

Baseline study on the freshwater ornamental fish industry in Palawan, Philippines

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ABSTRACT

The status of both freshwater and marine ornamental fish industries in the Philippines has been assessed in 2019; however, Palawan was excluded due to the unavailability of data with regard to the ornamental fish trade. Hence, this study collected baseline data on the freshwater ornamental fish industry specifically the distribution of freshwater ornamental fish hobbyists, socio-demographic profile of the respondents, the key players involved in the market chain, classification and number of fish species and strains involved, and the challenges (economic and scientific) and opportunities encountered by the key players which could be used for the improvement and development of the ornamental fish sector in Palawan. A poll was conducted in order to obtain information on the general location of the ornamental fish hobbyists in Palawan in which 77 individuals participated. An online survey form was then sent to participants, however, only 40 responded. The freshwater ornamental fish hobbyists were distributed in 11 localities of Palawan. Key players involved in the market chain of freshwater ornamental fish were categorized as producers, traders, and sellers. Twelve freshwater ornamental fish species with 83 strains/varieties were involved, dominated by the Siamese fighting fish and guppy. Economic and research problems were some of the problems cited by the key players.

Keywords: challenges and opportunities, key players, market chain, online survey, strain

INTRODUCTION

Ornamental fish keeping was known as the second largest hobby in the world with millions of enthusiasts (Lipton 2006). It was a multi-billion-dollar aquaculture-based industry with an annual demand of USD 10 billion globally (Rao et al. 2013; Dey 2016; Ponraj 2019) which involved both freshwater and marine ornamental fish sectors (Livengood and Chapman 2007; Muyot et al. 2019). In the freshwater sector, more than 4,000 species were involved (Faruk et al. 2012) wherein the 90% traded worldwide were farm-produced (Faruk et al. 2012; Bassleer 2017) and 65% originated from developing countries in Asia (Livengood and Chapman 2007). Thailand, Malaysia, Singapore, Indonesia and Vietnam were the top five freshwater ornamental fish - producing countries (Mutia et al. 2007; Dey 2016).

The continued increasing production due to high demand globally and the potential to become one of the alternatives for aquaculture as source of income brought many problems to the freshwater ornamental fish industry (Rao et al. 2013; Dey 2016). A review paper of Biondo and Burki (2020) emphasized that data on ornamental fishes, both marine and freshwater,

were still limited making the number and diversity of fishes in the trade unclear. There was also a growing concern about the impact and monitoring on the importation of ornamental fish as this could be the cause for the spread of diseases which can adversely affect the environment and biodiversity (Rose et al. 2013; Dey 2016). Even though the quantity of ornamental fish produced met the demand for trade, lack of knowledge and appropriate trainings on how to improve the growth, survival rate, forms and color of freshwater ornamental fish are still the biggest problems for its development (Maceda-Veiga et al. 2016; Muyot et al. 2019).

Although ornamental fishes were not among the priority species of the Philippine government, it was still part of the major exported fish species as of 2019 (BFAR 2019). Moreover, the recent published study of Muyot et al. (2019) reported that the Philippines produced 14,304,739 pieces of freshwater ornamental fish worth PHP 145,958,667 and has the potential to become a booming industry. On the other hand, Palawan is known as one of the major sources of marine ornamental fish in the country (Dalabajan 2005), but the province was not included in the latest studies dealing with ornamental fishes (Muyot et al.

2018, 2019). Moreover, published records on the potential of Palawan for freshwater ornamental fish were still non-existent. Further, Palawan was proclaimed as the last ecological frontier of the Philippines and was designated as a biosphere reserve by the UNESCO - Man and Biosphere Programme (MAB) in 1990 (Sandalo and Baltazar 1997). Therefore, this baseline study on freshwater ornamental fish in Palawan will give information on the distribution of freshwater ornamental fish hobbyists, socio-demographic profile of the respondents, the key players involved in the market chain, classification and number of fish species and strains involved, and the challenges (economic and scientific) and opportunities encountered by the key players in freshwater ornamental fish industry in Palawan that could be used as baseline data for future conservation, other research and economic studies related to freshwater ornamental fish.

METHODS

Study Site

The study covered the whole province of Palawan (9°30'N and 118°30'E) which has 23 municipalities and one city (Figure 1).

Data Collection

Due to the surge of COVID-19 cases starting 2020 and the restrictions that came with it, data on the

distribution of freshwater ornamental fish hobbyists in Palawan were monitored through Facebook and the Messenger group of Palawan Fish Hobbyist which has more than 112 members engaged in freshwater ornamental fish activities in Palawan from March 2019 to May 2021. In order to obtain information on the general distribution of ornamental fish hobbyists throughout Palawan, a poll was conducted in the above-mentioned social media group. The poll was participated by 77 individuals where the online survey form was sent, however, only 40 responded. The respondents were then classified into various types of key players based on their level of engagement in the freshwater ornamental fish industry (Table 1). The survey form consists of multiple-choice questions on the demographic profile and other activities related to the freshwater ornamental fish in Palawan including the challenges and opportunities encountered by the key players. Informed consent was obtained from the respondents prior to the conduct of the survey on 27 March to 18 May 2021.

Data Analysis

All data collected were encoded and tallied in MS Excel for descriptive (frequency and percentage) and quantitative analysis. The data percentage were obtained by dividing each of the variables' value by 40 and then multiplying by 100. The tables present the distribution of these variables per key player so as to give ample baseline information on the status of the ornamental fish industry in Palawan.

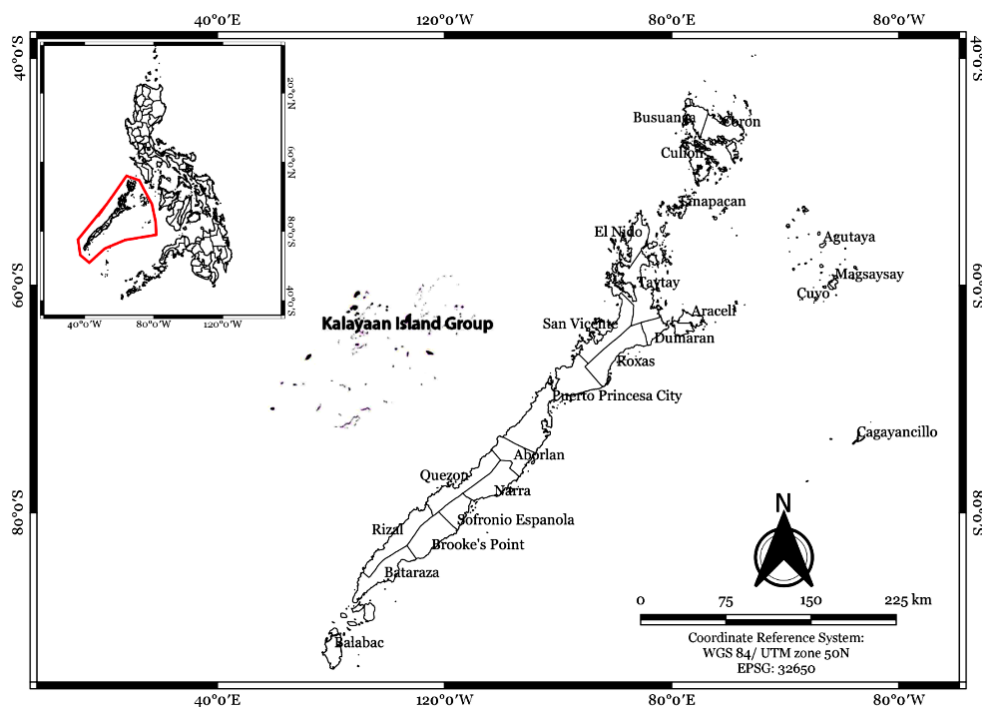


Figure 1. The map of Palawan and its 23 municipalities and one city as the target areas of the study.

Table 1. Classification and condition of key players in this study based on the surveyed respondents.

Classification	Conditions	Definition
Producers	Spend at least 80-90% of their time on breeding and farming activities	A person who keeps and produces fish in aquaria or ponds, multiplies fish in large quantities for profit and has some level of knowledge and expertise in genetics, breeding, and animal husbandry.
Traders	Spend at least 80-90% of their time on trading and dealing	Those who act as middlemen and usually buy fish of different species from producers on a wholesale basis and sell these fish to retailers or pet shops.
Sellers	Spend at least 80-90% of their time on selling	Those who sell freshwater ornamental fish directly to consumers on a retail basis.

RESULTS

Distribution of Freshwater Ornamental Fish Hobbyist in Palawan

The freshwater ornamental fish hobbyists in Palawan were distributed in 11 localities (Figure 2). Puerto Princesa City (61%) and Narra (12%) has the highest number of hobbyists, while Araceli has the lowest with only 1% (Figure 2).

Socio-demographic Profile of the Respondents and the Key Players Involved in Market Chain

The market chain of the freshwater ornamental fish in Palawan involves mainly three key players (Figure 3, Table 2). Out of the 40 respondents who participated in the online survey, 27 are producers, 12 are traders, and only one is a seller (Table 2). The majority of the respondents are male (75%), aged 16-20 years old (30%). More than half (65%) of the

respondents were just starting to venture into the freshwater ornamental fish industry. Producers mostly bought freshwater ornamental fish to be used as breeders once or twice a month (47.5%); while traders (20%) and seller (2.5%) mostly bought freshwater ornamental fish on a daily basis. Ornamental fishes were sourced from within or outside Palawan. (Table 2).

Number of Species and Strains Involved in Freshwater Ornamental Fish Industry in Palawan

There were 12 species of freshwater ornamental fish involved in the ornamental fish industry in Palawan with 83 strains/varieties (Table 3). Betta (20) and guppy (16) were the most common freshwater ornamental fishes in Palawan as indicated by the number of strains available for these fishes. Most of the strains were locally-produced by the producers (Table 3).

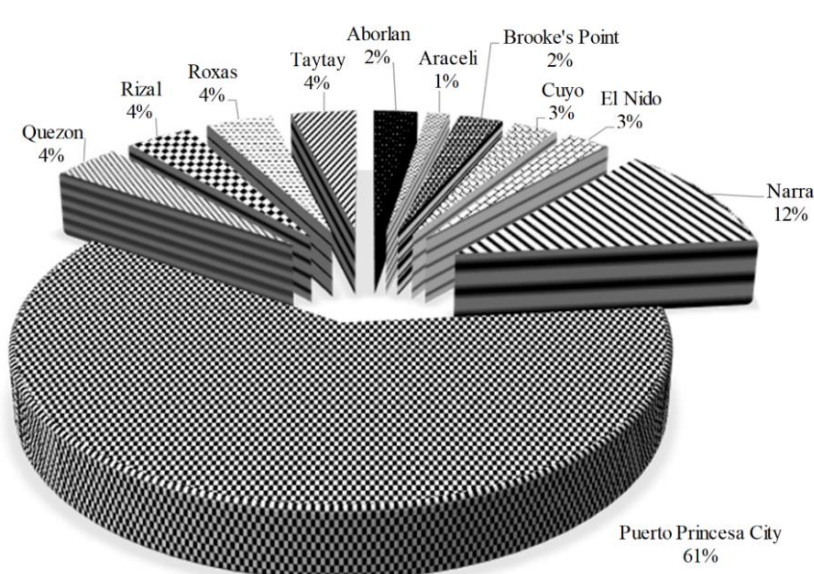


Figure 2. Percent distribution of freshwater ornamental fish hobbyists and number of localities with fish hobbyist in Palawan based on the online poll conducted (n=40).

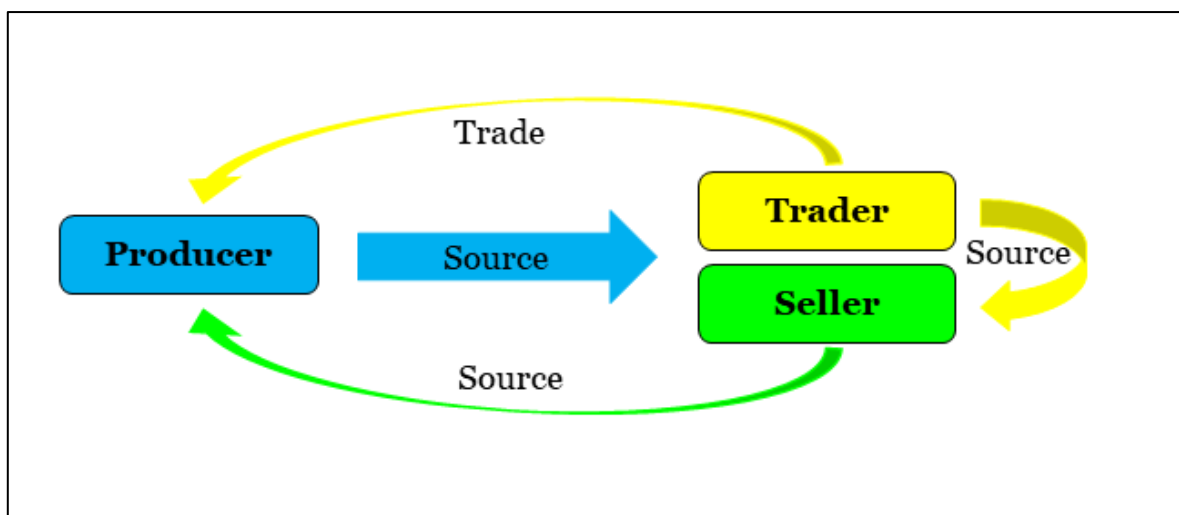


Figure 3. The key players involved in the market chain of freshwater ornamental fish industry in Palawan.

Table 2. Socio-demographic profile and other additional information on the market and activity of the respondents who participated in the online survey. (n=40, the data are presented in frequency and percentage (%). *multiple answers per respondent. Producer (n=27); Traders (n=12) and Seller (n=1).

Variable	Producers (%)	Traders (%)	Sellers (%)	Total (%)
Sex				
Male	20 (50)	9 (22.5)	1 (2.5)	30 (75)
Female	4 (10)	1 (2.5)	0	5 (12.5)
Others	3 (7.5)	2 (5)	0	5 (12.5)
Age (yrs. old)				
13-15	1 (2.5)	0	0	1 (2.5)
16-20	7 (17.5)	5 (12.5)	0	12 (30)
21-25	4 (10)	3 (7.5)	0	7 (17.5)
26-30	7 (17.5)	1 (2.5)	0	8 (20)
31-35	5 (12.5)	1 (2.5)	0	6 (15)
36-40	2 (5)	2 (5)	1 (2.5)	5 (12.5)
> 41	1 (2.5)	0	0	1 (2.5)
Years in freshwater ornamental fish industry				
1	18 (45)	8 (20)	0	26 (65)
2-5 years	7 (17.5)	2 (5)	0	9 (22.5)
> 6	2 (5)	2 (5)	1 (2.5)	5 (12.5)
Frequency of buying ornamental fish				
Daily	2 (5)	8 (20)	1 (2.5)	11 (27.5)
Once a week	3 (7.5)	3 (7.5)	0	6 (15)
Once or twice a month	19 (47.5)	0	0	19 (47.5)
Once or twice a year	4 (10)	0	0	4 (10)
Amount of money spent				
Below 500	10 (25)	8 (20)	0	18 (45)
600-1000	9 (22.5)	1 (2.5)	0	10 (25)
> 1000	8 (20)	3 (7.5)	1 (2.5)	12 (30)
Source of ornamental fish*				
Local market	27 (67.5)	12 (30)	1 (2.5)	40 (100)
Other parts of the Philippines	27 (67.5)	12 (30)	1 (2.5)	40 (100)
International market	7 (17.5)	4 (4)	0	11 (27.5)
Number of species of ornamental fish in possession				
1-2	5 (12.5)	2 (5)	0	7 (17.5)
3-5	12 (30)	4 (4)	0	16 (40)
> 6	10 (25)	6 (15)	1 (2.5)	17 (42.5)

Table 3. Species and strains of freshwater ornamental fish present in Palawan. (n=40, the data is presented in frequency and percentage (%)). *multiple answers per respondent.

Species	Strain/ Variety*	Producers (%)	Traders (%)	Sellers (%)	Number of Strain/ Variety
Angelfish (<i>Pterophyllum scalare</i>)	Albino	1 (2.5)	1 (2.5)	0	6
	Golden head	1 (2.5)	1 (2.5)	0	
	Marble	4 (10)	2 (5)	0	
	Philippine blue	4 (10)	1 (2.5)	1 (2.5)	
	Sta. Isabel	1 (2.5)	0	0	
	Zebra	3 (7.5)	1 (2.5)	1 (2.5)	
Arowana (<i>Scleropages</i> sp.)	Silver	1 (2.5)	3 (7.5)	1 (2.5)	1
Cardinal tetra (<i>Paracheroideon axelrodi</i>)	Black skirt	0	1 (2.5)	0	5
	Buenos aires	1 (2.5)	0	1 (2.5)	
	Neon	4 (10)	2 (5)	1 (2.5)	
	Tiger	1 (2.5)	1 (2.5)	0	
	White skirt	1 (2.5)	1 (2.5)	0	
Flowerhorn (<i>Vieja synspilum</i>)	Golden base	1 (2.5)	1 (2.5)	0	4
	Kamfa	9 (22.5)	1 (2.5)	1 (2.5)	
	Nakeemix	1 (2.5)	2 (5)	0	
	Zhen zhu	9 (22.5)	2 (5)	0	
Siamese fighting fish (<i>Betta splendens</i>)	Alien hybrid	1 (2.5)	0	0	20
	Crowntail (bicolor)	1 (2.5)	1 (2.5)	1 (2.5)	
	Crowntail (patterned and multicolor)	1 (2.5)	2 (5)	1 (2.5)	
	Crowntail (solid)	3 (7.5)	2 (5)	1 (2.5)	
	Delta (bicolor)	1 (2.5)	1 (2.5)	1 (2.5)	
	Double tail (bicolor)	1 (2.5)	2 (5)	1 (2.5)	
	Double tail (patterned and multicolor)	1 (2.5)	0	0	
	Double tail (solid)	0	1 (2.5)	0	
	Dumbo ear	2 (5)	0	0	
	Halfmoon (bicolor)	5 (12.5)	2 (5)	1 (2.5)	
	Halfmoon (patterned and multicolor)	3 (7.5)	2 (5)	1 (2.5)	
	Halfmoon (solid)	14 (35)	1 (2.5)	1 (2.5)	
	Halfmoon plakat (bicolor)	3 (7.5)	1 (2.5)	1 (2.5)	
	Halfmoon plakat (patterned and multicolor)	4 (10)	1 (2.5)	0	
	Halfmoon plakat HMPK (solid)	17 (42.5)	5 (12.5)	1 (2.5)	
	Own breed	5 (12.5)	0	0	
	Rosetail (bicolor)	1 (2.5)	0	0	
	Rosetail (solid)	1 (2.5)	0	0	
Vailtail (multicolor)	1 (2.5)	0	0		
Wild	1 (2.5)	1 (2.5)	0		
Goldfish (<i>Carassius auratus</i>)	Black moor	1 (2.5)	1 (2.5)	0	7
	Bubble eye	1 (2.5)	0	1 (2.5)	
	Oranda	4 (10)	1 (2.5)	1 (2.5)	
	Ranchu	4 (10)	1 (2.5)	1 (2.5)	
	Ryukin	6 (15)	1 (2.5)	0	
	Shubunkin	7 (17.5)	0	0	
	Telescope	4 (10)	0	0	
Guppy (<i>Poecilla reticulata</i>)	Albino blue topaz	4 (10)	2 (5)	0	16
	Albino full red	4 (10)	2 (5)	1 (2.5)	
	Black lace	8 (20)	5 (12.5)	0	
	Black Moscow	3 (7.5)	0	0	
	Blue grass	3 (7.5)	1 (2.5)	0	
	Chops	11 (27.5)	6 (15)	1 (2.5)	
	Dumbo ear mosaic	1 (2.5)	0	0	
	Dumbo firetail	8 (20)	4 (10)	0	
	Electric blue Moscow	10 (25)	4 (10)	0	
HB blue	2 (5)	0	0		

Species	Strain/ Variety*	Producers (%)	Traders (%)	Sellers (%)	Number of Strain/ Variety
	HB red	6 (15)	(2.5)	0	
	HB white	2 (5)	1 (2.5)	0	
	Own breed	1 (2.5)	1 (2.5)	0	
	Purple dragon	1 (2.5)	0	0	
	Red lace snakeskin	15 (37.5)	1 (2.5)	0	
	Yellow king cobra	3 (7.5)	0	0	
Japanese koi (<i>Cyprinus carpio</i>)	Kohaku	5 (12.5)	1 (2.5)	1 (2.5)	2
	Sanke	4 (10)	0	0	
Molly (<i>Poecilia sphenops</i>)	Balloon belly molly	12 (30)	1 (2.5)	0	7
	Black molly	9 (22.5)	3 (7.5)	1 (2.5)	
	Dalmatian molly	6 (15)	3 (7.5)	0	
	Gold dust molly	10 (25)	1 (2.5)	0	
	Marble molly	5 (12.5)	3 (7.5)	0	
	Platinum molly	5 (12.5)	0	0	
Platy (<i>Xiphophorus maculatus</i>)	Gold	2 (5)	0	0	3
	Panda	2 (5)	4 (10)	0	
	Red	1 (2.5)	0	0	
Swordtail (<i>Xiphophorus helleri</i>)	Albino	2 (5)	0	0	6
	Black	4 (10)	0	0	
	Kohaku	13 (32.5)	3 (7.5)	0	
	Koi swordtail	1 (2.5)	0	0	
	Sanke	9 (22.5)	2 (5)	0	
	Velvet	1 (2.5)	0	0	
Zebrafish (<i>Danio rerio</i>)	Green danio	1 (2.5)	0	0	6
	Pearl danio	1 (2.5)	0	0	
	Pink danio	1 (2.5)	0	0	
	Rosy danio	1 (2.5)	0	0	
	Yellow danio	1 (2.5)	0	0	
	Zebra danio	5 (12.5)	0	0	

Challenges and Opportunities in Freshwater Ornamental Fish in Palawan

Challenges and opportunities encountered by the key players in freshwater ornamental fish keeping were listed in Table 4. The challenges were classified

into economic and scientific problems. Interestingly, some of the challenges listed by the respondents became opportunities to improve and sustain the production of freshwater ornamental fish in Palawan (Table 4).

Table 4. Challenges (economic and scientific) and opportunities encountered by key players in the freshwater ornamental fish industry in Palawan (n=40), results are presented in (F) frequency and percentage (%).

Key Players	Challenges				Opportunities
	Economic	F (%)	Scientific	F (%)	
Producer (n=27)	Limited capital	27 (100)	Inadequate knowledge in breeding	22 (81.48)	1. Reduce the number of freshwater ornamental fish species being cultured
	Limited participants on fish shows	15 (55)	Low-quality breeding materials	27 (100)	2. Knowledge-sharing among hobbyists regarding the best practices in breeding and propagation.
	Expensive feeds	27 (100)	Limited strains of fish in Palawan	27 (100)	3. Able to identify ornamental fish farms in Palawan that can supply quality breeders
	Problems in organizing on-site (bench-in) shows	10 (37)	Limited source of natural food	10 (37)	4. Exchange of male or female broodstock among breeders to improve the quality and quantity

Key Players	Challenges				Opportunities	
	Economic	F (%)	Scientific	F (%)		
Key Players					of freshwater ornamental fish production	
	Limited experts who can be invited as judges to the fish show	10 (37)	Difficulty in improving the quality of fish	15 (55)	5. Some of the breeders maintain and sell starters for natural food production (e.g. <i>Daphnia</i> , <i>Tubifex</i> , etc)	
			Insufficient supply of culture materials such as aquaria, cleaning materials etc.	19 (70.37)	6. Use of mixed feeding using natural food and formulated diets	
			Diseases causing high mortality in fish	27 (100)	7. Use of Indian almond tree (Talisay) leaves to enhance the color and vigor and to reduce risk of infections and disease occurrence in fish 8. Feed the fish with color-enhancing feeds 9. Recycling of plastic polyethylene terephthalate (PET) bottles and learning how to cut glass bottles to be used in the breeding farms 10. Produce new and unique strains of freshwater ornamental fish 11. Stress reliever/ therapy 12. Frequent fish shows to promote freshwater ornamental fish in Palawan 13. Online and on-site shows are now possible 14. New acquaintances from all around Palawan	
	Trader (n=12)	Unstable price of freshwater ornamental fish produced locally	12 (100)	Occurrence and recurrence of diseases	12 (100)	1. Buy only from trusted breeders to ensure the quality of the fish.
		Very high price of freshwater ornamental fish	10 (83.33)		2. Wise scheduling of shipping to avoid loss of money and fish.	
		Limited courier services	7 (58.33)		3. Buy directly from the local suppliers.	
		Inability to compete with other known traders in Palawan	10 (83.33)		4. Opportunity for online trading	
		Inadequate supply and low quality of locally-produced freshwater ornamental fish	12 (100)			
	Seller (n=1)	Unstable price of freshwater ornamental fish produced locally	1 (100)	Occurrence and recurrence of diseases	1 (100)	1. Buy only from trusted breeder or trader to ensure the quality of the fish.
Limited courier services		1 (100)	2. Wise scheduling of shipping to avoid loss of money and fish.			
Inability to compete with other known sellers in Palawan		1 (100)	3. Buy directly from local suppliers.			

Key Players	Challenges				Opportunities
	Economic	F (%)	Scientific	F (%)	
	Inadequate supply and low quality of locally-produced freshwater ornamental fish	1 (100)			4. Opportunity for online selling

DISCUSSION

Distribution of Freshwater Ornamental Fish Hobbyist in Palawan

The distribution of freshwater ornamental fish hobbyists in 11 localities is an evidence that a robust freshwater ornamental fish industry is present in Palawan. The reasons for the increasing number of fish hobbyists in freshwater ornamental fish keeping and breeding in Palawan is due to its health and financial benefits especially during the surge of COVID-19. Clements et al. (2019) emphasized that interaction with fishes in the aquarium could reduce anxiety, physiological stress, loneliness, nutritional intake and body mass, and glycemic control, while Duco and Vallejo (2003); Ghosh et al. (2003); Laskar et al. (2016) mentioned that ornamental fish keeping could be a source of alternative income from selling own-bred fishes. Aside from being the capital of Palawan, the high number of freshwater ornamental fish hobbyists in Puerto Princesa City could be due to its accessibility and the availability of fish keeping supplies.

Socio-demographic Profile of the Respondents and the Key Players Involved in the Market Chain

Male (75%) aged 16-20 (30%) are the most active fish hobbyists in Palawan (Table 2) which is comparable to the study of Laskar et al. (2016) in India. The nature of ornamental fish keeping required labor and time especially when it comes to aquarium setting, water change and aquarium maintenance (Yadav and Sharma 2017). Since most of the water source in Palawan are chlorinated tap water, most of the hobbyists stock the water to eliminate the chlorine before using it, while others need to fetch from a water well/pump to ensure the safety of the fishes. Chlorine was known to have severe side effects on ornamental fish (Tulloch 2006; Illes 2007). This explains why there are more male aged 16-30 than older male, and significantly less female actively engaged in the ornamental fish industry. Due to its time-consuming and labor-intensive nature, female are less engaged in ornamental fish keeping as most of their time were spent in households or in the other sources of income (Yadav and Sharma 2017).

The market chain of freshwater ornamental fish in Palawan is quite complicated as the three key players involved were also the end users of the ornamental fishes produced or for sale in the local market in Palawan. For instance, there are cases when the producer purchased fish from trader or seller. This happens when the breeder wants to breed certain strains of fish that are not available in the local farm. This explains why most (75%) of the producer’s fish supply were from local sources (Table 2). On the other hand, traders’ supply of fish (72.73%) are mainly from other parts of the country (Table 2), although sometimes they buy fish from sellers to sell to producer, especially when the freshwater ornamental fish available in the seller's store are rare. Also, seller tend to purchase fish directly from the producer instead from the trader to maximize profit. Compared to Tripura in India, the market channels of ornamental fish involved the seven major players in which the traders mostly purchased fish outside Tripura due to the low quality of fish produced by local producers (Yadav and Sharma 2017). The duration of involvement and number of respondents in each key player in ornamental fish keeping could be the reason why the market chain in Palawan revolved mainly within local production as most (50%) of the respondents have just started venturing into ornamental fish keeping (Table 2). Although this study did not include the value chain analysis for each species per classification due to variation of value, an estimated 50% price increase was observed from producer to trader and another 50% from trader to seller. The price of freshwater ornamental fish also varied depending on the rarity of the species, purity of the line, and the costs required to produce certain species of fish such as feed, manpower, utility, and many others.

Number of Species and Strains Involved in Freshwater Ornamental Fish Industry in Palawan

The 12 species of freshwater ornamental fish and 83 strains/varieties involved in the freshwater ornamental fish industry in Palawan is much lower compared to the 94 species and 422 varieties in the Philippines (Muyot et al. 2019). All of these freshwater ornamental fish species are exotic, introduced and mainly captive-bred (Muyot et al. 2019). Since the freshwater ornamental fish was just

starting to gain popularity among Palaweños, this could be the reason for the low number of species involved.

The Siamese fighting fish (Betta) and guppy are the most common freshwater ornamental fish species in Palawan. Although they are more difficult to breed due to a large number of strains, color, and pattern combinations (Tulloch 2006), they were the most popularly traded species in Palawan. Betta and guppy are sold based on its quality or classification because they are entered in fish beauty competitions locally and abroad (Table 3). Although Betta and guppy fish are not endemic to the Philippines, there is a potential that the Philippines can also produce its own type in the near future through selective breeding (Figure 4). Like Thailand, they were able to produce a betta fish that represent the colors of their national flag (blue, red, and white) and considered as the most expensive and high-quality betta in the world (Sermwatanakul 2019).

Challenges and Opportunities in Freshwater Ornamental Fish in Palawan

The culture system, facilities, breeding program and biosecurity were just some of the factors that contribute to the sustainability of production in ornamental fish industry (Livengood and Chapman 2007; Muyot et al. 2019). The existing culture system in Palawan is the open system wherein the rearing facility is subject to the changes in the weather condition, temperature, amount of daylight, and the availability of water. Very few invest in a closed system such as the recirculating system. The main

reason for this is the inappropriate design of their farm and the additional cost that would be incurred in establishing a recirculating system. Producers in Palawan usually use small aquaria, PET bottles, small modified outdoor ponds, ref tubs and basins to raise their fish. The use of recyclable materials in the production of ornamental fish partly contributes to the environmental waste reduction. Few producers use selective and line breeding methods in the production of freshwater ornamental fish. Selective and line breeding are important techniques that allow producers to develop new or improve existing strains, increase fish production and potentially bring more profit (Singh et al. 2010). Producers sometimes import breeders to breed high quality lines of freshwater ornamental fish. In addition, some producers participate in fish shows and use the imported fish as entries. The occurrence and recurrence of diseases in the producers' farms was also observed in this study, indicating that biosecurity is poorly applied in the production farms. This made the farms vulnerable and highly-susceptible to diseases (Walczak et al. 2017; Preena et al. 2019).

Data on the import and export value of freshwater ornamental fish in Palawan are not available. However, based on local observation and interviews from other fish hobbyists, most traders and sellers import freshwater ornamental fish which is depriving local producers the opportunity to earn money. According to traders and sellers, there is a shortage of freshwater ornamental fish in Palawan. In addition, most locally-produced fishes are of poor quality making them difficult to sell.



Figure 4. Example of locally-bred strain of Siamese fighting fish (A) and guppy (B) from a breeder farm in Palawan.

The freshwater ornamental fish industry has tremendous potentials in Palawan in terms of helping the economy and bringing prestige to the Philippines as one of the major producers of these kinds of commodity. Bartley (1999) emphasized that those involved in the fish trade should have a shared responsibility to ensure that the industry is environmentally sustainable. Therefore, in order to sustain the production of freshwater ornamental fish in Palawan, producers need to upgrade their knowledge in breeding, genetics, and animal husbandry and at the same time invest in improving their facilities. Traders and sellers on the other hand need to patronize locally-produced fish and promote its market outside Palawan. Government support to strengthen and sustain the production through research and extension services offered by the academe, and trainings on marketing and value chain of the ornamental fish could benefit those involved in the freshwater ornamental fish industry.

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