Re-establishing the Sea Cucumber Resources in the Philippines: the Masinloc Experience

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Sea cucumber of the Family Holothuriidae and Stichopodidae, is among the most commercially-exploited aquatic species in Southeast Asia in view of the increasing demand of their processed form in the international market. Together with its products, sea cucumber is called by many names in the Southeast Asian region, *e.g.* "*trepang*" in Indonesia, "*gamut*" in Malay, "*balatan*" or "*balat*" in the Philippines. In the international market it is popularly known as "*beche-de-mer*" which literally means "sea worm." Next to Indonesia, the Philippines is among the top Southeast Asian countries that produce sea cucumber from capture fisheries and aquaculture, where it is processed immediately through direct sun-drying after harvest or sold fresh in local markets for domestic consumption. Most of the reported 100 or more species of sea cucumber found in Southeast Asian waters belong to the Genera *Holothuria* (*e.g. Holothuria scabra*, *H. fuscogilva*); *Actinopyga*; *Bohadschia*; *Stichopus*; and *Thelenota*. The Philippines is blessed with high density of various sea cucumber species that inhabit its wide sea grass beds, soft bottom sea areas, and coral reefs, making the country one of the largest exporters of the processed sea cucumber to the world market. However, wild stocks of sea cucumber in the Philippines have long been depleted due to increased fishing pressure, prompting the Philippine Government through the Bureau of Fisheries and Aquatic Resources (BFAR) to regularly monitor and assess the population of sea cucumber in the country's waters, the results of which are used as basis for enhancing the country's sea cucumber resources to curb the near extinction of such commercially exploited aquatic species, and at the same time, meeting the demand for sea cucumber in the international market. The effort of the Philippines to revive and re-establish the stocks of sea cucumber in its waters is also meant to prevent the inclusion of more commercially-important species of sea cucumber in the International Union for Conservation of Nature (IUCN) Red List of Threatened Species that serves as basis for CITES to re-evaluate sea cucumber stocks' status for possible listing of the species into the CITES Appendices. Thus, BFAR has been promoting trials in its field stations to culture the local commercially-important sea cucumber species *H. scabra* from hatchery to grow-out. The sea cucumber juveniles produced from BFAR field stations are used not only for resource enhancement but also for the development of viable culture technologies that could be adapted by impoverished fisherfolks who have always relied on the collection of sea cucumber from the wild.

Sea cucumber is an important economic resource in Southeast Asia because of its potentials to alleviate poverty if cultured and processed properly, providing not only livelihoods to peoples in near-shore areas but also channels for investment opportunities. Sea cucumber is a multi-million dollar industry (FAO, 2008), especially in the food business and in pharmaceutical industries as well. There is a big export market for sea cucumbers, *e.g.* Hong Kong SAR, China, Taiwan, Republic of Korea, Japan, and in the United States, where dried sea cucumber could easily command high prices that range from US$180 to US$250 per kg. Bruckner *et al.* (2003) reported that approximately 80% of the overall international trade of sea cucumber is destined for China and Hong Kong SAR.

Sea Cucumber Resources of the Philippines

In the Philippines (**Figure 1**), collection from the wild and processing of sea cucumbers have been practiced throughout the country but most especially in the Provinces of Pangasinan, La Union, Cagayan, Zambales, Quezon, Batangas, Cebu, Negros Occidental, Surigao del Norte, South Cotabato, and Tawi-Tawi (Trinidad-Roa, 1987). Akamine (2001) added that sea cucumbers are also harvested in the southern part of the Palawan and in Leyte (Shoppe *et al.*, 1998), and in Misamis Occidental (Heinen, 2001). Sea cucumbers are collected by subsistence and artisanal fisheries in West Central Visayas (Nievales, 2007), Iligan Bay (Metillo *et al.*, 2004), and Davao Gulf (Gamboa *et al.*, 2004). During the 1900s, Seale (1911) reported that supplies of processed sea cucumbers are regulalry transported to Manila from Leyte, Quezon, and Camarines Provinces.

Figure 1. Map of the Philippines showing the major sea cucumber collection hotspots

Trinidad-Roa (1987) also reported that in recent years, Zamboanga City and Puerto Princesa City were the largest suppliers of processed sea cucumbers in the Philippines, where such commodity is commercially important not only because of its export potential but also for its nutritious value as tonic food having high protein and low fat contents. Treated as luxury food, sea cucumber is exported by the Philippines to oriental markets that include Hong Kong SAR, the Republic of Korea, Malaysia, Singapore, Taiwan, and to China where it is used as an important ingredient for the production of traditional medicine (Ferdouse, 2004).

The Philippines is among the Southeast Asian countries that exploit the different species of sea cucumber (Devanadera *et al*., 2015) as shown in **Table 1**, although information on the total production from capture fisheries as well as from aquaculture is rather scarce. Recent available data however showed that the Philippines ranked second to Indonesia as the largest producer of sea cucumber from capture fisheries (**Table 2**).

Although sea cucumber is a major export commodity of the Philippines, the assessment by Conand *et al*. (2014) indicating that the Philippines is a hotspot country for sea cucumber fisheries, had alerted the Philippines to explore the means of restoring the almost depleted sea cucumber resources. The country is therefore evaluating the status of its sea cucumber resources as some of these species could be subjected to possible listing into the CITES Appendices.

Philippine Sea Cucumber R&D Program

The Philippines has therefore launched a national program that promotes the culture of sea cucumber in various BFAR research outreach stations to field test and compare the most efficient culture technology viable for the local fisherfolks. Through this program, the Philippine Government expects to develop the means of diverting the uncontrolled collection of sea cucumber from the wild as practiced by fisherfolks, and promoting stock enhancement as well as meeting the market demand. Through the efforts of BFAR, sea cucumber resource enhancement has been advocated in strategic waters of the country, while viable culture techniques are being developed, especially for the local species *H. scabra* also known as sandfish. Furthermore, BFAR has also been promoting the sustainable management of the country's natural stocks of sea cucumber through the issuance of Fisheries Administrative Circular No. 248 Series of 2013 that sets the size limit for harvesting and processing sea cucumber at 320 g/piece (BFAR, 2013). This has provided the enabling policy for improved production of premium grade-size sea cucumbers to curb untoward depletion of the country's sea cucumber resources. BFAR has also been collaborating with various national and international agencies for its R&D Program on Sea Cucumber (Juinio-Meñez *et al*., 2012), *e.g.* Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD), Department of Science and Technology (DOST), Aquaculture

Table 1. Sea cucumber species exploited by Southeast Asian countries (adapted from Devanadera *et al*., 2015)

Family	Genus	Scientific Name	Countries involved in the exploitation
Holothuriidae	*Actinopyga*	*Actinopyga echinites*	Viet Nam
		A. lecanora	Philippines, Viet Nam
		A. mauritiana	Indonesia, Philippines
	Bohadschia	*Bohadschia atra*	Indonesia
		B. marmorata	Indonesia, Malaysia, Philippines, Thailand, Viet Nam
		B. vitiensis	Viet Nam
		B. subrubra	Thailand
	Holothuria	*Holothuria atra*	All throughout Southeast Asia
		H. coluber	Indonesia, Philippines
		H. cinerascens	Philippines
		H. edulis	Indonesia, Malaysia, Philippines, Thailand, Viet Nam
		H. impatiens	Indonesia, Viet Nam
		H. leucospilota	All throughout Southeast Asia
		H. notabilis	Indonesia
		H. pervicax	Indonesia
		H. scabra	All throughout Southeast Asia
		H. scabra var. versicolor	All throughout Southeast Asia
	Pearonothuria	*Pearonothuria graeffei*	Indonesia, Malaysia, Philippines
Stichopodidae	*Stichopus*	*Stichopus chloronotus*	Viet Nam
		S. herrmanni	Indonesia, Malaysia, Philippines, Thailand, Viet Nam
		S. horrens	Indonesia, Malaysia, Philippines
		S. quadrifasciatus	Indonesia, Philippines
	Thelenota	*Thelenota ananas*	Indonesia, Malaysia, Philippines, Thailand, Viet Nam

Table 2. Sea cucumber production of Southeast Asia from capture fisheries and aquaculture (metric tons (MT))

	2011	2012	2013	2014	2015	2016
Capture Fisheries: sea cucumber						
Indonesia	5,768	6,500	4,390	5,428	6,480	3,901
Philippines	924	800	732	692	686	747
Aquaculture: sea cucumber						
Indonesia	2,019	475	206	138	-	-
Malaysia	-	-	-	-	-	54
Total sea cucumber production	**8,711**	**7,775**	**5,328**	**6,258**	**7,166**	**4,702**
Marine capture fisheries production						
Indonesia	5,328,637	5,400,977	5,707,020	5,967,139	6,065,060	6,070,965
Philippines	2,171,770	2,145,233	2,127,368	2,131,872	2,094,346	1,994,338
Aquaculture production						
Indonesia	7,928,962	12,969,364	13,147,288	14,187,124	15,634,093	16,675,033
Malaysia	287,042	283,559	260,774	524,565	506,465	407,689
Total fisheries production: Southeast Asia	**33,654,492**	**39,491,091**	**40,150,808**	**42,117,647**	**43,998,242**	**45,336,312**

Source: SEAFDEC (2017, 2018)

Department of the Southeast Asian Fisheries Development Center (SEAFDEC/AQD), and the Australian Centre for International Agricultural Research (ACIAR), among others. In addition, BFAR also works closely with academic and research institutions in the Philippines, *e.g.* University of the Philippines - Marine Science Institute (UP-MSI), UP in Los Baños (UPLB), and with the private sector, *e.g.* the Palawan Aquaculture Corporation (PAC) and Alsons Aquaculture Corporation (AAC) that serves as partners in technology verification (Juinio-Meñez and Samonte, 2016).

Breeding Experiments in Masinloc, Zambales

One of the sites identified by BFAR for the breeding and culture trials for sea cucumber is Masinloc in Zambales (**Figure 2**) considering several factors that include the established sea cucumber hatchery facilities at the DA-BFAR Technology Outreach Station: Marine Waters (TOSMW) in Bamban, Masinloc; the presence of intertidal zone (0.5 m in depth at the lowest tide) in Masinloc Bay; type 1 climate of Zambales, *i.e.* two pronounced seasons: dry in December to May, and wet in June to November; and the presence of organized fisherfolks in the area. The sea cucumber species *H. scabra* (**Figure 3**), which is considered as the commercial species suitable for mariculture in the Philippines, is being used because of its capability to grow in captive conditions while its adults could command a fairly high price in the market.

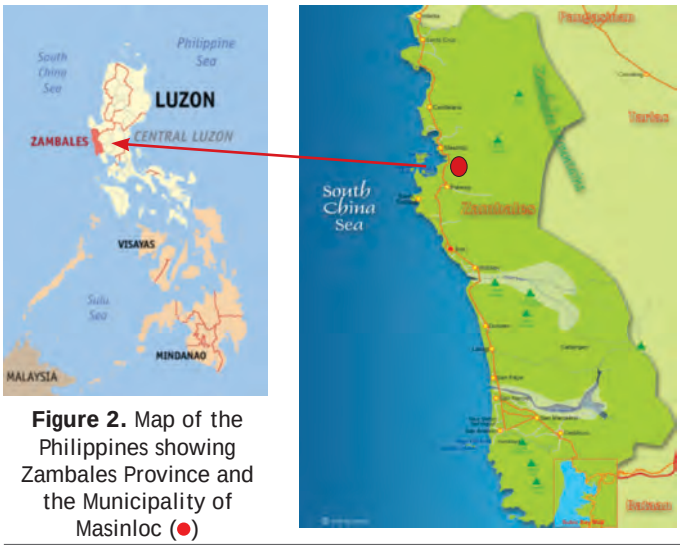

Figure 2. Map of the Philippines showing Zambales Province and the Municipality of Masinloc (●)

At the outset, the DA-BFAR TOSMW refined the breeding and culture techniques developed by the University of the Philippines-Marine Science Institute (UP-MSI) for *H. scabra* using broodstocks from the wild, to suit the environmental conditions of Masinloc, Zambales. The DA-BFAR TOSMW also adapted the breeding and hatchery technologies developed by SEAFDEC Aquaculture Department (SEAFDEC, 2015) for the sea cucumber, resulting in continuous supply of seeds (**Figure 3**) for the mariculture trials and stock enhancement activities in Masinloc Bay, Zambales.

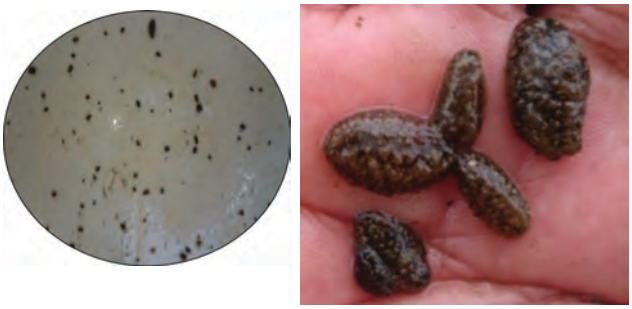

Figure 3. Sea cucumber seeds produced at the DA-BFAR ROSMW for mariculture trials in Masinloc Bay, Zambales

Grow-out Culture Experiments in Masinloc Bay, Zambales

Tuwo (2004) reported that Indonesia has already led the culture of *H. scabra*. Although the biology of *H. scabra* is not specifically explained, the organism could be cultured in cages, pens or ponds until the specimens are large enough

to be sold or processed, or used for resource enhancement. Nonetheless, BFAR recognizes that there is a need to conduct grow-out culture trials to determine the growth performance of sea cucumber in natural waters.

As part of the Philippine Sea Cucumber R&D Program, BFAR has therefore intensified the culture of sea cucumber in its research outreach stations to field test and compare the most efficient culture technology viable for adoption by local fisherfolks, divert the uncontrolled practice of collecting sea cucumber from the wild, and promote the re-establishment of the country's sea cucumber resources. Labe *et al.* (2007) reported that although some fishers collect sea cucumber as by-catch from traditional fisheries, other fishers collect by diving into deeper reefs to individually glean the sea cucumber unmindful of their sizes since middlemen buy all their catch that usually comes in various sizes.

Moreover, the inadequate monitoring and recording of the catch had made it difficult to determine the actual situation of the country's sea cucumber resource. However, some fishers had been saying that recently, it had taken them longer time to collect a considerable volume of sea cucumber (Labe *et al*., 2007). This is the same scenario that encouraged SEAFDEC to carry out in 2007 the Regional Comprehensive Compilation of Data and Information on Sea Cucumbers, the results of which had been used for the management of the sea cucumber resources by concerned Southeast Asian countries (Bumrasarinpai, 2007). Thus, BFAR has been conducting culture experiments of sea cucumber using its field stations, one of which is the DA-BFAR TOSMW in Masinloc, Zambales.

The sea cucumber pen culture site in Masinloc Bay is in a 200 m^2 sea area and follows the prescribed bottom substrate criteria which should be with muddy bottom and salinity that range from 35 to 40 ppt (SEAFDEC, 2014). The pen was set-up in an intertidal zone with 0.5 m depth at the lowest tide and was stocked with 500 pcs of sea cucumber at an initial average weight of 50 g/pc (**Figure 4**). No feeding was done since sea cucumbers could rely on the natural nutrients found on the bottom substrate. The culture period was from April to December 2014.

While stocking was done at the near end of the dry season in April, the incoming wet season from June to November, has laid a good culture environment for the sea cucumber as indicated by its increasing growth trend. Although in some parts of November the growth rate slowed down, still the sea cucumber gained increases in body weights (**Figure 5**). Therefore, future culture trials should be carried out to establish the optimum and poor months for culturing sea cucumber based on the climate type of Zambales.

Figure 4. Sea cucumber juveniles for mariculture trials at Masinloc Bay, Zambales

Figure 5. Premium size sea cucumber for resource enhancement as well as processing

At the end of the culture period, 321 pieces of sea cucumber have been recovered indicating a survival rate of 64%. Average body weight after eight months was 444 g with an average weight gain of 135 g and growth rate of 52% (**Table 3**). The presence of juveniles at 3-5 cm was observed inside and outside the pen at a density of 2 juveniles/m^2 inside and 300 individuals outside at 50 meters transect line, a phenomenon that was replicated three times. Results of the experiment also showed that the growth trend of sea cucumbers was continuously increasing even beyond eight (8) months of culture. A sudden increase in growth rate was observed between the second and third month (from June to July) with 142 g weight gain from 108 g to 250 g or growth rate of 131% growth rate. Meanwhile, the percent lowest weight gain at 10% was observed in June, the second month of culture.

Overall, the growth performance after eight months of sea cucumber pen culture in Masinloc Bay attained a 52% monthly average growth rate with weight gain that ranged from 10 to 328 g every month averaging at 135 g. Although this could be comparable to that of Indonesia's experience considering the same species cultured in the same tropical environment, the feat attained in Masinloc Bay is much higher than that of Indonesia's 28-33 g wet weight gained per month (Tuwo, 2004), and is still higher compared with Indonesia's target increase of 32-73 g wet weight per month using different doses of organic matters (Pirdausi, 1989 as cited by Tuwo, 2004). From 30 g to 50 g initial weight, the *H. scabra* in Indonesia's trials was harvested after six (6) months of rearing, reaching 200-250 g in weights and lengths at 15-20 cm, whereas, in the Masinloc Bay experience, *H. scabra* gained mean body weights of 701 g after six months of culture as shown in **Table 3**. The survival rate of 64% in pen culture was also higher compared with that of Indonesia's 50% survival in ponds.

The weight increase attained by the sea cucumber beyond eight months of culture in Masinloc Bay, and the presence of

Table 3. Monthly sampling results of sea cucumber cultured in marine pen in Masinloc Bay, Zambales

Months of culture	Total Stocks	Mean Initial Weight (g)	No. of Months of Culture	Mean Body Weight (g)	Mean Body Weight Gain (g)	% increase / %growth rate
April 2014	500	50	0	50	-	-
May			1	98	48	96
June			2	108	10	10
July			3	250	142	131
August			4	350	100	40
September			5	508	158	45
October			6	701	193	38
November			7	803	102	15
December	321		8	1131	328	41
	Average			**444**	**135**	**52**

Figure 6. Adult sea cucumber for processing and marketing

juveniles could be indications that the sea cucumbers might have spawned during the span of the culture period. Considering its fast growth, the culture period of *H. scabra* could be shortened to four months, wherein the sandfish have reached 350 g, the size ideal for marketing and processing (**Figure 6**). As reported by Tacio (2009), 250 g is the desired weight in the export market, so that results from the Masinloc trials that gave 350 g had overshot the 250 g requirements of DA-BFAR. The 250 g is the weight yield after four months culture in ponds, while the pen culture showed higher weight yield.

The growth performance in this experiment is indeed promising although continuous research would be necessary for comparison of the results of field demonstrations in other DA-BFAR research stations. Furthermore, the government should also consider providing support to the field demonstrations, assisting in the analysis of the data, providing fora where the results could be presented and discussed, and fully supporting the publication of the results from such research efforts in order that the data could be made available for resource management as well as resource enhancement of the country's sea cucumber stocks.

Figure 7. Results after eight months mariculture in Masinloc Bay, Zambales: from an average of 30-50 g *(left)*, the final yield had an average weight of 1.11 kg *(right)*

After eight months of mariculture using 30-50 g juvenile sea cucumber, the final harvest had an average weight of 1.11 kg/ adult sea cucumber (**Figure 7**).

Enhancement of the Sea Cucumber Resource in Masinloc Bay, Zambales

BFAR has always advocated the sea ranching of sea cucumber considering its behavior in the culture area, especially in terms of its movement, traveling just one to two meters a day and about one kilometer in a year. Since BFAR has recently established the country's commercial hatchery for sea cucumber producing 60,000 "juveniles" every month, the juveniles could be distributed to fish farmers for pond culture or for sea ranching by stocking the sea cucumber in designated areas in the sea to be gathered by them later, thus enhancing the massive culture of the commodity nationwide. Using the juveniles produced from the hatchery facilities of the DA-BFAR TOSMW, BFAR Region III together with the Provincial Local Government Units of Zambales and Local Government Units of Masinloc cooperatively launched the sea cucumber stock enhancement and sea ranching project in Masinloc Bay on 21 May 2019 and in nearby San Salvador Island also in Masinloc, Zambales (**Figure 8**).

The sea cucumber stock enhancement and sea ranching project in Masinloc Bay is aimed at increasing the population of sea cucumber in the wild as well as enhancing the role that sea cucumber plays in the ecosystem specifically filtering sediments and recycling the nutrients back to the sea. With increased population of sea cucumber in the wild, the oceans would be cleaner and healthier.

Conclusion and Discussion

Another culture experiment in four months should be pursued to reconfirm the results of the trials conducted by DA-BFAR TOSMW. Once proven and tested, such scheme would guarantee good marketability making the culture technology in pens viable to local fisherfolks specifically for those who have long depended on collecting sea cucumber from the

Figure 8. Sea cucumber being prepared by the DA-BFAR ROSMW for resource re-establishment activities *(left)*, and resource enhancement *(middle)* and sea ranching *(right)* in Masinloc, Zambales

wild as their source of livelihood. Nevertheless, beyond four months of culture, juveniles could be spilling over in adjacent areas and thus, facilitating stock enhancement which is also in line with the efforts of the Philippine Government to revive the natural stocks of sea cucumber in the country which is feared to be almost at the verge of collapse.

The advances made by many agencies in the Philippines with regard to seed production and mariculture of sea cucumber could be tapped to facilitate the re-establishment of the depleted natural stocks of sea cucumber in the country by properly releasing juveniles for restocking (SEAFDEC, 2014; SEAFDEC, 2015; SEAFDEC Aquaculture Department, 2018), as well as for stock enhancement (Dance *et al*., 2003; Bell and Nash, 2004; Choo, 2008). Aquaculture and stock enhancement are considered the best approaches to address the over-exploitation trends of the sea cucumber resources, as the technologies for spawning as well larval and juvenile rearing have already been developed for some commercially important sea cucumber species (Lovatelli *et al*., 2004), *e.g. H. scabra*. In the Philippines, steady supply of sea cucumber seeds and juveniles is available. However, access to their source for mariculture and resource enhancement in Philippine seawaters should be facilitated by the government in order that such activities could be sustained by the stakeholders. Moreover, continuous research to improve breeding and hatchery techniques of sea cucumber, especially the sandfish, as well as mariculture, either in ponds and pens should therefore be pursued in order to re-establish depleted stocks. The release strategies that have been developed for sea cucumber could be adapted to suit the local conditions of the prospective release sites.

Way Forward

There are many factors that contribute to the overexploitation of sea cucumber. In their adult stage, sea cucumbers have limited mobility, mature late and with density-dependent reproduction, tend to have habitat preferences, and have low rates of recruitment. Their large size makes sea cucumbers very easy to detect and collection is easy as this does not require high-technology fishing methods while processing is simple. As the demand for sea cucumber in the world market has been increasing, other species are now being targeted as the high-value species in the wild are almost depleted and getting more scarce.

The Philippine Government is exerting much effort in refining the sea cucumber culture techniques from hatchery to grow-out by tapping the available resources and expertise nationwide, and strengthening the collaboration with national agencies and institutes involved in sea cucumber culture and stock enhancement. In addition, BFAR intends to enhance the capability of its field stations in the massive raising of sea cucumber nationwide, especially the field hatcheries and nurseries in order that juveniles could be distributed to fish farmers who are interested in fish pond culture or sea ranching. This is considering that culture of sea cucumber is profitable and environmentally-friendly, and provides livelihood industry for coastal communities. Moreover, once sea cucumbers are placed in the seafloor or in ponds, the survival rate could be almost 100%.

Furthermore, efforts would also be intensified to address habitat degradation in many coastal areas due to unmanaged resource use and management issues. In the case of Masinloc Bay, findings of the Masinloc Integrated Coastal Resources Management (ICRM) on the adverse impacts of rapid growth of coastal settlements, inappropriate coastal land use schemes, destructive fishing practices, excessive sediment loading, pollution and generally the demand for greater economic outputs, would be addressed. This forms part of the nationwide plan to rehabilitate the coastal habitats that host various natural resources, including echinoderms, *e.g.* sea cucumber, as marine productivity continues to decline and fishing communities are increasingly encountering economic difficulties due to the declining catch per unit during the past years. Concerns on institutional deficiencies and low awareness on proper coastal resource management would also be addressed by the government by building the capacity of concerned national government staff especially those working in the field stations of BFAR, as well as enhancing the capability of the field stations and similar units under BFAR.

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