causing dinoflagellate *Amphidinium carterae*. *Publiscience* 2:159-164.
- Campbell I, Kambey CS, Mateo JP, Rusekwa SB, Hurtado AQ, Msuya FE, Stentiford GD, Cottier-Cook EJ. 2020. Biosecurity policy and legislation for the global seaweed aquaculture industry. *Journal of Applied Phycology* 32:2133-2146.
- Dennis LP, Nocillado J, Palma P, Amagai T, Soyano K, Elizur A. 2020. Development of a giant grouper Luteinizing Hormone (LH) Enzyme-Linked Immunosorbent Assay (ELISA) and its use towards understanding sexual development in grouper. *General and Comparative Endocrinology* 296:113542.
- Drakeford B, Failler P, Nunes A, Hossain MA, Van PT, Xinhua Y, Ayson F, Marinda P, Nyandat B. 2020. On the relationship between aquaculture and food security: Why does aquaculture contribute more in some developing countries than it does in others?. *International Journal of Fisheries and Aquatic Studies* 8:12-17.
- Estante-Superio EG, Pakingking RV Jr., Corre VL Jr., Cruz-Lacierda ER. 2021. *Vibrio harveyi*-like bacteria associated with fin rot in farmed milkfish *Chanos chanos* (Forsskal) fingerlings in the Philippines. *Aquaculture* 534:736259 (short comm.)
- Fazhan H, Waiho K, Quinitio E, Baylon JC, Fujaya Y, Rukminasari N, Azri MF, Shahreza MS, Ma H, Ikhwanuddin M. 2020. Morphological descriptions and morphometric discriminant function analysis reveal an additional four groups of *Scylla* spp. *PeerJ*. 8:e8066.
- Garcia LMB, Sayco MJP, Aya FA. 2020. Point-of-no-return and delayed feeding mortalities in first-feeding larvae of the silver therapon *Leiopotherapon plumbeus* (Kner) (Teleostei: Terapontidae). *Aquaculture Reports* 16:100288.
- Kawamura G, Bagarinao TU, Cheah HS, Saito H, Yong ASK, Lim L-S. 2020. Behavioural evidence for colour vision determined by conditioning in the purple mud crab *Scylla tranquebarica*. *Fisheries Science* 86:299-305.
- Kawamura G, Bagarinao TU, Loke CK, Au HL, Yong AS, Lim LS. 2021. Touch-sensitive bristles on the carapace of the mud crab *Scylla paramamosain* may be receptors for courtship signals. *Fisheries Science* 87:65-70.
- Kurokura H, Altamirano J, Primavera Y, Ishikawa S. 2019. フィリピンバタン湾におけるウシエビ放流の試み [Feasibility of stock enhancement of tiger shrimp in Batan Estuary in Philippines]. *Journal of International Cooperation for Agricultural Development* 17:14-23.
- Lebata-Ramos MJHL, Dionela CS, Novilla SRM, Sibonga RC, Solis EFD, Mediavilla JP. 2021. Growth and survival of oyster *Crassostrea tredalei* (Faustino, 1932): A comparison of wild and hatchery-bred spat in grow-out culture. *Aquaculture* 534:736310.
- Ludevese-Pascual G, Ahmed F, De Troch M, Amar E, Laranja JL, Bode S, Boeckx P, Bossier P, De Schryver P. 2021. Determination of poly- $\beta$ -hydroxybutyrate assimilation by postlarval whiteleg shrimp, *Litopenaeus vannamei* using stable  $^{13}\text{C}$  isotope tracing. *Journal of the World Aquaculture Society* 52:184-194 (fundamental studies)
- Mandario MA. 2020. Survival, growth and biomass of mud polychaete *Marphysa iloiloensis* (Annelida: Eunicidae) under different culture techniques. *Aquaculture Research* 51:3037-3049.
- Mandario MAE, Castor NJT, Balinas VB. 2021. Interaction effect of light intensity and photoperiod on egg hatchability, survival and growth of polychaete *Marphysa iloiloensis* from larva to juvenile. *Aquaculture* 531:735890.
- Mateo JP, Campbell I, Cottier-Cook EJ, Luhan MR, Ferriols VM, Hurtado AQ. 2020. Analysis of biosecurity-related policies governing the seaweed industry of the Philippines. *Journal of*

- Applied Phycology 32:2009-2020.
- Monghit-Camarin MA, Cruz-Lacierda ER, Pakingking RV Jr., Cuvin-Aralar ML, Traifalgar RF, Añasco NC, Austin FW, Lawrence ML. 2020. Bacterial microbiota of hatchery-reared freshwater prawn *Macrobrachium rosenbergii* (de Man, 1879). Asian Fisheries Science 33:241-248.
- Pagador GE, Pakingking RV Jr., Dumaran-Paciente HD. 2020. First histopathological description of parasites and shell conditions of the donkey's ear abalone *Haliotis asinina* (Linnaeus, 1758) cultured in marine cages and land-based tanks in the Philippines. Journal of Shellfish Research 39:375-379.
- Pakingking R Jr, Palma P, Usero R. 2020. *Aeromonas* load and species composition in tilapia (*Oreochromis niloticus*) cultured in earthen ponds in the Philippines. Aquaculture Research 51: 4736-4747.
- Salayo ND, Azuma T, Castel RJ, Barrido R, Tormon-West DH, Shibuno T. 2020. Stock enhancement of abalone, *Haliotis asinina*, in multi-use buffer zone of Sagay Marine Reserve in the Philippines. Aquaculture 523:735138.
- Salayo ND, Marte CL, Toledo JD, Gaitan AG, Agbayani RF. 2021. Developing a self-sufficient Philippine milkfish industry through value chain analysis. Ocean & Coastal Management 201:105426.
- Santander-Avanceña SS, Traifalgar RF, Laureta LV, Monteclaro HM, Qunitio GF. 2021. Interactive influence of dietary protein and lipid on maturation of Indian white prawn, *Penaeus indicus* broodstock. Aquaculture Research 52:2243-2253.
- Superio DL, Oliveros MG, Palcullo VE, Geromiano JF. 2020. The information-seeking behavior of aquatic science librarians in response to a query. Public Services Quarterly 16:280-291.
- Suyo JG, Le Masson V, Shaxson L, Luhan MR, Hurtado AQ. 2020. A social network analysis of the Philippine seaweed farming industry: Unravelling the web. Marine Policy 118:104007.
- Uba KI, Monteclaro H, Noblezada-Payne MM, Qunitio G, Altamirano J. 2020. Value chain analysis of the horse mussel *Modiolus metcalfei* (Hanley, 1843) fishery in Iloilo, Philippines. Asian Fisheries Science 33:106-117.
- Yap DS, Bungay KCC, Alfonso JPV, Libo-on JB, Cordero C. 2019. Immune response of *Litopenaeus vannamei* juveniles immersed in *Gracilariopsis heteroclada* hot-water extract. Publisience 2:30-33.

## Palma conferred Dr. Elvira O. Tan award for paper on giant grouper

SEAFDEC/AQD Researcher Peter Palma and his team bagged the prestigious Dr. Elvira O. Tan Awards (Outstanding Published Paper in the Aquatic Science Category) for their paper that studied the sexual development of the hermaphrodite fish and debunked presumed norms on the origin of the male giant grouper.

Their paper titled "Reproductive development of the threatened giant grouper *Epinephelus lanceolatus*," published in the Aquaculture Journal last July 2019, presented evidence that male giant grouper do not need to pass through a female stage at an earlier stage in their lives, contrary to the belief that males only arise from mature females.

Palma's research paper was awarded in December 2020 by the Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD). The recognition is conferred to studies that made significant impacts in their respective fields.

The study was implemented by SEAFDEC/AQD, the University of Ryukyus (Japan), University of the Sunshine Coast (Australia), and Research Institute for Aquaculture (Viet Nam).



# Other Publications

Mature technologies produced and curated by SEAFDEC/AQD are packaged into publications to facilitate their dissemination to farmers, extension workers, the academe, and other stakeholders. Information materials are also produced to communicate the programs and activities of the Department.

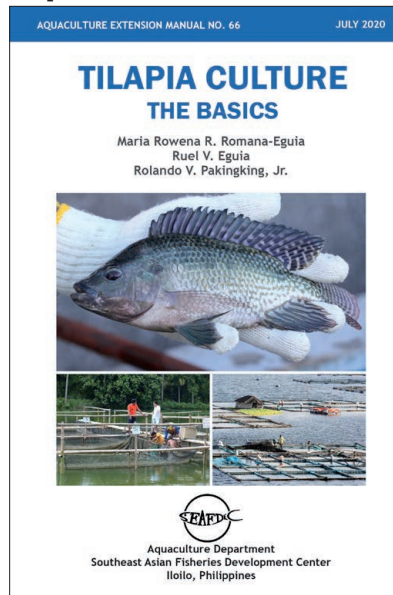
In light of the COVID-19 situation with limited opportunities to disseminate hard copies of publications, online dissemination was done through the SEAFDEC/AQD Institutional Repository (SAIR) and supported by social media promotions.

In 2020, two aquaculture extension manuals were produced. The manual *Tilapia Culture: The Basics* was immediately made available to the public through the SEAFDEC/AQD Institutional Repository, while the manual on *Biology and Hatchery Rearing of the Silver Therapon Leiopotherapon plumbeus* was made available by request.

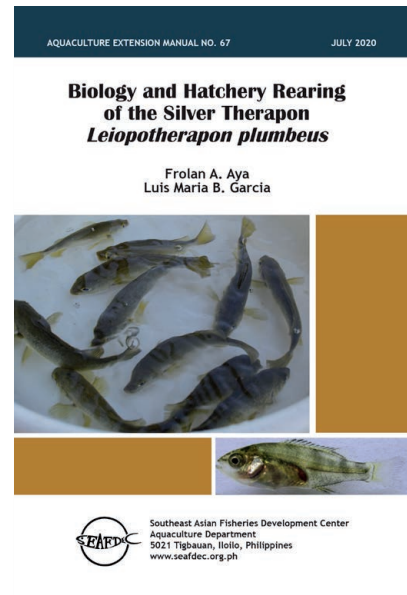
The *Regional Technical Guidelines on Early Warning System for Aquatic Animal Health Emergencies* was also published as an output of the ASEAN Regional Technical Consultation (RTC) on EMS/AHPND and Other Transboundary Diseases for Improved Aquatic Animal Health Management in Southeast Asia conducted in August 2018.

Other publications including a primer on the Department's priority programs, the *SEAFDEC/AQD Highlights 2019* annual report, and the bi-monthly *AQD Matters* newsletter were likewise produced and disseminated along with various brochures,

## Aquaculture extension manuals

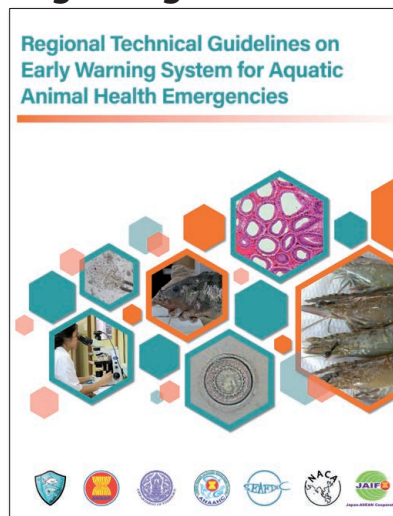


*Tilapia Culture: The Basics* (Aquaculture Extension Manual No. 66)



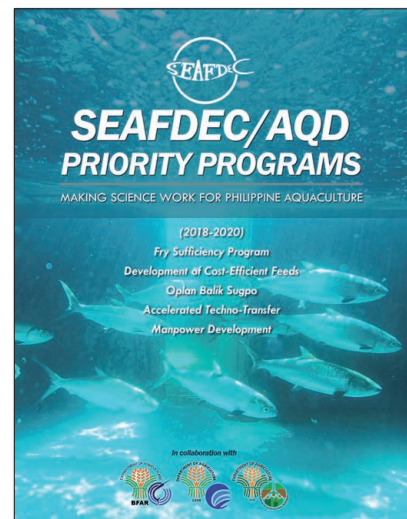
*Biology and Hatchery Rearing of the Silver Therapon Leiopotherapon plumbeus* (AEM No. 67)

## Regional guidelines



*Regional Technical Guidelines on Early Warning System for Aquatic Animal Health Emergencies*

## Primer



Primer on SEAFDEC/AQD Priority Programs (2018-2020)

## Annual Report



SEAFDEC/AQD Highlights 2019 Annual Report

## Newsletter



The AQD Matters newsletter continued to be released bimonthly in 2020

## Brochures



Some of the brochures published in 2020

## Online Platforms

SEAFDEC/AQD's Institutional Repository (SAIR) and Facebook pages led the dissemination of information over the Internet. The download of information materials through SAIR increased by 30.3% compared to 2019, logging a total of 2.2 million downloads. Meanwhile, followers of SEAFDEC/AQD Facebook pages increased by 48.3% to 24 thousand. This factors in the establishment of a new FishWorld Facebook page and the retirement of a previous account.

Website ([www.seafdec.org.ph](http://www.seafdec.org.ph)) traffic decreased by 5% compared to 2019, possibly due to the shift of users to information sourced directly from the repository. Views in the SEAFDEC/AQD YouTube channel also declined by 14.3%.

### WEBSITE



**54K**

(-2.9K ▼ 5.0%)

#### 2020 UNIQUE VISITORS

Most visitors come from English-speaking countries (Philippines, U.S.)

### FACEBOOK



**24K**

(+7.7K ▲ 48.3%)

#### FACEBOOK FOLLOWERS

Combined likes of Facebook pages (including Library, FishWorld)

### REPOSITORY



**2.2M**

(+514K ▲ 30.3%)

#### 2020 DOWNLOADS

The repository offers free downloads of SEAFDEC/AQD publications

### YOUTUBE



**62K**

(-10.3K ▼ 14.3%)

#### 2020 YOUTUBE VIEWS

Views mostly from instructional videos of aquaculture commodities

# News and Media

A total of 34 press releases were disseminated to the media in 2020, on top of other information campaigns that generated at least 71 appearances in local newspapers and international magazines. Another 67 features and other mentions of SEAFDEC/AQD were logged in news websites. Information staff also facilitated two local radio interviews and accommodated a shoot of a national TV show.

## FishWorld

FishWorld, SEAFDEC/AQD's visitor center and museum of aquatic biodiversity, received 8,584 guests in 2020. The Internship and On-the-Job Training Program of FishWorld listed 40 student participants from two high schools in Iloilo, Philippines.

FishWorld also works on the conservation of endangered megafauna. For 2020, 11 sea turtles were brought to FishWorld after being rescued from fish traps or found along the beach. Four of these turtles were released after tagging, two are undergoing rehabilitation, while the five turtles that died were preserved. Also, three hatchlings were released after FishWorld staff helped protect a nest in Iloilo.



Some media appearances of SEAFDEC/AQD in 2020

## FishWorld helps protect sea turtle nest



One of the turtle hatchlings released after FishWorld staff helped protect a nest

Staff of FishWorld provided assistance upon the discovery of a sea turtle nesting site last 24 October 2020 in the village of Atabay, Iloilo. Along with the locals, 68 turtle eggs were retrieved from the original nest and transferred a few meters to higher ground to keep them from the rising tide and stray dogs that began to gather around. FishWorld guided locals to secure the relocated nest while the eggs incubated. Towards the end of November 2020, three hatchlings surfaced from the nest and were immediately released to the sea. The hatchlings were identified as olive ridley turtles.



# PRODUCTION & SERVICES

To support food security in light of uncertainties surrounding the COVID-19 pandemic, seedstock production was ramped up and deliveries were made despite the hurdles of border restrictions. Market-size commodities continued to be produced as byproducts of research and verification activities. Service laboratories also continued to support the research needs of SEAFDEC/AQD as well as the private sector, academe, and government.



# Hatchery and grow-out production

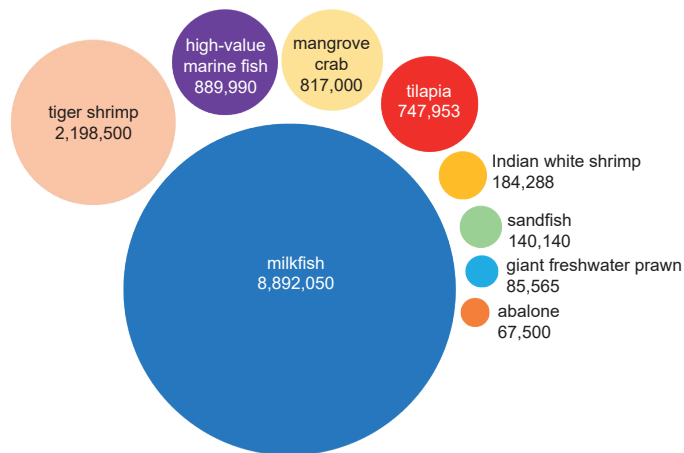
SEAFDEC/AQD labored to ramp up and ensure the uninterrupted production and delivery of aquaculture seeds despite difficulties in transportation and travel caused by the COVID-19 disruption. As a result, production of seeds expanded in 2020, led by almost nine million milkfish fry produced and harvested, an increase of more than two million from 2019. This was helped partly by thermal manipulation of broodstock tanks to allow breeders to continue spawning despite the cold season from November to February. It must be noted, however, that not all milkfish larvae produced are stocked and reared to fry because of lack of larval rearing facilities. New milkfish broodstock and hatchery facilities are being constructed to further expand production.

Tiger shrimp postlarvae production more than doubled to over two million in 2020 compared to just 862,600 in 2019. Production of crab instars also increased to 817,000 from just 656,200 the year before, while tilapia likewise increased to 747,953 from just 435,940.

Production of market-sized commodities generally scaled back in 2020, mainly because no white-leg shrimp were produced. Milkfish still constituted the bulk of grow-out production, reaping 14.6 tons in 2020, followed by 5.6 tons of tiger shrimp and Indian white shrimp.

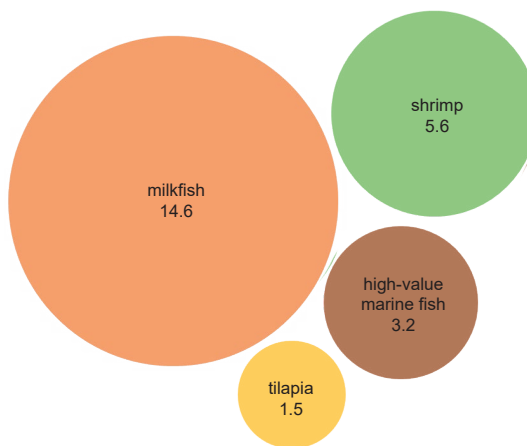
## Seedstock produced and harvested in 2020

pieces of fry for fish, postlarvae for shrimp and prawn, early juveniles for abalone and sandfish, crab instar 1 for mangrove crab

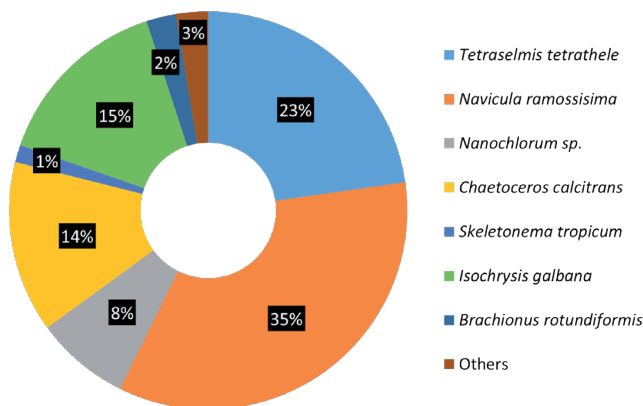


## Market-size commodities harvested in 2020

in metric tons



## Types of liquid starters produced in 2020



## Thermal manipulation increases milkfish fry production

THE PHILIPPINES experiences shortage of milkfish fry during the colder months of the year. Data from the SEAFDEC/AQD hatchery show that milkfish breeders normally spawn only between March and October when the weather, and consequently the water, is warmer. From November to February, the hatchery is essentially unproductive due to lower water temperatures.

To ensure the continuous supply of seeds even during the cold months, SEAFDEC/AQD promoted the use of thermal manipulation. Thermal manipulation was done by installing water heaters in a 500-ton tank and raising the temperature to at least 29 degrees Celsius from November to February.

Using this simple technology from December 2019 to February 2020 that is normally considered off-season by milkfish hatcheries, SEAFDEC/AQD was able to collect 23 million good eggs from the heated tank containing 76 breeders from which almost 13 million normal larvae were hatched. It was also observed that milkfish breeders in the unheated tank did not spawn.



Milkfish eggs produced during off-season with the help of thermal manipulation

## Production, delivery of seeds unhampered despite lockdowns

PRODUCTION and delivery of aquaculture seeds remain uninterrupted at SEAFDEC/AQD's main station in Tigbauan, Iloilo despite the enhanced community quarantine (ECQ) imposed in Iloilo and surrounding provinces due to the Coronavirus disease (COVID-19) pandemic.

During the ECQ period, SEAFDEC/AQD continued to deliver milkfish fry to fish farms in Iloilo, Guimaras, and Negros Occidental. Deliveries to Guimaras were received at Parola and Ortiz wharves while delivery to Negros Occidental was received at the Dumangas port. Crablets were also delivered to Capiz which were received at the Iloilo-Capiz border. Delivery of aquaculture seeds were done with due precaution by observing the minimum safety protocols such as physical distancing and wearing of mask among others.



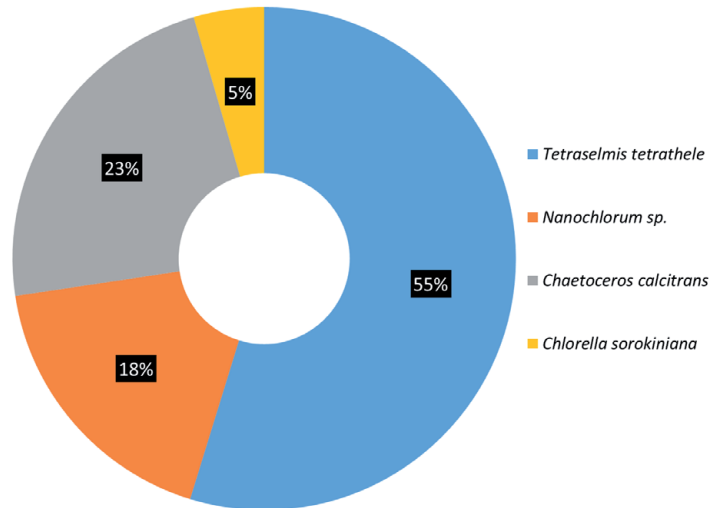
Delivery of milkfish fry done at the Iloilo-Capiz border to comply with COVID-19 quarantine measures

## Larval food production

To support the research and production activities of the Department, the Larval Food Laboratory served 7,197 liters (liquid) and 48.9 kg (paste) of microalgal, rotifer, and copepod starters.

The laboratory also catered to 163 clients from the private sector (70.55%), academe (20.86%), and government institutions (8.59%). The items disposed included 438 liters of liquid media fertilizers.

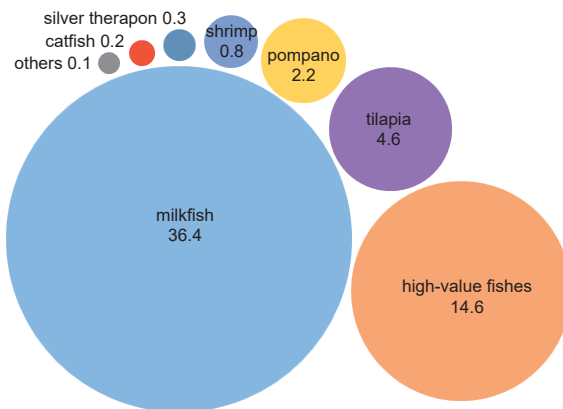
### Types of microalgal paste produced



## Feed mill production

Over 53 tons of aquafeeds for various commodities were produced by the Feed Mill in 2020, most of which (34 tons) were for milkfish. About 87% of these were produced for studies conducted at SEAFDEC/AQD. The rest were for external clients which included the academe (researchers and students) and private hatcheries. About 1.3 tons of feed ingredients were also supplied to stakeholders.

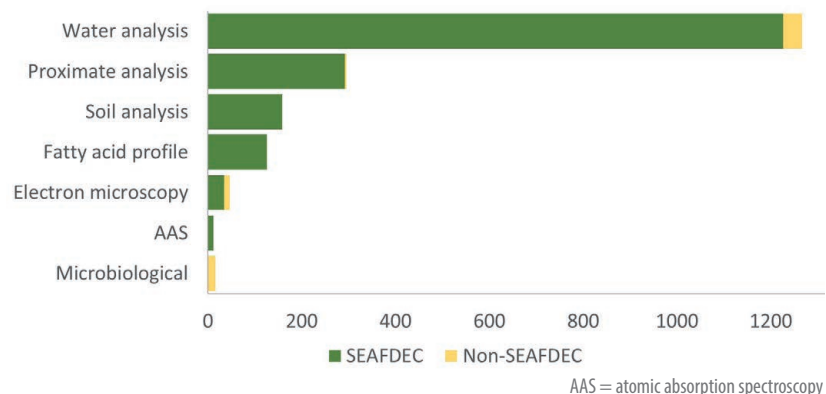
### Types of aquafeed produced in metric tons



## Analytical Services

The Laboratory Facilities for Advanced Aquaculture Technologies (LFAAT) conducts proximate, water, soil, microbiological, and atomic absorption analysis as well as fatty acid profiling and electron microscopy. LFAAT accepted 1,920 samples, most of which were analyzed in support of SEAFDEC/AQD's various research programs. Other samples were submitted by stakeholders from the private sector and the academe. Bulk of

### Types of analyses conducted

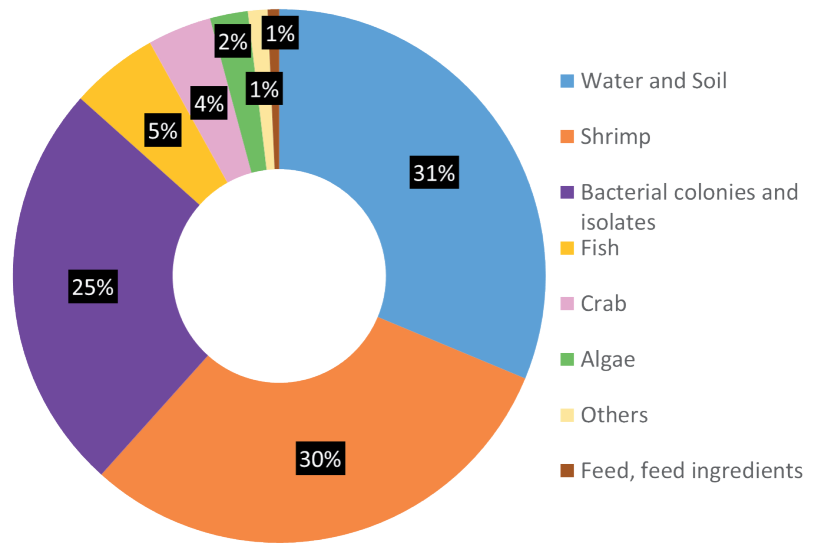


the samples received were for water analyses (1,266). Other services given were proximate analysis (295), soil (158), fatty acid profiling (126), electron microscopy (47), microbiological analysis (16), and atomic absorption spectroscopy (12). LFAAT also received 25 requests on the use of laboratory facilities.

## Diagnostic Services

The Fish Health Section handles diagnostic cases for a range of viruses, bacteria and parasites. Diagnostic services catered to 2,865 cases in 2020, mostly provided with water and soil samples (31%). Diseases were detected mainly through polymerase chain reaction (PCR)

Types of diagnostic cases examined



## Certificate of Authority to Operate granted to CAL

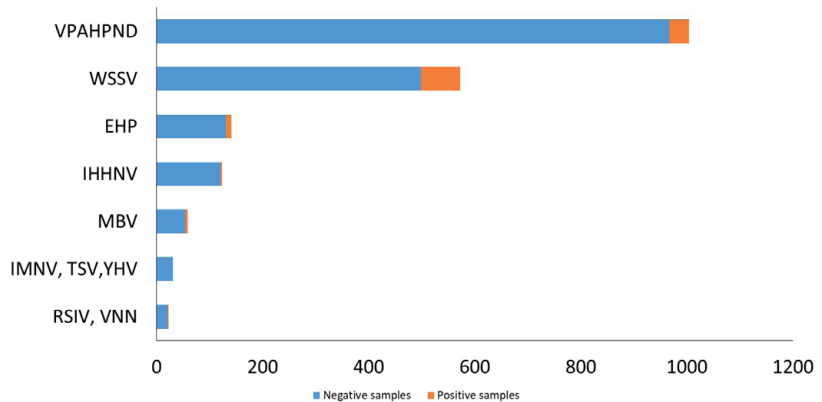
SEAFDEC/AQD's Centralized Analytical Laboratory (CAL) received its Certificate of Authority to Operate (CAO) on 31 January 2020 from the Professional Regulation Commission Iloilo Branch, which was issued by the Professional Regulatory Board of Chemistry on 10 October 2019 and is valid for three years. The Certificate is in compliance with Sec. 35 of RA 10657 and known as the Chemistry Law of the Philippines, which states that "only firms, corporations and government agencies duly authorized by the Board that hold a valid certificate may operate a chemical laboratory or engage in the practice of chemistry or chemical analysis in the Philippines." The granting of the Certificate to CAL was facilitated by the Laboratory Facilities for Advanced Aquaculture Technology team headed by Engr. Margarita Arnaiz.



with 1,952 samples analyzed. Acute hepatopancreatic necrosis disease (AHPND) was the most requested disease for diagnosis with 1,004 samples analyzed followed by white spot syndrome with 572 samples.

Bacterial count was also done on 1,303 samples and bacterial identification was done for 160 samples with a total of 160 isolates. Meanwhile, the Microtechnique Laboratory released 540 slides and 446 blocks from 486 samples received.

### Diagnosis summary



## Library services

The present collection of the SEAFDEC/AQD Library stands at 46,649 titles with 79,850 volumes or copies. The collections stand at 21,476 monographs, 5,795 SEAFDEC Publications, 19,382 bound serial volumes, 10,691 pamphlets, and a variety of maps, posters, microfiche, and CD-ROMs. These were available for use and could be searched online through the SEAFDEC/AQD Library online public access catalog (OPAC).

The OPAC was visited by a total of 3,636 global searchers. In addition,

the library offers access to the following databases: ASFA, Springer, ProQuest Central, and TEEAL. The Library served 1,280 readers, a majority of whom were from different academic institutions in the Philippines, students, faculty, and researchers. The remaining percentage was composed of visitors from fisheries-related agencies in SEAFDEC member countries, private sectors, and non-government institutions.

A total of 3,442 (1,895 SAIR; 1,547 in-house) document requests were catered from about 1,462 (1,327 SAIR; 84 in-house) individ-

uals. Seventy-eight percent of the documents requested were placed thru the SEAFDEC/AQD Institutional Repository (SAIR). Majority of the requesters were from the Philippines, India, Malaysia, Indonesia, USA, Singapore, Thailand, United Kingdom, Sri Lanka, Denmark, Germany, Uganda, etc. The remaining percentage of documents requested were in person, and remotely, through email, phone, chat, and Facebook messenger, the majority by SEAFDEC/AQD employees.

# HUMAN RESOURCES & FINANCE

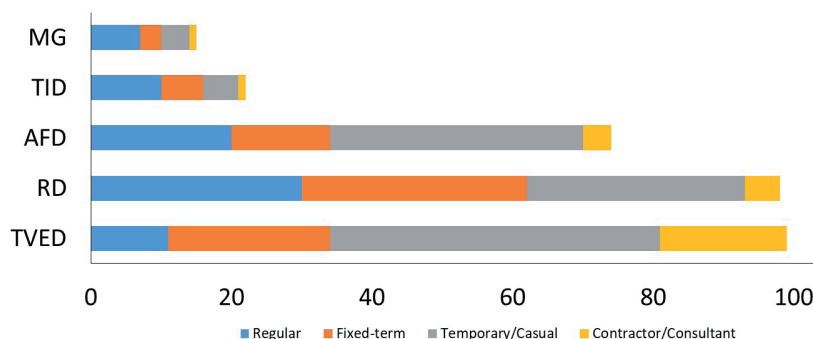
SEAFDEC/AQD personnel continued to work productively despite the limitations brought about by COVID-19. Despite travel restrictions, a shift to online meetings and conferences also opened up new avenues to enhance the capacity and promote the productivity of employees. The fiscal resources provided to SEAFDEC/AQD remained robust, enabling the construction of new research and production facilities.



# Personnel Distribution

As of end of 2020, SEAFDEC/AQD's personnel numbered 308 composed of 78 regular employees, 78 fixed-term staff, 123 casuals, and 29 contractors/consultants. The Technology Verification and Extension Division (TVED) had the most staff (99) assigned to it, followed by the Research Division (RD) with 98, Administration and

## Personnel Distribution



## Dr. Sayaka Ito is new Deputy Chief



DR. SAYAKA Ito began his term as SEAFDEC/AQD Deputy Chief, last 1 Oct. 2020 and was welcomed to the Tigbauan Main Station in 20 Oct. 2020.

Dr. Ito, a Japanese scientist with expertise in aquatic conservation biology, replaced Dr. Koh-ichiro Mori who served as Deputy Chief from April 2018 to June 2020.

Upon endorsement by the Government of Japan, SEAFDEC Secretary-General Malinee Smithrithee appointed Dr. Ito to a 2-year term to end 30 Sept. 2022 wherein he will also serve as co-manager of the Japanese Trust Fund.

Dr. Ito has experience working in Lao People's Democratic Republic where they established a research-based stock management system for their indigenous high-value freshwater prawn. The system also considered the customs and behaviors of the locals and eventually contributed to the sustainable

use of the prawn resource and improvement in the income of the people.

Immediately prior to his appointment, Dr. Ito worked for seven years at the Hokkaido National Fisheries Research Institute of the Japan Fisheries Research and Education Agency (FRA).

As the leader of the Stock Enhancement Group, Dr. Ito and his colleagues examined the migration pattern and habitat use of high-value prawn and the environmental characteristics of the kelp (*Laminaria*) fishing grounds using GIS (Geographic Information System). He also studied the business structure of small-scale fishing households in the coastal area of eastern Hokkaido.

From 2006 to 2013, he was a senior researcher at the Fishery Division of the Japan International Research Center for Agricultural Sciences (JIRCAS). During his 7-year stint with the organization, he worked on the stock management system of prawn in Lao People's Democratic Republic.

From 2003 to 2005, he became a Postdoctoral Research Fellow at the Center for Marine Environmental Studies at Ehime University. He became involved in researches examining non-native freshwater fishes and its interspecific interactions with native fishes in Japan.

Dr. Ito also briefly worked as a junior high school science teacher from 2005 to 2006 at Komatsu Junior High School in Saijyo City, Ehime, Japan. From 2002 to 2003, he also taught science at the Hanada Junior High School for Handicapped Students in Nagano, Japan.



Finance Division (AFD) with 74, and the Training and Information Division (TID) with 22. The Management Group was composed of 15 personnel.

## COVID-19 measures

The Coronavirus disease (COVID-19) pandemic, caused by the global spread of the SARSCoV-2, as the novel virus is called, caused unprecedented disruptions in the way people live and work all over the world. When COVID-19 cases were increasing and with cases of local transmission detected, Philippine President Rodrigo Duterte issued Presidential Decree No. 922 “Declaring a State of Public Health Emergency Throughout the Philippines” on 8 March 2020.

Following suit from the national government, SEAFDEC/AQD Chief Dan Baliao, issued an administrative order (AO) “Department-wide Guidelines on COVID-19 Pandemic” on 19 March 2020. The administrative order prescribed precautionary measures that affected employee work schedules, travels, the conduct of trainings and seminars, and processing of documents.

The next day, on 20 March, Iloilo Gov. Arthur Defensor, Jr. issued Executive Order No. 080 declaring an enhanced community quarantine in the province of Iloilo, effectively shuttering nonessential establishments, imposing strict curfews, and restricting travel for the duration of the quarantine

Despite broad restrictions eventually imposed over the entire Panay Island, SEAFDEC/AQD continued to function as a provider of essential services that are vital to food security. Nevertheless, preventive measures were necessary and dis-



SEAFDEC/AQD employees observing physical distancing inside service shuttles



Disinfection of offices and common areas as a precautionary measure against COVID-19

ruptions to some activities were inevitable.

To ensure the safety and well-being of employees during the COVID-19 pandemic, the HRMS formulated Department-wide guidelines for the different community quarantine settings imposed throughout the Philippines. The guidelines include the implemen-

tation of work from home and skeleton workforce arrangement, transportation arrangement for employees, prohibiting the conduct of hands-on training and in-house seminars, and observance of safety protocols in accepting guests and visitors with official transaction, among others. To recognize the services of employees who physically

report to work during the Enhanced Community Quarantine period, the Management, through the Human Resource Management Section (HRMS), approved the granting of the COVID-19 hazard pay to compensate for health risks brought about by the COVID-19 pandemic.

Meanwhile, the use of email for the electronic processing of documents and requests were also encouraged to minimize physical interaction. Important meetings were done following safety measures such as wearing of mask and observing physical distancing. SEAFDEC/AQD also adopted video conferencing as a way to communicate with other SEAFDEC departments and with key personnel who cannot be present in person. The conduct of in-house seminars and other gatherings within SEAFDEC/AQD premises were also put on hold.

## Alayon is PRC Outstanding Professional Awardee



STEPHEN Alayon, head of the Library and Data Banking Services Section, joins the roster of Outstanding Professional Awardees chosen by the Professional Regulation Commission (PRC) of the Philippines. Under the Business Education and Social Services Cluster, Alayon is the sole librarian bestowed with the award.

According to PRC, the Outstanding Professional of the Year award is the highest recognition conferred by the commission to individuals who excelled and contributed significant impacts to society in their line of expertise.

Under his leadership at the SEAFDEC/AQD Library, Alayon pioneered numerous projects that remarkably contributed to information dissemination in the field of aquatic science. He, along with his colleagues, developed the SEAFDEC/AQD Institutional Repository, wherein thousands of research papers and other references produced by the research center were made freely accessible to the public. The success of the online repository led to its recent adoption by other SEAFDEC departments.

As the president of the International Association of Aquatic and Marine Science Libraries and Information Centers (IAMSLIC), he also initiated the distribution of the IAMSLIC Digital Library to 35 state universities and colleges around the Philippines. The library boxes contain over 26,000 digitized publications from SEAFDEC, Secretariat of the Pacific Community, Aquatic Commons, and OceanDocs repositories that users can access freely using their smartphones or laptops without the need for data or an Internet plan.

## Meetings & Conferences Attended by Staff

Event	Date	Location
SEAFDEC Inter-Departmental Information Workshop: "Status of the Implementation and Monitoring of the Strategies for Enhancing SEAFDEC Visibility and Communication"	4–7 Feb 2020	Samut Prakan, Thailand
Global Seaweed STAR Capacity Building Workshop for the Bioinformatics Analysis of Seaweed Microbiomes	7–17 Feb 2020	Kuala Lumpur, Malaysia
Foundation Course on Intellectual Property	19–22 Feb 2020	Taguig City, Philippines
Global Seaweed STAR Workshop: Capacity Building Workshop on Seaweed Taxonomy and Fieldwork	1–15 Mar 2020	Tanzania
Introduction to Patent Search and Basic Claim Drafting Training Course	3–14 Mar 2020	Taguig City, Philippines
Hazardous Waste Management & Updated Regulatory Guidance for Laboratories	6 Mar 2020	Bacolod City, Philippines
DOST PCAARRD TREP Evaluation of R&D Proposals (Milkfish, Shrimp, Tilapia, Eel and Inland Aquatic Biodiversity)	11 Mar 2020	Laguna, Philippines
Consultative Meeting on the Crafting of the IRR for RA 11398 or the Philippine Fisheries Profession Act	12 Mar 2020	Pasay City, Philippines
Emerald Publishing and PLAI Online Lecture: Forum on COVID-19 and Post Community Quarantine Strategies for Libraries	27 April 2020	Online
PAARL Webinar on From Practice to Publication: Publications Tips for Filipino Librarians	8 May 2020	Online
DA BAFS Technical Working Group Meeting to finalize Tilapia and Milkfish Philippine National Standards	14, 27 May 2020	Online
UST MALIS Webinar Series on Libraries in the New Normal: Managing Reference Service in the Virtual Environment	23 May 2020	Online
Philippine Shrimp Aquaculture in the Midst of the COVID-19 Pandemic	29 May 2020	Online
FAO Virtual Workshop: Development of a Global Information System for Aquatic Genetic Resources	8–12, 22 June 2020	Online
NLP, ALPS, Regalo: Touching Lives Webinar on Library Resiliency	11 June 2020	Online
Government of Japan Trust Fund 6 (GOJ-TF6)	18 June 2020	Online
National Research Council of the Philippines (NRCP) Scientific Conference and General Membership Assembly	30 June 2020	Online

Event	Date	Location
Research Integrity and Publishing Ethics	30 June 2020	Online
40th Philippine-American Academy of Science and Engineering (PAASE) and 2020 APAMS Annual Scientific Meeting Philippines	5 July 2020	Online
FAO AMR Program Lecture Series: Proposal Writing and Research Collaboration	7 July 2020	Online
National University of Singapore (NUS) - Digital Scholarship Team Webinar on Digital Scholarship and Open Access in Southeast Asia	15 July 20	Online
Science Policy and Information Forum on Fish Security Amidst COVID-19 Pandemic	15 July 2020	Online
The Current and Future Outlook of Aquaculture and Aquaculture Nutrition	26 July 2020	Online
PLAI-NIRLC, CE-Logic Inc. Webinar on Responding to New Normal Environment: Keeping Your Staff, Patrons, and Facilities Safe	26 July 2020	Online
Aquaculture in the time of COVID 19: Improving Farm Productivity through Genetic Interventions in Aquatic Animal Health Management	5 Aug 2020	Online
Innovative Technologies in Improving Aquaculture Practices	7 Aug 2020	Online
DOST WVHRDC Webinar: Guide to Writing a Health Research Proposal (Module 1: Writing the Different Parts of a Research Proposal)	12, 19, 26 Aug 2020	Online
Joint Web Seminar on the Blue Economy in the Southern Philippines: A Pathway to Policy Change: Improving Philippine Fisheries, Blue Economy, and Maritime Law Enforcement in the Sulu and Celebes Seas	17 Aug 2020	Online
2nd TWG Meeting on Risk Assessment Analysis of Tilapia and Common Carp using FISK	19 Aug 2020	Rizal, Philippines
Role of Women in Developing a Climate-Smart Seed System in the Philippines	19 Aug 2020	Online
OIE Regional Virtual Meeting on Decapod Iridescent Virus 1	20 Aug 2020	Online
PGLL Webinar on A Tripartite Discussion on Copyright and Access to E-Resources for Librarians and Information Professionals	20 Aug 2020	Online
PLAI-WVRLC Webinar Libraries and Pandemic: Personal and Institutional Preparedness of Libraries and Librarians in Western Visayas	20 Aug 2020	Online

Event	Date	Location
Teleseminar on Way Forward for Combatting IUU Fishing in Southeast Asia	24–26 Aug 2020	Online
Environmental Governance Webinar Series (Environmental Justice Sector Reform Project)	2 Sept 2020	Online
ASEAN on Point' Public Forum #1: Ensuring The Resilience and Sustainability of Agriculture and Food Sector in ASEAN in the Context of COVID-19	3 Sept 2020	Online
DOST WVHRDC Webinar: Guide to Writing a Health Research Proposal (Module 2: Research Methods)	8, 15, 22, 29 Sept 2020	Online
3rd TWG Meeting on Risk Assessment Analysis of Tilapia and Common Carp using FISK	9 Sept 2020	Batangas, Philippines
The Lonely Road Travelled: Lessons learned as an ECR/PhD	22 Sept 2020	Online
Philippine Chamber of Commerce Incorporated (PCCI) 2020 Alfredo M. Yano Intellectual Property Awards	29 Sept 2020	Online
UPIS ISDA talk: A Conversation on Conservation	30 Sept 2020	Online
Mental Health in time of Pandemic	30 Sept 2020	Online
ASEAN Fisheries Education Network	10 Oct 2020	Online
46th IAMSLIC Annual Conference: Changing Tack: Adjusting our Sails to Navigate Uncertain Waters	13–14 Oct 2020	Online
Genetics and Genomics Technologies for Sustainable Aquaculture	21 Oct 2020	Online
Aquafeeds in Africa	22 Oct 2020	Online
The Research Grant Applications Guide	22 Oct 2020	Online
PAPRB Philippine Professional Summit	23–24 Oct 2020	Online
Regional Review on Aquaculture in Asia and the Pacific	26 Oct 2020	Online
Application of Advanced Technologies in Fisheries	4 Nov 2020	Online
Forum on Blue Economy: Aquaculture Potential in the MIMAROPA Region	9 Nov 2020	Online
1st Consultation Meeting on the Crafting of Fisheries Biotechnology Tilapia R&D Program	10 Nov 2020	Online

Event	Date	Location
Iloilo Mega Book Fair (IMBF) 2020: A City Built on Books	12–15 Nov 2020	Online
PLAI Online Congress and General Assembly: Libraries as Catalysts in the New Normal Environment: Changes. Reforms. Transformation.	24–27 Nov 2020	Online
Symposium on Biotechnological Applications Towards a Resilient and Sustainable Agriculture	25 Nov 2020	Online
Twenty First Meeting of SEAFDEC Information Staff Program	30 Nov–1 Dec 2020	Online
UN Food and Agriculture Organization Asian Regional Consultation on the Development of Guidelines for Sustainable Aquaculture	30 Nov–2 Dec 2020	Online
Iloilo Investment Forum for Economic Recovery	10 Dec 2020	Online

## Summary of Grants Received

Organization	Scope	Amount (USD)
National Fisheries Research and Development Institute (NFRDI)	Field testing of low cost aquaculture feed for milkfish and tilapia in ponds and cages (Jan 2018–Dec 2020)	145,763
Australian Centre for International Agricultural Research (ACIAR)	Increasing technical skills supporting community-based sea cucumber production in Vietnam and the Philippines (Oct 2018–Dec 2020)	42,583
Japan International Research Center for Agricultural Sciences (JIRCAS)	Demonstration and verification of sustainable and efficient aquaculture techniques by combination of multiple organisms (Jan–Dec 2020)	27,466
DSM Nutritional Products Phils.	Evaluation of DSM formulated feeds with phytase and carbohydrases	24,601
The Scottish Association for Marine Science (SAMS)	Safeguarding the future of the Seaweed Industry in the Philippines: Disease and Pest Detection (Jan–Dec 2020)	23,369
National Fisheries Research and Development Institute (NFRDI)	On-line Training Course on SEAFDEC/AQD Developed Aquaculture Technologies for Milkfish & Mangrove Crab (Sept 14–17, 2020)	2,287
Department of Science and Technology (PCAARRD)	Molecular mechanism underlying <i>Scylla serrata</i> response to white spot syndrome virus (WSSV) infection (Jan–Dec 2020)	3,618
<b>TOTAL</b>		<b>269,687</b>

# Statement of Financial Position

SOURCES OF FUNDS		USD	APPLICATION OF FUNDS		USD
<b>Contributions from the Government of the Philippines</b>		<b>6,038,773.09</b>	<b>General/Administrative &amp; Non-project Expenses</b>		
<b>Government of Japan Trust Fund (GOJ-TF)</b>			Research Division (RD)		889,859.20
Development of strategies & technologies for aquaculture production in Southeast Asia		40,000.00	Technology Verification & Extension Division (TVED)		506,668.25
Development of procedures in disease control and management against shrimp and fish diseases in Southeast Asia		40,000.00	Training and Information Division (TID)		84,034.69
Capacity Enhancement on Sustainable Aquaculture and aquatic animals Health Management in Southeast Asia		30,000.00	Administrative & Finance Division (AFD)		1,497,958.29
Progress Management of Project		20,000.00	Management Group (MG)		244,573.06
<b>Sub-total</b>		<b>130,000.00</b>	<b>Sub-total</b>		<b>3,223,093.49</b>
<b>External Grants</b>			<b>Program/project expenses</b>		
DOST PCAARRD-Molecular mechanisms		3,618.06	RD		1,800,688.16
NFRDI-Aquaculture Feed Development		145,763.49	TVED		221,376.15
DSM-Evaluation of DSM formulated feeds		24,600.71	TID		63,087.73
ACIAR-USC Technical skills support community-based sea cucumber production		42,582.73	<b>Sub-total</b>		<b>2,085,152.04</b>
FSWCLA-NFRDI		2,286.82	<b>Projects of GOJ-TF</b>		
SAMS Global SeaweedSTAR		23,369.37	Development of strategies & technologies for aquaculture production in Southeast Asia		40,017.39
JIRCAS Demonstration and Verification of sustainable and efficient aquaculture techniques		27,466.13	Development of procedures in disease control and management against shrimp and fish diseases in Southeast Asia		39,963.27
<b>Sub-total</b>		<b>269,687.30</b>	Capacity Enhancement on Sustainable Aquaculture and aquatic animals Health Management in Southeast Asia		29,725.44
<b>Internally generated (Income)</b>			Progress Management of Project		20,293.90
Research Division		107,335.88	<b>Sub-total</b>		<b>130,000.00</b>
Training & Information Division		9,138.32	<b>Externally-funded projects</b>		
Technology Verification & Extension Division		259,147.26	DOST PCAARRD		8,991.64
Administrative & Finance Division		97,085.03	NFRDI		52,873.47
Management Group		6.98	DSM		24,343.13
<b>Sub-total</b>		<b>472,713.47</b>	University of Sunshine Coast		61,145.11
<b>TOTAL</b>		<b>6,911,173.86</b>	JIRCAS		26,681.47
			BFAR		2,761.39
			JAIF		288.61
			<b>Sub-total</b>		<b>177,084.81</b>
			<b>Committed Funds</b>		
			On-going activities		400,053.47
			Capital outlay/repairs		895,790.05
			<b>Sub-total</b>		<b>1,295,843.52</b>
			<b>TOTAL</b>		<b>6,911,173.86</b>

Note: US\$1.00 = PHP48.02

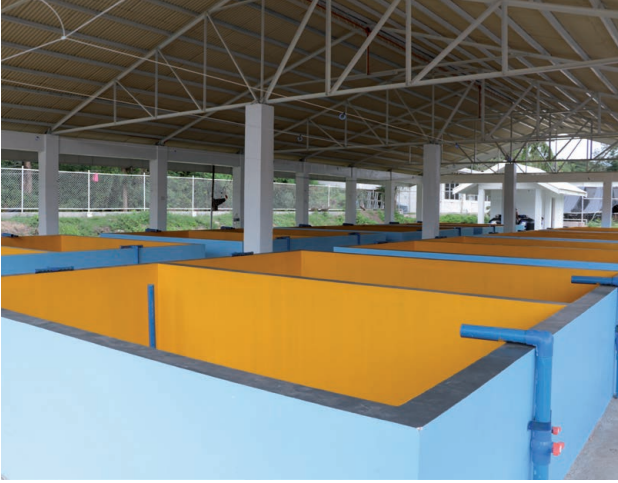
# Priority infrastructure projects as of end 2020



Milkfish broodstock tanks (4 units)



Multi-species marine hatchery



Multi-species freshwater hatchery





# COLLABORATION IN 2020

## Academe

Partner Institution	Nature of collaboration	Period
Western Philippines University	On-the-Job Training Program	27 Jan 2016– 26 Jan 2021
John B. Lacson Foundation Maritime University-Arevalo	Research collaboration	17 Feb 2017– 31 Jan 2022
St. Paul University Iloilo	Collaboration in undertaking research, instruction, training, and extension programs	25 Oct 2019– 24 Oct 2024

## Government and Non-Government Organizations

Partner Institution	Nature of collaboration	Period
Department of Agriculture-Bureau of Fisheries and Aquatic Resources (DA-BFAR)/BFAR Caraga	Establishment of the Multi-species Hatcheries in the Municipality of Jabonga in the Province of Agusan del Norte	June 2020
DA-BFAR/BFAR Caraga	Establishment of the Multi-species Hatcheries in the Municipality of Lingig in the Province of Surigao del Norte	June 2020
DA-BFAR/BFAR Caraga	Establishment of the Multi-species Hatcheries in the Municipality of Del Carmen in the Province of Surigao del Norte	June 2020
BFAR Region 6	Conduct an assessment of existing hatcheries in the region, prepare plans and cost estimates of identified priority hatchery for rehabilitation, and extend necessary technical assistance in the hatchery operation	2020–2025
DSM Nutritional Products Philippines, Inc.	Evaluation of DSM formulated Feeds with Phytase and Carbohydrase	2020
Japan International Research Center for Agricultural Sciences (JIRCAS)	Provide technical assistance to visiting scientist from JIRCAS	14 July 2016– 31 March 2021
Scottish Association for Marine Science	Conduct of the research project on “Safeguarding the Future of the Seaweed Industry in the Philippines”	01 Oct 2017– 31 Dec. 2021
National Fisheries Research and Development Institute (NFRDI)	Collaborative projects on aquafeed research, development and extension	July 2018– June 2021

# HEADS OF OFFICES IN 2020

## Executive Committee

Chief	Mr. Dan Baliao
Deputy Chief	Dr. Koh-ichiro Mori (until 30 June) Dr. Sayaka Ito (beginning 1 Oct)
Head, Research Division	Dr. Leobert de la Peña
Head, Technology Verification & Extension Division	Dr. Roger Edward Mamauag
Head, Training & Information Division	Dr. Edgar Amar
Head, Administration & Finance Division	Ms. Amelita Subosa

## Program Leaders

Quality Seed for Sustainable Aquaculture	Dr. Maria Rowena Eguia
Healthy & Wholesome Aquaculture	Dr. Mae Catacutan, Dr. Eleonor Tendencia
Maintaining Environmental Integrity through Responsible Aquaculture	Dr. Jon Altamirano
Meeting Social & Economic Challenges in Aquaculture	Dr. Nerissa Salayo
Regional Programs	Dr. Koh-ichiro Mori (until 30 June) Dr. Sayaka Ito (beginning 1 Oct)

## Station Heads/OIC

Binangonan Freshwater Station	Dr. Frolan Aya
Dumangas Brackishwater Station	Mr. Victor Emmanuel Estilo
Igang Marine Station	Mr. Mateo Paquito Yap
Manila Office	Ms. Christine Joy Catig

## Section Heads/OIC

### *Research Division*

Breeding & Seed Production	Dr. Shelah Mae Ursua
Fish Health	Dr. Eleonor Tendencia
Nutrition & Feed Development	Mr. Joseph Biñas
Farming Systems & Ecology	Dr. Jon Altamirano
Socioeconomics	Dr. Nerissa Salayo

### *Technology Verification & Extension Division*

Technology Verification	Dr. Roger Edward Mamauag
Extension & Packaging	Ms. Erish Estante

### *Training & Information Division*

Training	Mr. Caryl Vincent Genzola
Development Communication	Mr. Rex Delsar Dianala
Library & Databanking Services	Mr. Stephen Alayon

### *Administration & Finance Division*

Engineering	Engr. Hermoso Igcasan Jr.
Human Resources Management	Ms. Sunshine Mae Salonga
Budget-Cashiering	Ms. Jiji Rillo
Accounting	Ms. Jo Anne Coronel

# Ongoing and completed infrastructure projects at the Tigbauan Main Station

Broodstock Tanks

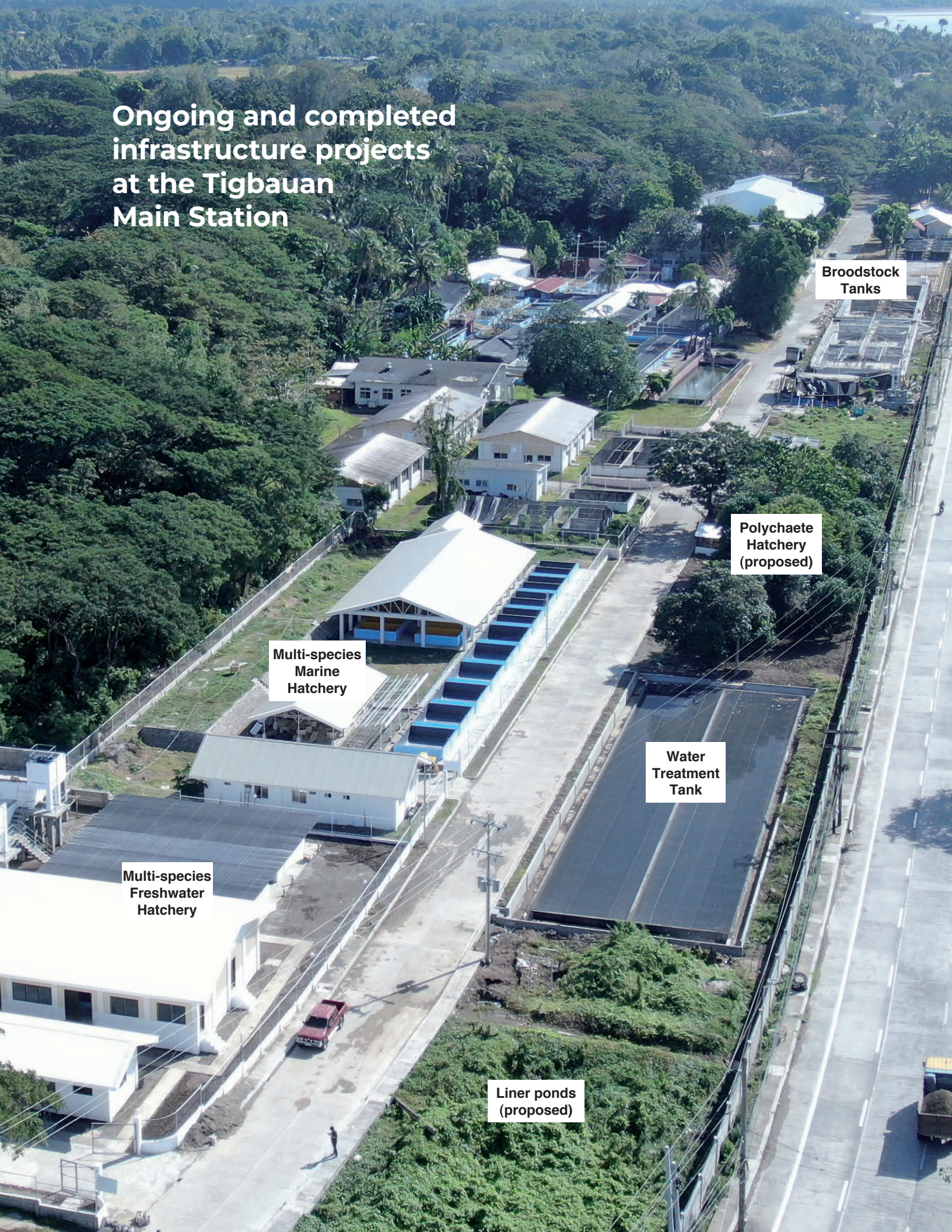
Polychaete Hatchery (proposed)

Multi-species Marine Hatchery

Water Treatment Tank

Multi-species Freshwater Hatchery

Liner ponds (proposed)





Southeast Asian Fisheries Development Center  
**AQUACULTURE DEPARTMENT**  
[www.seafdec.org.ph](http://www.seafdec.org.ph)

The Southeast Asian Fisheries Development Center (SEAFDEC) is a regional treaty organization established in December 1967 to promote fisheries development in the region. The member countries are Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam.

The policy-making body of SEAFDEC is the Council of Directors, made up of representatives of the member countries.

SEAFDEC has five departments that focus on different aspects of fisheries development:

- The Training Department (TD) in Samut Prakan, Thailand (1967) for training in marine capture fisheries
- The Marine Fisheries Research Department (MFRD) in Singapore (1967) for post-harvest technologies
- The Aquaculture Department (AQD) in Tigbauan, Iloilo, Philippines (1973) for aquaculture research and development
- The Marine Fishery Resources Development and Management Department (MFRDMD) in Kuala Terengganu, Malaysia (1992) for the development and management of fishery resources in the exclusive economic zones of SEAFDEC member countries, and
- The Inland Fishery Resources Development and Management Department (IFRDMD) in Palembang, Indonesia (2014) for sustainable development and management of inland capture fisheries in the Southeast Asian region.

AQD is mandated to:

- Conduct scientific research to generate aquaculture technologies appropriate for Southeast Asia
- Develop managerial, technical and skilled manpower for the aquaculture sector
- Produce, disseminate and exchange aquaculture information

AQD maintains four stations: the Tigbauan Main Station and Dumangas Brackishwater Station in Iloilo Province; the Igang Marine Station in Guimaras province; and the Binangonan Freshwater Station in Rizal province. AQD also has a Manila Office in Quezon City.