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Species Composition, Length-Weight Relationship (LWR) and Catch Rate (CPUE) of Dominant Fishes Caught by Ring Net in Romblon Pass, Philippines

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Romblon Passage is part of Sulu-Sulawesi eco-region which is considered the global center of marine biodiversity. This area between the major basins provides an important route for migratory species including commercially important marine species. Because of the rich marine resource of this area, it serves as an important fishing ground for the fishermen of Romblon. Despite this, no study had been conducted on the species composition, abundance, size structure, and Length-Weight Relationship of common caught by ring net in Romblon Passage, Philippines. Thus, this study was realized. From July 2017 to January 2018. Six species were identified and *Selar crumenophthalmus* was the dominant species in the area. The majority of this species were in the

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immature stage. An increasing trend of growth of *S. crumenophthalmus* was observed during the survey. The growth of this species is said to be isometric. Catch Per Unit Effort (CPUE) varied in every month. Sample sizes were ranging from 3 to 155 grams with an average weight of 59.24 grams. Based on the findings of this study, a whole year duration of sampling should be conducted. The reproductive biology of *S. crumenophthalmus* such as the gonadosomatic index, hepatosomatic index, and fecundity of this species should be done. In addition, a comprehensive whole-year study of the catch rate of ring net fishing in Romblon Pass should be conducted in order determines the population status of the small and big pelagic fishes in the area.

Keywords: Species composition; relative abundance; size structure; CPUE; LWR and Selar crumenophthalmus; Romblon passage.

1. INTRODUCTION

Fishing activities not only have a direct impact on target species and by-catch but also on the whole marine ecosystem [1]. The loss of biological diversity is a massive worldwide phenomenon [2]. Human activities threatened the productivity, diversity, and survival of coastal resources leading to a growing need to understand and manage coastal zones [3,4]. Fishing activity affects population structure, habitats, biodiversity, and productivity [5] especially when using inappropriate fishing gear, either passive or active gear [6]. Ring net is an example of active gear.

The length-weight relationship is important in fisheries research because it provides population parameters information [7]. In addition, it can be used in evaluating and studying the natural history of fishes [8] and is also important in fish biology, and population in studying stock conditions in estimating the status of fish communities in the Philippines [9].

To estimate the abundance of fish in a particular area, catch per unit effort (CPUE) can be applied. It is useful if the relation between CPUE is linear through the origin [10]. It can also use in commercial and recreational fisheries in the assessment of fish population [11]. CPUE and abundance are frequently assumed and recognized that CPUE may not accurately reflect changes in abundance [12]. In some reviewed studies, the CPUE with the use of data in fisheries argued the importance of understanding the spatial distribution of fish and allocation of fishing efforts to interpret CPUE data [13]. Romblon Passage is part of the Sulu-Sulawesi eco-region that connects the major fishing grounds of the Sulu Sea, Visayan Sea, and Verde Island Passage in the Philippines. The narrow channels between the major basins provide important corridors for migratory species including the large population of economically important marine species such as yellowfin, skipjack, and big-eye scads. The passage also harbors diverse species of demersal and pelagic fishes and threatened and endangered species such as commercially important marine resources. Based on the World Bank report in 2005, Romblon Pass is a heavily exploited fishing area with 2-70 fishers/km [14].

Despite of being rich, no study had been conducted such as the species composition of commercially important species such as small pelagic species and their status as well as the catch rate in the area. This circumstance was evidenced by the limited published literature online. According to 15.

Center for Biodiversity and Conservation [15], Romblon Passage was placed under the priority marine and coastal conservation area in the province. Thus, this kind of study will provide information and baseline data in crafting a management plan to protect and conserve its resource in the long run.

2. OBJECTIVES

This study aimed to determine the species composition and relative abundance caught by Ring Net in Romblon Pass, Philippines as well as the size structure in terms of length and weight, catch per unit effort and Length-Weight Relationship (LWR) of the most dominant species.

3. MATERIALS AND METHODS

3.1Sampling Site

The study was conducted in Romblon Pass, approximately 187 nautical miles (346 km) south of Manila, which lies between Tablas Island and

Romblon Island. Romblon Passage is part of the Sulu-Sulawesi eco-region which is considered the global center of marine biodiversity. It also connects the major fishing grounds of the Sulu Sea, the Visayan Sea, and Verde Island Passage in the Philippines (Fig. 1). The narrow channels between the major basins provide important corridors for migratory species including the large population of economically important marine species such as yellowfin, skipjack, and big-eye tuna. The passage also harbors diverse species of demersal and pelagic fishes, threatened and endangered species such as sea turtles, whale sharks, dolphins, stingrays and other commercially important marine resources [14,15].

The biodiversity of Romblon Passage earned recognition among conservation NGOs and has been included as part of the Sulu-Sulawesi Ecoregion. Conservation International (CI) includes the Passage as part of the Verde Island Passage, believed to be the center of global marine biodiversity, while the Philippine Biodiversity Conservation, in its National Biodiversity Strategy and Action Plan, identified the Passage as a very high priority for marine areas of biological significance. Up till now the coastal and marine resources of in this area have been subjected to various natural and anthropogenic stresses which have resulted in the degradation of inter-related ecosystems and increasing poverty incidence among the fisher-households [14,15].

3.2 Sampling Procedure

The collected fish samples were caught using ring net or locally known as “Pangulong”. Sampling was started on July 2017 to January 2018 and conducted every Saturday or Sunday. At least 300 individuals of the most abundant fish species caught by the ring net were measured and analyzed. Meanwhile, were collected to determine the relative abundance.

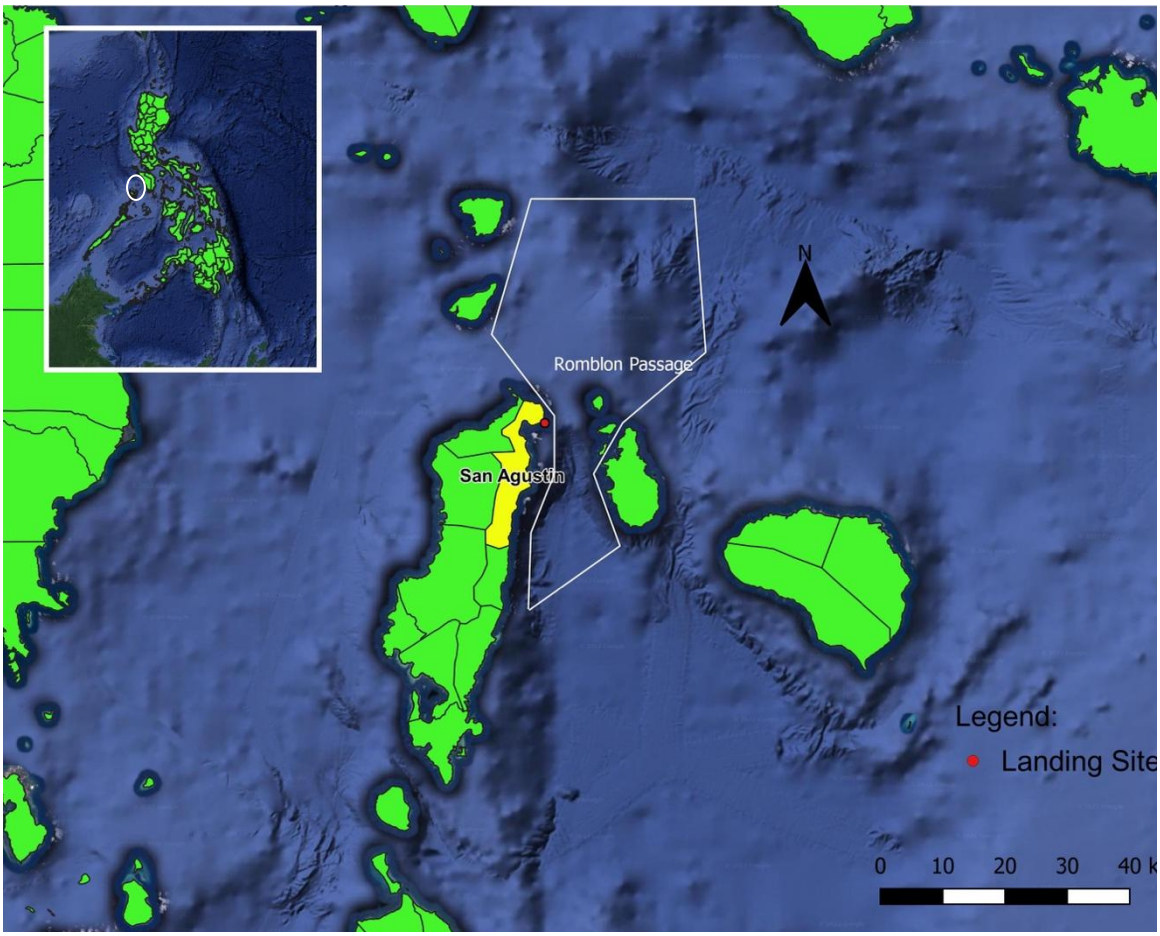

Fig. 1. The map Romblon Passage (white line) where the Ring net operation occurred and landing site (red dot) in San Agustin, Romblon, Philippines

3.3 Biometrics Assessment of the Samples

Three hundred individuals of the` most abundant fish caught by the "Pangulong" was assessed in the landing site of Barangay Long Beach, San Agustin. Biometrics such as Body Weight (BW) and Total Length (TL) were measured using Digital Weighing Scale (DWS) and for the Length-Weight Relationship (LWR)

3.4 Statistical analysis

The data were analyzed using Statistical Package for Social Science (SPSS, version 29). A descriptive statistic was used in the correlation among various parameters such as CPUE. The species composition of all fish caught in the handline was determined by using the following formula:

$$\text{Relative Abundance (\%)} = \frac{\text{Total Weight by Species}}{\text{Total Weight of All Species}} \text{X } 100$$

Length–weight relationships were calculated after Ricker (1975):

$W = aL^b$ (Logarithmic form: log W = log a + b*log L)

Where W - is the total weight (g), L - the total length (cm), a - the intercept (initial growth coefficient or condition factor), b - the slope (relative growth rate). Simple T-test was applied to determine the significance of differences between the isometric growth (b = 3) and the estimated b-value of the equation. The fish growth was also analyzed for allometric or isometric form of growth.

The Catch Per Unit Effort (CPUE) was also determined using the following formula:

$$\text{CPUE} = \frac{\text{Total Catch (Kg)}}{\text{Total Time Spent for Fishing (Hour)}}$$

4. RESULTS

4.1 Species Composition Caught by Ring Net

A total of 2,281 kg catch caught by ring net was recorded from July 2017 to January 2018. Five pelagic species and one demersal species were identified under three families. Carangidae with three species such as *Carangoides coeruleopinnatus, Decapterus macrosuma* and *Selar crumenophthalmus,* two species under family Scrombidae such as *Euthynnus affinis* and *Rastrilliger kanagurta* and one demersal species under family Pomacentridae was *Abudefduf sexfaciatus* (Table 1). Notably, majority of the species composition of ring net caught was pelagic species. The term 'small pelagic fishes' refers to a diverse group of mainly planktivorous fishes that share the same habitat, the surface layers of the water column, usually above the continental shelf and in waters not exceeding 200m in depth (Dalzell 1988) but unexpectedly a reef fish like *Abudefduf sexfaciatus* was caught during fishing.

4.2 Relative Abundance

A total of 160 kilos of fish were sampled from July 2017 to January 2018 with 6 identified species from ring net. *S. crumenophthalmus* dominated the catch with 73% share of the total catch followed by *E. affinis* with 15% *D. macrosoma* with 12% and three species (*Rastrelliger kanagurta, Carangoides coeruleopinnatus, Abudefduf sexfasciatus*) shared about less than 1% to the total catch (Fig. 2).

Table 1. The composition of fish caught by ring net in Romblon Passage, Philippines

Family	Species	Common Name	Local Name
Carangidae	*Carangoides coeruleopinnatus*	Onion Trevally	Putian
	Decapterus macrosuma	Round Scad	Galonggong
	Selar crumenophthalmus	Bigeye Scad	Magudlong
Scrombridae	*Euthynnus affinis*	Little Tuna	Bangkulisan
	Rastrilliger kanagurta	Indian Mackerel	Haguma-a
Pomacentridae	*Abudefduf sexfaciatus*	Scissor-Tailed Sergent Major	Payata

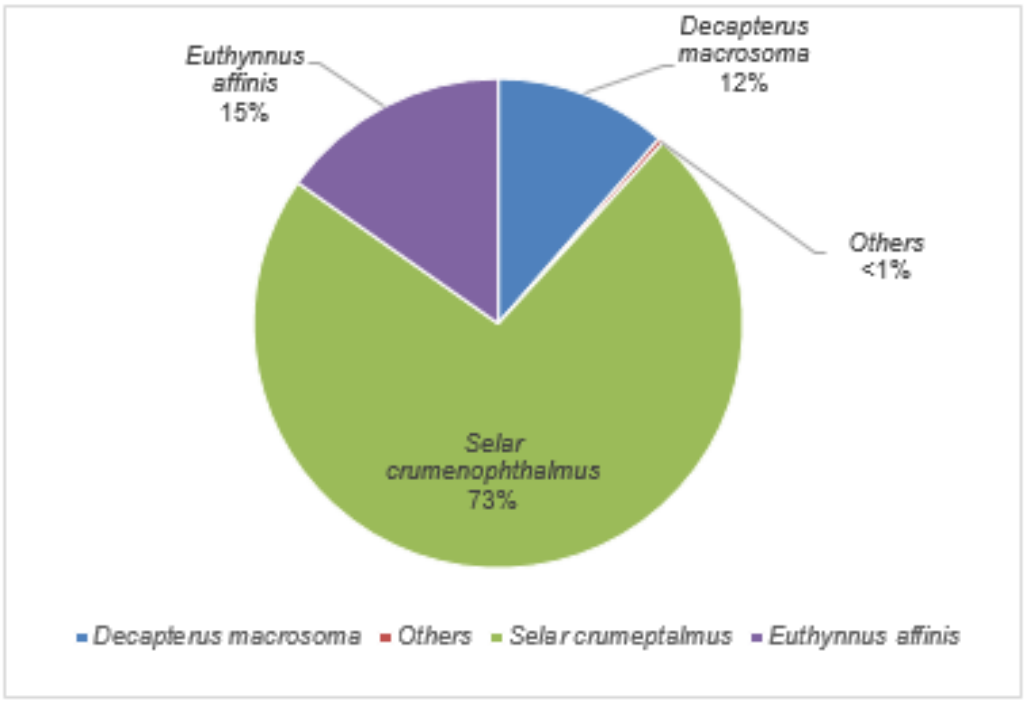

Fig. 2. Relative abundance of fish caught by Ring net from Romblon Passage, Philippines

This study revealed that *S. crumenophthalmus* was the dominant small pelagic species present in Romblon Passage, Philippines at this season. However, according to the fishermen, species composition dominance varied depending on the season and month. For example, during the month of April to June red-tail scad and round scad are the dominant species caught by ring net. These changes might be attributed with the biological production of small pelagic fishes which are highly seasonal, being influenced by environmental conditions most notably by monsoon winds (Pauly and Navaluna 1983; Navaluna and Pauly 1988; Dalzell and Corpuz 1990).

4.3 Size Structure of *Selar crumenophthalmus* in Romblon Passage, Philippines

4.3.1 The length distribution of *Selar crumenophthalmus*

A total of 2,289 individuals of *Selar crumenophthalmus* weighing 164 kilograms were measured from July 2017 to January 2018 caught by ring net from Romblon Passage, Philippines. Sample sizes were ranging from 19 to 297 mm with an average length of 177.22 mm. The majority of the recruitments caught in the area were in belonged to 19 mm to 204 mm meanwhile, about only 7 percent or 194 individuals were belonging to the 205 mm-297 mm group (Fig. 3). *Selar crumenophthalmus* is a small coastal pelagic fish reaching 255 mm mean fork length which achieves sexual maturity at 215 mm (Smith-Vaniz et al. 2002). This distribution of recruitment indicates that the majority were immature.

4.3.2 The weight distribution of *Selar crumenophthalmus*

Selar crumenophthalmus weight was ranging from 3 to 155 grams with an average weight of 59.24 grams. Weight ranging from 37 to 53 grams has the highest number with 776 individuals recorded and weight ranging from 139 to 155 grams has the lowest number observed with 6 individuals (Fig. 4). A normal curved of distribution was observed in the weight of the recruitment of *S. crumenophthalmus,* though an extreme concentration of recruitments was observed in 37 to 53 grams.

4.4 Catch Per Unit Effort (CPUE) of Ring Net

A total of 2281.14 kilos of fish were caught by the ring net from July 2017 to January 2018 in

Romblon Passage, Philippines. The Catch Per Unit Effort (CPUE) of ring net per trip has an average of 25.07 per hour. The highest CPUE was recorded during the fifth sampling with 37.14 kilos per hour while the lowest CPUE was recorded during the first sampling with 12.14 kilos per hour, respectively (Fig. 5). Notably, Catch Per Unit Effort (CPUE) varied every month. This result is affected by different factors such as moon phase, weather, and the number of other fishermen like "jumpers".

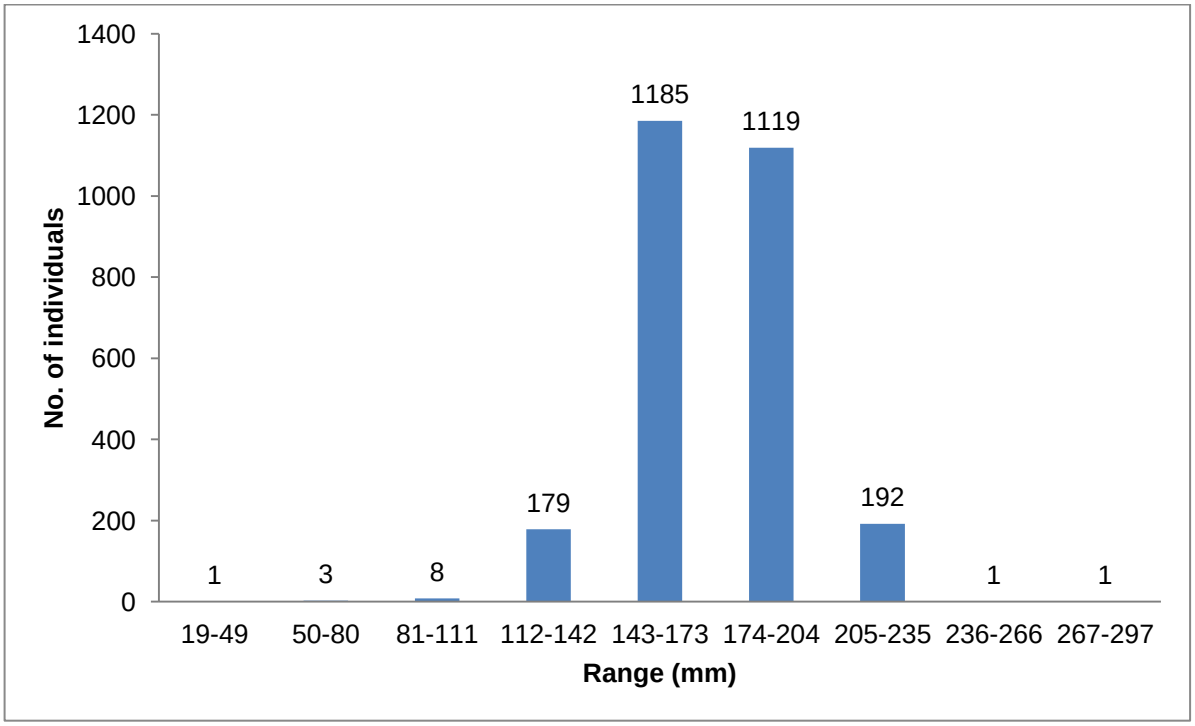

Fig. 3. Length distribution of *Selar crumenophthalmus* in Romblon Passage, Philippine

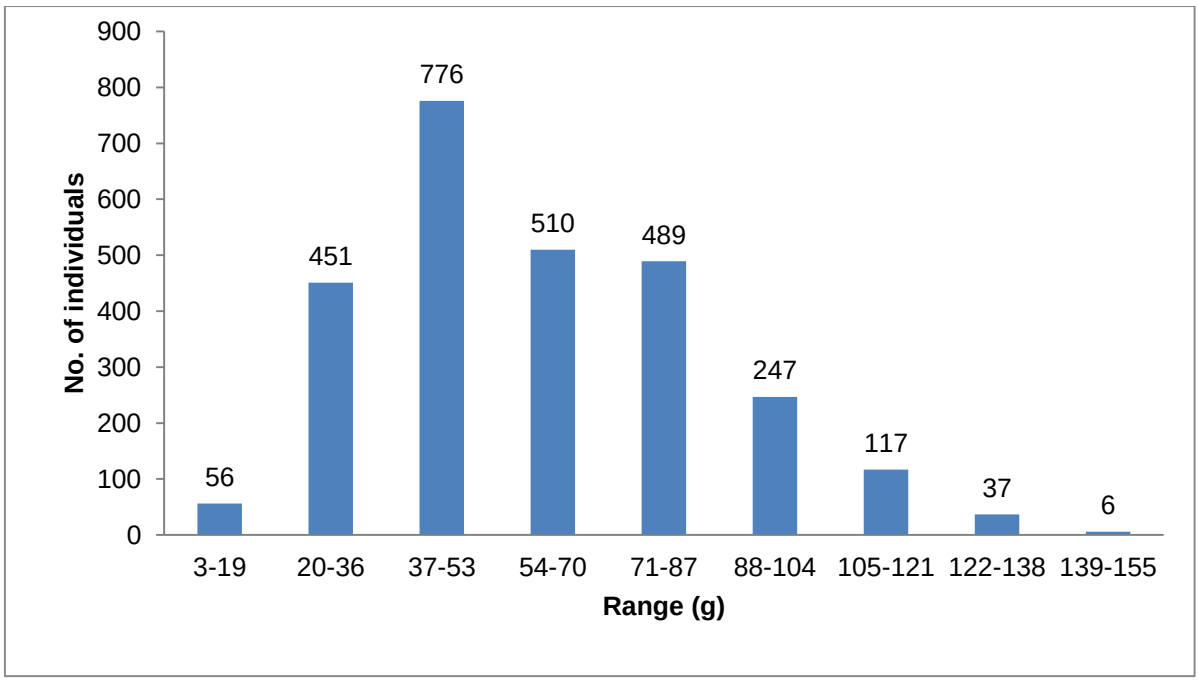

Fig. 4. Weight distribution of *Selar crumenophthalmus* in Romblon Passage, Philippines.

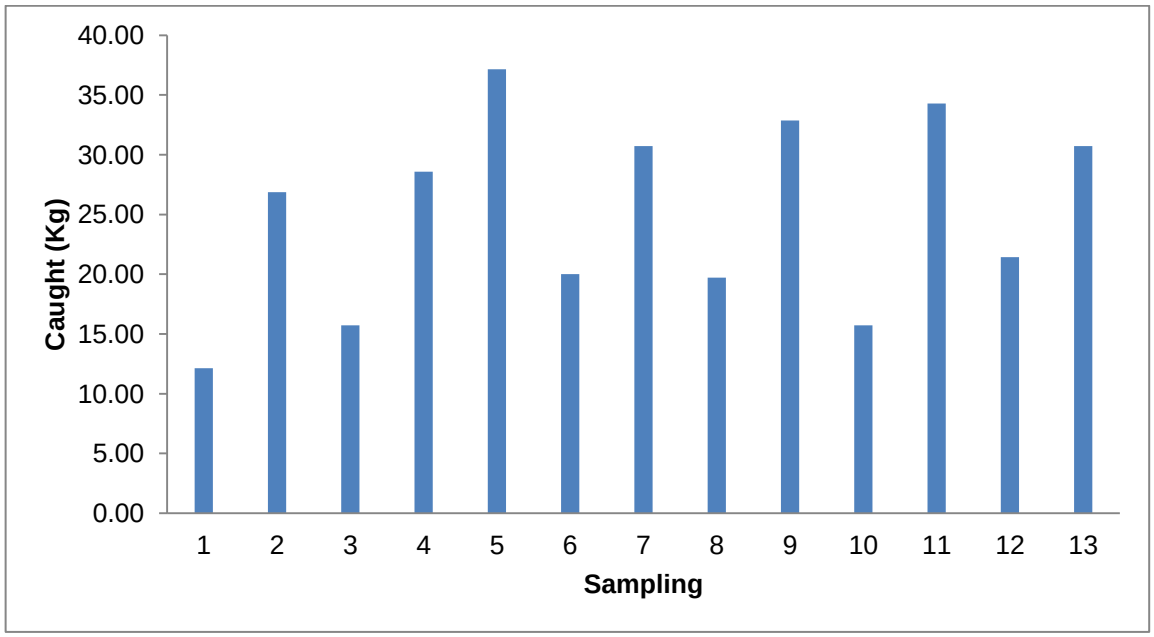

Fig. 5.The average of Catch Per Unit Effort of Ring net in Romblon Passage, Philippines from July 2017 to January 2018

4.5 Length-Weight Relationship of *S. crumenophthalmus* from Romblon Passage, Philippines

A total of 2,268 individuals of *Selar crumenophthalmus* were measured from July 2017 to January 2018. Sample weights were ranging from 3 to 155 grams with an average weight of 59.24 grams. The Length-Weight Relationship of *S. crumenophthalmus* was W=3.367X-13.30 where the correlation coefficient was 0.93 (Fig. 6). It simply indicates that there is a strong relationship between length and weight since the correlation coefficient is almost perfect. It also indicates that 93.33% of the variation in weight is caused by length. The *b* value was found to be 2.77. Since the slope was almost equal to three, the *Selar crumenophthalmus*'s growth is considered isometric (*b*=3). This conveys that there is a strong relationship between their lengths and weights increment and that the models developed from these lengths and weights data are reliable and can be used in the conversion between fish length and weight to provide some measure of biomass. Overall *b* for *S. crumenophthalmus* was lower than theoretical *b* which indicated that the majority of the large specimens have changed their body shape to become more elongated or small specimens were in better nutritional condition at the time of sampling [16].

In addition, the result of this study suggests that the *S. crumenophthalmus* from Romblon Passage, Philippines grows faster in weight than length [16,17,18]. Differences in length-weight relationships can occur due to environmental factors, seasonal changes, food availability in the area, and population [16,18].

5. DISCUSSION

The number of species identified from Romblon Passage, Philippines was quite lower compared to the places in the country like in Honda Bay, Palawan [19], and in Western and Central Visayan Sea [20]. However, this result is comparatively the same as the study of Purwanto et al. [21] in Indonesia (Table 2). The results might be affected by the duration of the study whereas the data collection in Honda Bay, Palawan, and Western and Central Visayan Sea was done over four years by the Bureau of Fisheries and Aquatic Resources (BFAR)-National Stock Assessment Program (NSAP). Notably, the species composition caught by the Ring net was relatively the same. All sites cited in this study including Romblon Passage, Philippines were dominated by small pelagic fish species. The small pelagic fishes can be defined as the Engraulidae, Clupeidae, Carangidae, Scombridae, Caesionidae, Exocoetidae, Hemiramphidae, and Atherinidae [22]. The

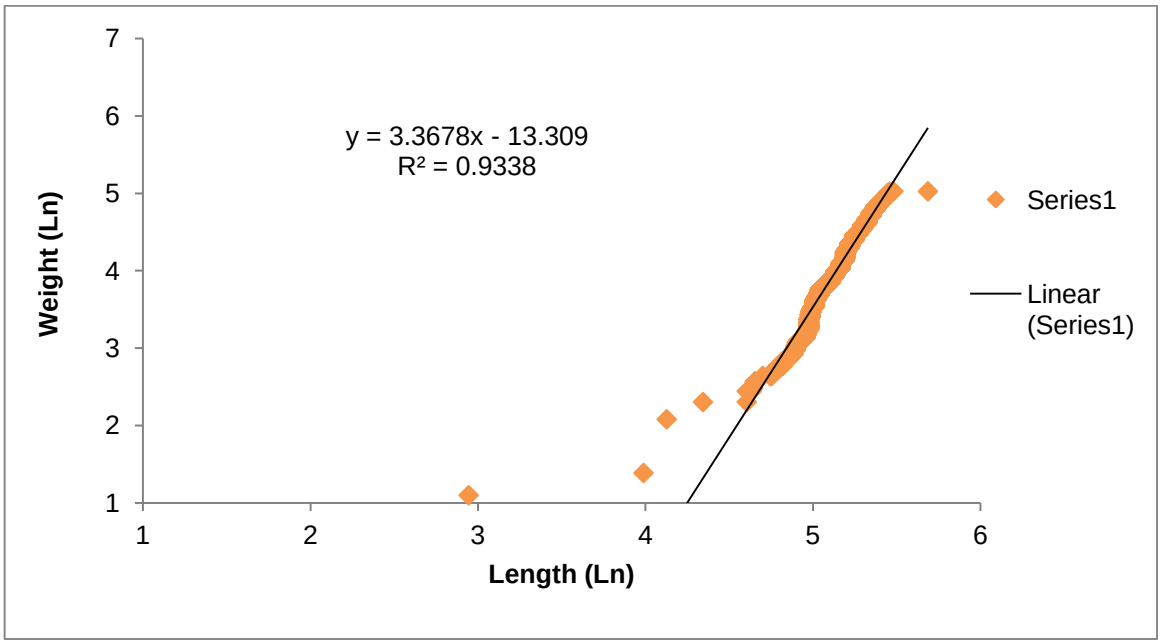

Fig. 6. The Length-Weight Relationship of *S. crumenophthalmus* from Romblon Passage, Philippines

Table 2. The number of common species caught in some fishing ground in the Philippines and neighboring country

Location	Number of Species	Author
Romblon Passage, Philippines	6	This Study
Honda Bay, Palawan, Philippines	10	Canderio et al. [19]
Western and Central Visayan Sea, Philippines	15	Guanco et al. [20]
Java Sea, Indonesia	5	Purwanto et al. [21]

fisheries of small pelagic fishes comprise an important segment in the country's fishery industry. In the Philippines, small pelagic fisheries contributed 35% of the total fisheries production in 2001 [23]. Being widely available in large groups, it is not surprising that they provide over 45% of global fish production [24].

The relative abundance of Ring nets in Romblon Passage, Philippines exhibited the same pattern as the other conducted studies in the country. It was supported by the study of Baclayo et al. [25] where the *S. crumenophthalmus* was the dominant species in Hinatuan Passage, Caraga Region, Philippines as well as in Honda Bay, Palawan [19]. According to Baclayo et al. [25], small pelagic fishes like *S. crumenophthalmus*, *E. affinis*, *D. macrosuma* were abundantly caught by commercial fishing like Ring net.

The majority of them were in the immature stage. In this study, it was observed that the majority of the sample contained immature fishes and this could immensely affect the healthy survival of the stock. According to Clark and Privitera [26] and Smith-Vaniz [27], this species matured and spawned at above 21.50 mm. This result was supported by the study of Baclayo et al. [25] in Hinatuan Passage, Caraga Region, Philippines where the majority of the fish caught of Ring nets were immature. Based on the results, it appeared that this gear has a negative impact on the sustainability of capture fisheries. For instance, *S. crumenophthalmus* attained maturity at 21.5 cm, these are clear indications that immature fishes are very vulnerable to being caught with these gears [25]

Generally, an increasing trend of growth of *Selar crumenophthalmus* was observed in the entire survey. A gradual increase in the length of the samples was observed while an average increase was observed in the weight of the samples. This pattern was influenced by the

spawning season of this species. According to Roux and Conand [28], on Reunion Island, this species has an annual reproductive cycle. Spawning occurs mostly from October to December with the length of one-year old individuals averaging 21.5 cm FL. In other places like Haiwaii, spawning periods are potentially staggered from April to November, with a peak from September to November [29]. Some studies indicate that the spawning period for this species extends over a period of 6-7 months (between March and September). Its life cycle is rapid and short [28,29]. On the other hand, the size structure trend especially the weight of the *Selar crumenophthalmus* in the Romblon Passage was influenced by the spawning period.

Recruitments of *Selar crumenophthalmus* from Romblon Passage, Philippines was relatively smaller compared to the studies conducted in Zambuanga City [30], Peninsular Malaysia [31], Sarawak Malayisia [32], Manzanillo Bay, Mexican Central Pacific [33] and Bangaa Faru, Maldives [33]. Nevertheless, the recruitments of *Selar crumenophthalmus* were relatively bigger compared to the recruitments measured about two years ago in the place [35]. It simply indicates that the size structure of *Selar crumenophthalmus* around the world varies (Table 3).

According to Froese [36], overfishing can be prevented by following certain rules, such as by catching fishes that have reached their optimum length, which is usually a bit larger than the length at first maturity. However, the spawning of fish must be avoided. Moreover, large females must be avoided as they are more fecund and a minimum catch length can be set such that more than 90% of the individuals get at least one chance to reproduce before being caught as overfishing can be stopped if all the fishes get an equal chance to reproduce before capture [36].

To maintain an efficient and sustainable fishing industry, one of the main aspects that need to be monitored is the understanding of fish reproductive biology [37,38]. Information about reproductive biology could be conveyed to the related authorities to monitor fish productivity and prevent over-exploitation of the fish population [34,39]. Such information also suggests the suitability of fish as biological indicators of environmental stability [40]. Sex ration provides the basic information needed for the assessment of the potential of reproduction and stock size estimation [41].

Catch Per Unit Effort (CPUE) is commonly used as an index to estimate relative abundance and is then applied within stock assessments so that fisheries managers can make justified decisions for how to manage a particular stock or fishery using measures such as catch quotas, catch limits, and gear or license restrictions [42,43].

The catch rate of Ring net fishing in Romblon Passage, Philippines was comparable to other places in the country like Honda Bay, Palawan [19] but lower to Western and Central Visayan Sea [20]. On the other hand, CPUE in this area was quite higher compared to Indonesia [21] (Table 4).

The operation of the ring net, which was introduced in the 1970s, also increased, and there were >500 ring netters in 1995. Nevertheless, the landings of small pelagics from offshore vessels doubled during 1984-1995, forming 70% of the total landings of small pelagics in 1995 [44,45]. The increasing trend of ring net operation in the country in the subsequent years resulted in the decline of the CPUE especially small pelagic fishes [23].

Table 3. Size structure comparison of *Selar crumenophthalmus* across the country

Location	Average Size (cm)	Length (cm)	Weight (g)	Author
Romblon Pass, Philippines	17.72	1.9-29.7	3-155	This study
Romblon Pass, Philippines	17.12	11-22.3	2.83-4.78	Catajay et al. [35]
Zambuanga City, Philippines	18.27	20.47	115.82	Echem and Miñoza [30]
Penensular Malaysia		9.2-28.6	2.9-293.3	Isa et al. [31]
Sarawak Malaysian	24.90	15.4-28.6		Rajali and Rampet [32]
Manzanillo Bay, Mexican Central Pacific	20.00	13.20-24.8	25-172	Espino Barr et al. [33]
Bangaa Faru, Maldives		77-24.5	8-255.6	Fadzly et al. [34]

Table 4. Catch Per Unit Effort (CPUE) of Ring net fishing in Romblon Passage, Philippines to fishing ground

Location	CPUE (Kilo Per Hour)	Author
Romblon Passage, Philippines	25.07	This Study
Indonesia	8.83	Punwanto et al. [20]
Western and Central Visayan Sea	37.85	Guanco et al. [21]
Honda Bay, Palawan	28.73	Candelario et al. [19]

Table 5. Comparison of the Length-Weight Relationship of *S. crumenophthalmus* by fishing ground

Location	b- value	R^2-value	Author
Romblon Pass, Philippines	2.77	0.93	This study
Romblon Pass, Philippines	2.40	0.53	Catajay et al. [35]
Palawan, Philippines	2.78		Gonzales et al. 2000
Penensular Malaysia	3.251	0.99	Isa et al. [31]
Sarawak, Malaysian	2.98	0.95	Rajali and Rampet [32]
Manzanillo Bay, Mexican Central Pacific	3.23		Espino-Barr et al. [34]
Seramang Waters, Indonesia	2.85	0.99	Siwat et al. [45]

The growth of *S. crumenophthalmus* from Romblon Passage, Philippines was isometric (*b*=3). The recruitments from this area were relative the same to the *S. crumenophthalmus* population from Sarawak, Malaysia [32] and Seramang Waters, Indonesia [45]. Meanwhile, the growth of *S. crumenophthalmus* from Peninsular Malaysia [31] and Manzanillo Bay, Mexican Central Pacific [34] was positive allometric *(b*>3) (Table). On the other hand, the length and weight of *S. crumenophthalmus* recruitments from Romblon Passage, Philippines as well as the recruitment from Sarawak, Malaysia, and Seramang Waters, Indonesia was proportion. The same study was conducted about two years ago [35]. The same growth (isometric) was observed but the *b* value of this study was relatively high compared to the study conducted by Catajay et al. [35]. The number of samples affected the lower results of Catajay et al. [35] whereas the number of their samples was only 300 individuals quite lower compared to the number of samples in this study (2668 individuals).

According to Conor et al. [46], in modeling the length and weight characteristics of fish, it is imperative to account for two characteristics. First, LWR violates linearity which implies that length is a linear variable whereas weight is related to volume [46,47]. Therefore, increasing length means adding a disk of volume carrying a corresponding weight. Second, higher weight differences result when the fish length is increased. Earlier Length-Weight Relationship studies did not account for any sex difference [48]. Famoofo and Abdul [49] reported that the variations in Length-Weight Relationship cannot be attributed to a single factor; but the combination of factors-physical like seasons, environmental conditions, habitat, biological sexual maturity, stomach fullness, and diet.

6. CONCLUSION AND RECOMMENDATIONS

Based on the results of the study, it was concluded that there were six species of fish identified belonging to three families that can be caught by ring net in the Romblon Passage. The majority of the species composition of ring net caught was pelagic species. The number of species identified from Romblon Pass was quite lower compared to the places in the country. Among six species, *S. crumenophthalmus* was the dominant small pelagic species present in Romblon Passage, Philippines at this season. The majority of the *S. crumenophthalmus* were in an immature stage. Generally, an increasing trend of growth of *S. crumenophthalmus* was observed in the entire survey. This pattern was influenced by the spawning season of this species. Catch Per Unit Effort (CPUE) varied every month. This result is affected by different factors such as moon phase, weather, and the number of other fishermen like “jumpers”. The catch rate of Ring net fishing in Romblon Passage, Philippines was comparable to the other fishing ground. Sample sizes were ranging from 3 to 155 grams with an average weight of

59.24 grams. The Length-Weight Relationship of *S. crumenophthalmus* has a strong relationship between length and weight. The *b* value was found to be 2.77. Since the slope was almost equal to three, the growth of the *S. crumenophthalmus* is said to be isometric (*b*=3).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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