E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2019; 7(5): 548-554

www.fisheriesjournal.com
Received: 14-07-2019
Accepted: 18-08-2019

Bernard C Gomez
Surigao State College of Technology Malimono, Surigao del Norte, Philippines

Teresita P Senados
Surigao State College of Technology Malimono, Surigao del Norte, Philippines

Gregorio Z Gamboa Jr
Surigao State College of Technology Malimono, Surigao del Norte, Philippines

Corresponding Author:
Bernard C Gomez
Surigao State College of Technology Malimono, Surigao del Norte, Philippines

Fishery of flying fish (Exocoetidae) in west coast of Surigao del Norte, Philippines

Bernard C Gomez, Teresita P Senados and Gregorio Z Gamboa Jr

Abstract
This study was conducted within 1-year period to determine relative abundance, catch per unit effort and fecundity of Flying fish in West Coast of Surigao del Norte, Philippines. A total of 2,537 Flying fish individuals belonged to three (3) genera and 11 species were recorded. The yellow-wing Flying fish, *C. poecilopterus* was the most dominant and abundant species with 37.80% of the total sample gathered. November obtained the highest catch landings, 8,041.67 kg and CPUE, 15.11 kg·boat^{-1}day^{-1}. The estimated total catch landing for the whole duration of the study has reached to 46,604.51 kg with a mean CPUE of 12.20 kg·boat^{-1} day^{-1}. A significant linear relationship was observed between absolute fecundity and total length, body weight, ovary length and ovary weight of *C. poecilopterus*. Absolute fecundity varies from 7668±713 to 11218±769 with a mean of 9402±1827 eggs. The ova diameter is significantly increasing from 589.4±161.5μm in September with a maximum diameter of 1416.7±54.7μm in March and decrease slightly from the month of April to May. Similarly, the mean values of gonadosomatic index were recorded from September (5.84±0.64) to May (11.08±2.58) and also showed highest in March (13.18±2.01).

Keywords: Flying fish, species composition, catch per unit effort, fecundity and Surigao Del Norte

1. Introduction
The Flying fish locally known as "Bangsi" is a group of small fish which belongs to family Exocoetidae. It is distributed globally in tropical and subtropical waters of three oceans [1-3]. They are known as Flying fish due to their ability to glide in the air over the water using large and elongated pectoral and asymmetric caudal fins [4]. This uncommon ability is a natural defense mechanism to evade predators [5]. Flying fish are considered as commercially and ecologically important species irrespective of their geographical distribution [6, 7]. The Flying fish are assumed fast growing and short lived, with a longevity of less than 2-year [8].

In west coast of Surigao del Norte, Philippines, Flying fish is one of the important fishery resources for it provides a source of livelihood. It is caught by using modified surface drive-in net locally called as "sari" and surface drift gillnet locally known as "anod". The catches are used for local consumption or sold directly to consumers fresh or dried. Some fishermen utilized Flying fish as bait for line fishing. The flesh of *H. affinis* is frequently used as bait to capture larger predatory fish species and their eggs are marketed for the production of local caviar [9]. The Flying fish is also the main prey for the dolphinfish, *Coryphaena hippurus* and various tunas [10-12]. Flying fish is also among the most dominant catches in some areas in the Philippines like the western portion of the Verde Island Passages in the West Philippine Sea and around the Camotes Sea in the Visayan Seas [13]. Emperua *et al.* [13] also reported that Flying fish contributed an average of about 84% of the annual catch production but showed a declining trend over the 3-year period from 2013 to 2015, indicating declining abundance and unsustainable state of Flying fish fishery.

The continued harvesting of this species without considering the present status would lead to overexploitation. Fishermen harvested this species beyond the capacity of the resource. Current harvest rates of Flying fish species are thought to be unsustainable - that is, unable to be maintained year after year without depletion of the fish stock. The increasing number of fishermen and fishing boats to catch this species requires better management of the fishery resources to make it sustainable. Thus, this study assessed the current status of Flying fish species in west coast of Surigao del Norte, Philippines. The abundance, catch per unit effort and fecundity were determined to established baseline information of the Flying fish species in the study area. The data gathered would be the basis for appropriate management policies in the future.

2. Materials and Methods

2.1 Study area

The study was conducted in the west coast of Surigao del Norte for 1-year period from June 2018 to May 2019. Three (3) sampling stations (Figure 1) were established; Station 1, Linonggannan (9^0 2' 55.45"N, 125^0 23' 45.19"E), Station 2, Cagtinae (9^0 38' 26.54"N, 125^0 23' 42.27"E) and Station 3, Cansayong (9^0 34' 43.70"N, 125^0 24' 43.09"E). The designated stations are landing points of surface drift gillnet boats engaged in catching Flying fish and located in the west portion of the province facing Bohol Sea.

2.2 Sampling procedure

Fish sampling was conducted once a week and two (2) kilograms of samples were taken randomly from each station. A total of 6 kg of Flying fish was purchased directly from fishermen every sampling. Samples were brought to the laboratory room for the measurement of length and weight. Total length for each sample was measured to the nearest 0.1 cm using fish board. Body weight was also recorded to the nearest 0.01 gram using 500g x 0.01g Electronic Digital Jewelry Scale. Samples with broken tails were not included in the measurement. Each species of Flying fish was pictured and identified based on fishbase.org.

2.3 Relative abundance

The different species of Flying fish and the number of individuals per species were recorded. Relative species abundance is the ratio of individuals of a given Flying fish species to the total number of flying fish individuals sampled. It was calculated as follows:

$$\text{Relative abundance} = \text{Pi } (\%) = \frac{Ni}{N} \times 100$$

Where, Ni is number of individuals of a given Flying fish species and N is total population of Flying fish sampled.

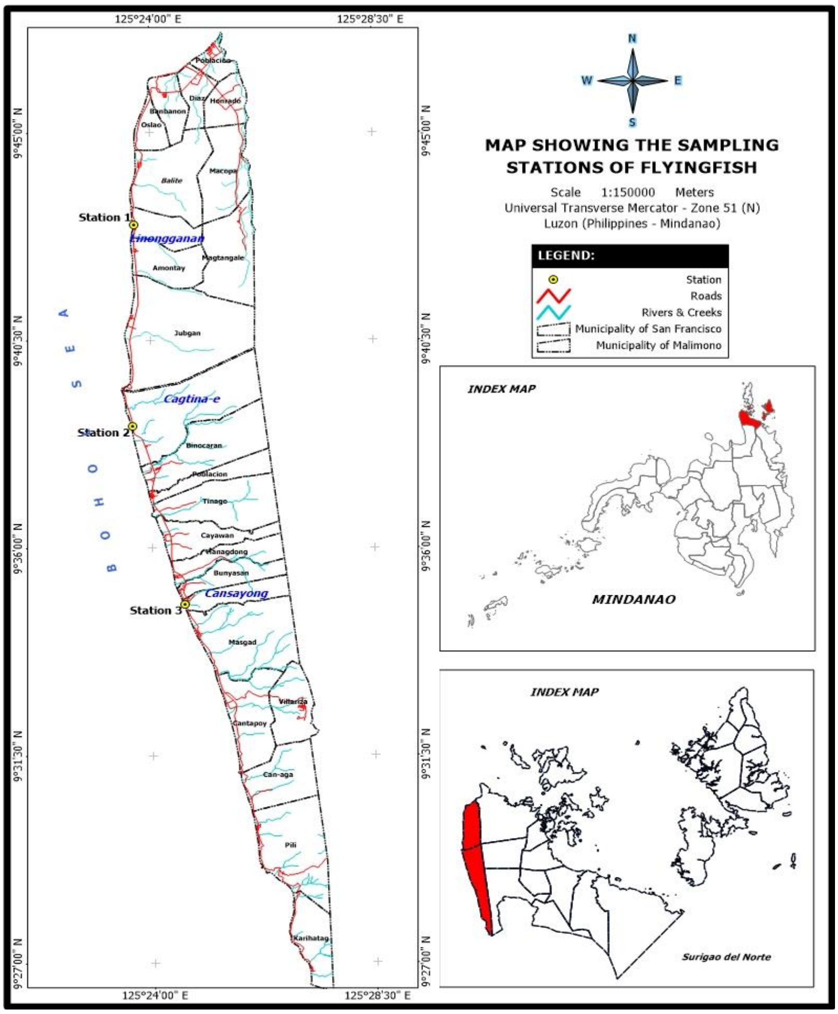

Fig 1: Location map of the study area in west coast of Surigao del Norte, Philippines.

2.4 Catch per unit effort (CPUE)

A daily catch from the 15 fishing boats or 30% of total number of boats operating in the study area was monitored and recorded to estimate the total catch and CPUE for the entire duration of study. These boats are engaged in catching Flying fish using surface drift gillnet. The CPUE for this study was calculated as the number of kg· $boat^{-1}$ day^{-1}.

2.5 Fecundity

Fecundity was determined only for yellow-wing Flying fish, *C. poecilopterus* collected within entire duration of the study. The two parts of ovary from each fish were removed intact and placed in 10% buffered formalin. Fecundity was calculated by relating the number of eggs in a subsample to the whole gonad. Subsamples, representing approximately 5% of the total gonad weight, were taken from the middle and both ends of each gonad and weighed to the nearest 0.01 g. The eggs in each subsample were counted to determine fecundity using the formula of [14];

$$F = \frac{W \times (N_1 + N_2 + N_3)}{(W_1 + W_2 + W_3)}$$

Where F = fecundity, W = total weight of ovary; W_1, W_2, W_3 and N_1, N_2, N_3 are the weight and ova counts respectively of each sub-sample.

The least square regression analysis [15] was used to compute the relationship between fecundity and total length, total weight, ovary length and ovary weight.

Gonadosomatic index (GSI) of the samples collected was also calculated by applying the formula of [16];

$$GSI = \frac{\text{Weight of the gonad (g)}}{\text{Weight of the fish (g)}} \times 100$$

Twenty eggs were taken randomly from the mixed sample of eggs in each ovary and diameter was determined with the aid of micrometer spaces installed in the microscope.

3. Results and Discussions

3.1 Species composition and relative abundance

A total of 2,537 Flying fish individuals which belonged to three (3) genera and 11 species were recorded from the three (3) sampling stations in the west coast of Surigao del Norte, Philippines from June 2018 to May 2019 (Table 1). Results also show that yellow- wing Flying fish, *Cypselurus poecilopterus* (Valenciennes, 1847) (Plate 1) was the most dominant and abundant species which obtained the highest count (37.80%) followed by spotfin Flying fish, *Cheilopogon furcatus* (Mitchill, 1815) (18.41%), Glider Flying fish**,** *Cheilopogon atrisignis* (Jenkins, 1903) (8.36%). These three (3) species, *C. poecilopterus* and *C. furcatus* and *Cheilopogon atrisignis* accounted to 64.56% of the total catch. The *C. poecilopterus* was noted consistently and dominantly caught in 1-year period from June 2018 to May 2019. The species observed dominant in this study such as *C. poecilopterus*, *C. furcatus*, *C. unicolor*, *C. atrisignis* and *H. speculiger* were also noted dominant in Maitum, Sarangani, Philippines [13] and in the Kuroshio Current off eastern Taiwan, in the South China Sea [17].

Three (3) genera of Flying fish were found, namely, Cheilopogon which constituted about 49.31% of the Flying fish caught, followed by Cypselurus and Hirundichthys with 43.75% and 6.94% contributions, respectively (Figure 2). These findings are also similar to the observations of Emperua *et at*. [13] That these three genera resulted highest contributions of the Flying fish species.

3.2 Catch per unit effort (CPUE)

Figure 3 presents the estimated monthly catch landings and Figure 4 shows the estimated Catch Per Unit Effort (CPUE) of Flying fish landed in the west coast of Surigao del Norte from June 2018 to May 2019. From the figure, the highest catch landings of 8,041.67 kg was noted in the month of November followed by March (6,925.00 kg), then, December (4,881.67 kg), June (4,465 kg), April (4,324.17 kg). November obtained also the highest.

Table 1: Species composition and relative abundance of Flying fish species (Exocoetidae) landed in the west coast of Surigao del Norte, June 2018 to May 2019.

Genera/Species	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	Rel. Abun. (%)
Cheilopogon														
C. atrisignis	15	14	-	25	50	12	16	15	8	31	17	9	212	8.36
C. dorsomacula	6	5	-	5	8	-	-	-	-	-	-	-	24	0.94
C. exsiliens	6	1	-	1	-	-	-	-	-	-	-	-	8	0.32
C. furcatus	119	109	93	48	46	36	-	-	-	13	3	-	467	18.41
C. heterurus	15	-	-	5	7	23	28	23	21	20	8	7	157	6.19
C. spilopterus	12	11	25	29	35	24	19	24	6	7	3	4	199	7.84
C. unicolor Cypselurus	86	26	-	33	21	10	-	-	-	4	4	-	184	7.25
C. poecilopterus	88	136	60	47	101	137	102	132	80	46	20	10	959	37.80
C. simus Hirundichthys	19	12	-	7	17	37	26	21	12	-	-	-	151	5.95
H. affinis	26	63	-	5	12	-	-	5	-	9	5	-	125	4.93
H. speculiger	21	10	-	-	-	-	-	-	-	5	5	10	51	2.01
Total	413	387	178	205	297	279	191	220	127	135	65	40	2537	100.00

Plate 1: The two (2) most dominant Flying fish species; a) yellow-wing Flying fish, *Cypselurus poecilopterus* and b) spotfin Flying fish, *Cheilopogon furcatus*

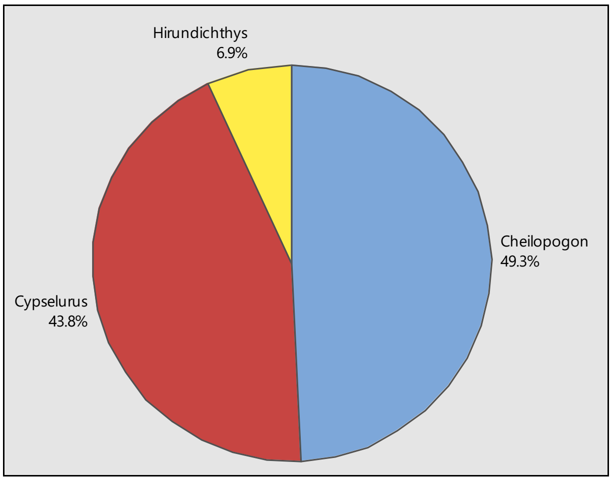

Fig 2: Pie graph showing percentage contribution of the three (3) genera of Flying fish (Exocoetidae) landed in the west coast of Surigao del Norte, June 2018 to May 2019.

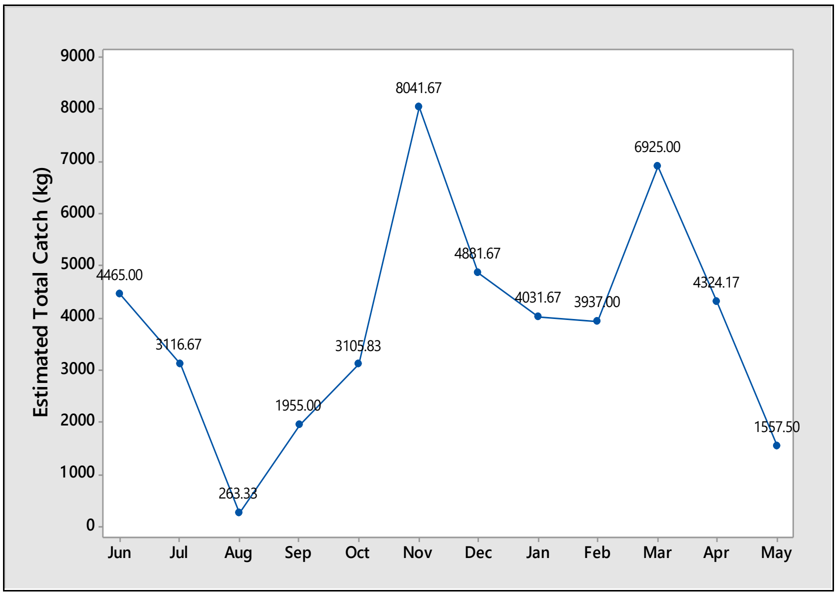

Fig 3: The estimated monthly catch landings of flying fish (Exocoetidae) from the west coast of Surigao del Norte, June 2018 to May 2019.

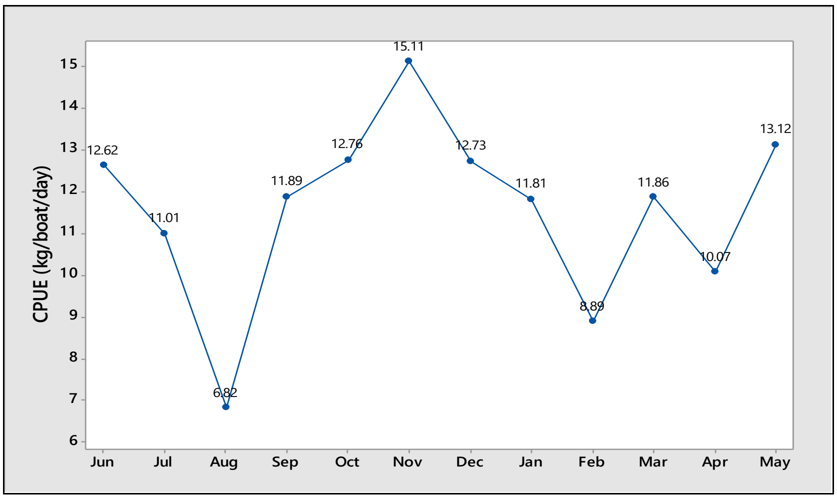

Fig 4: The estimated Catch Per Unit effort (CPUE) in kg·boat^{-1}·day^{-1} of Flying fish (Exocoetidae) from the west coast of Surigao del Norte, June 2018 to May 2019.

CPUE of 15.11 kg·boat^{-1}day^{-1}, followed by May, October, December and June with CPUE of 13.12 kg·boat^{-1} day^{-1}, 12.76 kg·boat^{-1}day^{-1}, 12.73 kg·boat^{-1}day^{-1} and 12.62 kg·boat^{-1}day^{-1}, respectively. The month of August resulted lowest in the total catch landings (263.33 kg) and CPUE of 6.82 kg·boat^{-1} day^{-1}.

The catch landings and CPUE displayed monthly variations. The decrease was noted from June to August and the significant increase was observed in September until it reached the peak in the month of November. However, the total catch and CPUE have shown a decreasing trend from December to February and rise again in March.

The monthly variation of flying fish production in the present study is attributed to weather conditions which greatly affect the fishing activities of the Flying fish species. August obtained the lowest catch landings because of less number of fishing days and trips by the

fishermen due to the occurrence of typhoons and southwest monsoon locally known as "hanging habagat". The southwest monsoon begins on mid-June to mid-September which brings humid air, thick clouds, and heavy rains to the country. This wind becomes stronger whenever a typhoon enters to the "Philippine Area of Responsibility". The southwest monsoon makes the seas very rough, lesser appearance of the species and making it difficult for fishermen to catch fish. Hadil and Richard [18] claimed that fish abundance and distribution pattern is also influenced by the monsoon systems. During the calm season, small pelagic fishes move inshore within 15-40 meters depth and during the rough season, they migrated offshore towards the more saline and deeper water.

The highest total production and CPUE were also observed in the month of November. This observation is similar to the report of De Croos [19] that the highest catch of Flying fish off northwestern coast of Sri Lanka was in November 2002 while the lowest catch was reported in March 2003. He also reported that fishing effort was high in November 2002 and remained at a more or less steady level till February 2003. Jayawardana and Dayaratne [20] concluded that the total Flying fish production in off Kandakuliya, Sri Lanka was high in the months of November to March from 1991 to 1993 due to greater relative abundance of the stocks. Emperua, *et al.* [13] observed that in the Philippines the Flying fish were caught throughout the year using surface gill nets. They also noted that in 2013 and 2015 peak months occurred in the months of February to April and October to November in 2014.

The mean total number of Flying fish fishing trips conducted per month by the surface gillnet boats from June 2018 to May 2019 in the study area was 17. The estimated total catch landing of Flying fish for 1-year period has reached to 46,604.51 kg with a mean CPUE of 12.20 kg·boat^{-1} day^{-1}. The mean total catch and CPUE in this study is lower than compared to the findings of De Croos [19]. Emperua, *et al.* [13] reported that the annual catches of Flying fish in the Philippines showed a downward trend from 2013 to 2015 indicating declining abundance and unsustainable state of flying fish fishery.

3.3 Fecundity

Fecundity refers to the number of eggs contained in ovary of a fish. It denotes the egg laying capacity of a fish or it refers to the number of ripe eggs produced by a fish in one spawning season. Knowledge about fecundity of a fish is essential for evaluating the commercial potentialities of its stock, life history, practical culture and actual management of the fishery [21]. In this study, the fecundity of yellow-wing Flying fish, *C. poecilopterus* was determined. Fecundity in relation to total length, body weight, ovary length and ovary weight are shown in Table 2. No data were gathered in the months of June, July and August due to the absence of gonad in the collected samples.

3.3.1 Fecundity in relation to different body measurements

There was a linear relationship between fecundity and total length. The relationship between fecundity (F) and total length (TL) is expressed by the F = 1603.8 TL – 25359 to be significant (r= 0.75; P<0.05), indicating moderate positive relationship between TL and F.

Table 2: Mean ± SD of total length (cm), body weight (g), ovary length (cm), ovary weight (g), fecundity and ova diameter (µm) of yellow-wing Flying fish, *C. poecilopterus*, June 2018 to May 2019.

Months	Total Length	Body Weight	Ovary Length	Ovary Weight	Fecundity	Ova Diameter (µm)
Jun	-	-	-	-	-	-
Jul	-	-	-	-	-	-
Aug	-	-	-	-	-	-
Sep	21.30±0.70	81.09±5.33	6.06±0.91	4.73±0.58	7668±713	589.4±161.5
Oct	21.40±0.57	91.29±9.01	8.16±1.04	7.38±1.76	8930±1346	892.1±147.2
Nov	21.46±1.07	90.66±14.36	8.38±1.61	8.24±2.47	9076±1871	1194.6±170.8
Dec	21.98±0.96	93.79±17.88	9.12±0.91	9.70±2.46	9746±2202	1216.8±193.0
Jan	21.50±0.73	94.18±9.34	8.37±.62	10.76±3.84	9186±2132	1310.0±101.7
Feb	22.03±1.05	106.15±12.89	8.60±0.96	12.79±4.17	10080±1604	1404.4±63.6
Mar	22.21±0.69	106.43±10.80	9.32±0.40	14.04±2.86	11218±769	1416.9±54.7
Apr	21.28±1.18	96.71±9.56	8.58±1.11	10.21±3.52	8897±2197	1411.7±53.9
May	21.63±1.14	9737±10.56	9.07±0.64	10.94±371	9913±2521	1403.6±59.2

The fecundity and body weight obtained the value of r=0.80 which is highly significant (P<0.05). This means that there is a strong positive linear relationship between fish body weight and fecundity. The relationship is expressed as: F = 114.8 BW – 1492.3. These relationships also suggest that in fishes of the same weight, the heavier the gonads, the greater would be the fecundity.

A significant linear relationship was also obtained for the ovary length and the fecundity. The relationship is expressed with the equation: F = 1116.6 OL + 9.3237. The value of correlation r was found to be 0.74 which is highly significant (p<0.05), indicating strong uphill linear relationship between ovary length and fecundity.

This study also found that the increase in weight of ovaries results in increase in fecundity. Plotting a linear line to the data, regression line is F = 376.35 + 5773.9 OW with a significant r value of 0.76. Thus, it is observed that fecundity of the fish linearly increases with the increase of ovary weight.

The present study reveals a significant linear relationship between absolute fecundity and total length, body weight, ovary length and ovary weight. Linear relationships of fecundity with body measurements were also reported by Borthakur [21]; Shafi *et al.* [22]; Pathani [23]; Bhuiyan [24]. Length and weight are reliable indicators of the capacity of egg production once the fecundity increased with the increase of the fish in size and weight [14].

This study further shows that absolute fecundity varies from 7668±713 to 11218±769 with a mean of 9402±1827 eggs.

Khokiattiwong *et al.* [25] noted that Flying fish are batch spawners, with females laying approximately 7000 eggs per batch. Oliveira *et al.* [13] reported that the mean absolute fecundity of fourwing Flying fish, *H. affinis* taken from Northeastern coastal waters of Brazil was 9,092 vitelogenic oocytes. Different fishes exhibit different reproductive potential in terms of fecundity [22]. Kovalevskaya [26] found that small species of Flying fish (*Parexocoetus mento*, certain species of Exocoetus and Prognichthys) spawn between 400 to1100 eggs at a time. Larger forms have considerably greater fecundity, ranging between 16,000 and 24,000 eggs in certain species in the genera Cheilopogon, Cypselurus and Hirundichthys [27]. Fecundity is known to vary within species with latitude and location [28, 29].

3.3.2 Ova Diameter

The ova diameter of *C. poecilopterus* was measured in micrometer (µm). The ova diameter is significantly increasing from 589.4±161.5µm in September with a maximum diameter of 1416.7±54.7µm in March and decrease slightly from the month of April to May (Table 2). Similarly, the mean values of gonadosomatic index were recorded from September (5.84±0.64) to May (11.08±2.58) and also showed highest in March (13.18±2.01) (Table 3). This observation further proved that the *C. poecilopterus* spawned starting February to May with spawning peak in the month of March. Other species of Flying fish like fourwing Flying fish, *H. affinis* spawns throughout the fishing-season (December–June) in Northeastern coastal waters of Brazil and shows a peak in spawning activity from March to June [8].

Table 3: Monthly gonadosomatic index of yellow-wing Flying fish, *C. poecilopterus*

Month	No. of Samples Examined	Total Length (cm)	Body Weight (g)	Ovary		Mean GSI
				Mean Length (cm)	Mean Weight (g)	
Sep	5	20.10 - 21.80	72.33- 86.40	6.06±0.91	4.73±0.58	5.84±0.64
Oct	18	20.30 - 22.80	74.54- 108.12	8.16±1.04	7.38±1.76	8.10±1.77
Nov	9	20.20 - 23.50	70.25- 118.54	8.38±1.61	8.24±2.47	8.95±1.69
Dec	9	20.70 - 23.30	77.00- 125.39	9.12±0.91	9.70±2.46	10.29±1.14
Jan	9	20.60 - 22.40	78.03- 112.42	8.37±.62	10.76±3.84	11.34±3.60
Feb	8	20.60 - 23.40	90.21- 124.48	8.60±0.96	12.79±4.17	11.86±2.76
Mar	8	21.30 - 23.30	91.71- 124.34	9.32±0.40	14.04±2.86	13.18±2.01
Apr	5	20.40- 23.30	88.23- 112.29	8.58±1.11	10.21±3.52	10.40±2.46
May	3	20.70- 22.90	87.56- 108.55	9.07±0.64	10.94±371	11.08±2.58

Lewis *et al.* [30] also noted that spawning of *H. affinis* takes place twice a year in May/June towards the end of the peak fishing season and at the end of November; but may take place throughout the year. In Northeastern Brazil, the reproductive period of this species registered from May to June [31-33] and in Barbados was from December to June, with a peak from March to June [25]. Breeding season may be influenced by local climatic conditions [9].

4. Conclusions

The present study found that *C. poecilopterus* was the most dominant and abundant Flying fish species in the study area. This species start maturing at the length of 20.1 cm. and spawned in the months of February to May with spawning peak in March. The absolute fecundity has significant relationship with the total length, body weight, ovary length and ovary weight. The weather conditions are the causes of the monthly variation of flying fish production. The month of November was observed highest in total production and CPUE.

5. Acknowledgment

Surigao State of College of Technology (SSCT) is highly acknowledged for funding this study. Special gratitude to the office of the College President and Office of VP-Research, Development and Extension for the continued encouragement; to the Budget Office for financial facilitation; the SSCT-Malimono Campus administration for the moral support; and the BS Fisheries students, Batch 2018-2019 for assisting in the data collection.

6. References

1. Nelson JS. Fishes of the world, 4th edn. John Wiley and Sons, Inc., New York Google Scholar, 2006.
2. Chang SK, Chang CW, Ame E. Species composition and distribution of the dominant flying fishes (Exocoetindae) associated with the Kuroshio current, South China Sea. The Raffles Bulletin of Xology. 2012; 60(2):539-550. National University of Singapore.
3. Xu GH, Zhao LJ, Gao KQ, Wu FX. A new stem-neopterygian fish from the Middle Triassic of China shows the earliest over-water gliding strategy of the vertebrates. Proc R Social Biology Science Service 2013; 280(1750):20122261, doi:10.1098/rspb.2012.2261.
4. Davenport J. How and why do flying fish fly? Rev Fish Biol Fish 1994; 4(2):184-214. doi:10.1007/BF00044128.
5. Froese R, Pauly D. Fish ruler. Fishbase. www.fishbase.org., 2002.
6. Gomes C, Dales RBG, Oxenford HA. The application of RAPD markers in stock discrimination of the four-wing Flying fish, *Hirundichthys affinis* in the central western Atlantic. Molecular Ecology. 1998; 7(8):1029-1039; http://dx.doi.org/10.1046/j.1365-294x.1998.00427.x.
7. Parin NV. Flying fish (Exocoetidae) of the northwestern part of the Pacific Ocean. Trudy Instituta Okeanologie Akademii Nauk SSS; 1960; 31:205-285.
8. Mahon R, Oxenford H, Hunte W. Development strategies for Flying fish fisheries of the eastern Caribbean, International Development Research Centre Man. Rep, 1986, 128e.
9. Oliveira MR, Carvalho MM, Silva NB, Yamamoto ME, Chellappa S. Reproductive aspects of the Flying fish, *Hirundichthys affinis* from the Northeastern coastal waters of Brazil, 2015. http://dx.doi.org/10.1590/1519-6984.11513.
10. Rose CD, Hasler WW. Food habits and sex ratios of dolphin *Coryphaena hippurus* captured in the Western Atlantic Ocean off Hatteras, North Carolina, Trans Am Fish. Soc. 1974; 103:94-100.
11. Oxenford H, Mahon A, Hunte R. (eds.). The Eastern Canbbean Flying fish Project. Organisation of Eastern Caribbean States (OECS) Fishery Report 9, St. Vmcent,

1993.
12. Wu CC, Lin JC, Su WC. Diet and feeding habits of dolphinfish, *Coryphaena hippurus* in the waters off eastern Taiwan. J. Taiwan Fishery Resources. 2006; 14:13-27.
13. Emperua LL, Muallil RN, Donia EA, Pautong AT, Pechon RR, Balonos TA. Relative abundance of flying fish gillnet fisheries in Maitum, Sarangani province. International Journal of Fisheries and Aquatic Studies. 2017; 5(5):438-442.
14. Sinha M. Observations on the biology of [Untius sarana (Ham.) of Loni reservoir (M.P.) Journal of Inland Fisheries. 1979; 7:49-57.
15. Bagenal TB. A short review of fish fecundity, In Gerking, S.D. (ed). The Biological Basis of Fresh Water Fish production. Blackwell Scientific, Oxford, 1965; 495:89-111.
16. Howaida RG, Hanlon TH, Mahmoud HH, Eletreby SG. Maturation, fecundity, seasonality and reproduction of two commercially valuable cuttlefish, Sephia pharaonis and S. dollfusi in Suez Canal. Journal of Fisheries Research. 1998; 36(23):99-115.
17. Chang CW, CH Lin, Chen YS, Chen MH, Chang SK. Age validation, growth estimation and cohort dynamics of the bony flying fish *Hirundichthys oxycephalus* off eastern Taiwan. Aquatic Biology 2012; 15(3):251-260, doi:10.3354/ ab00425.
18. Hadil R, Richard R. Distribution and biological status of the pelagic resources off Sarawak Malaysia. *Fisheries Bulletin* Department of Fisheries Malaysia. 1991, 68.
19. De Croos M. Status of the fishery of flying fish off northwestern coast of Sri Lanka and the effect of lunar pattern on catchability. Sri Lanka Journal of Aquatic Sciences, 2010; 14:1-13. DOI: http://doi.org/ 10.4038/sljas.v14i0.2189
20. Jayawardana, PAAT, Dayaratne P. A preliminary analysis of the flying fish fishery off Kandakuliya in Sri Lanka. Ceylon Journal of Science (Bio-Science), 1998; 26:18-28.
21. Borthakur MK. Study of gonadosomatic index and fecundity of fresh water fish *Xenontedon cancila.* Journal of Entomology and Zoology Studies. 2018; 6(3):42-46.
22. Shafi S, Yousuf AR, Parveen M. Study on the fecundity of *Cyprinus carpio communis* (Linneaus, 1758, introduce). International Journal of Scientific and Research Publications, 2012; 2(2):1. ISSN 2250-3153. www.ijsrp.org.
23. Pathani SS. Fecundity of mahaseer Tor putitora. Proc. Indian. Acad. Sci. (*Anim. Sci.)*, 1991; 90(2):253-260.
24. Bhuiyan A, Islam K, Zaman T. Fecundity and ovarian characteristics of *Puntius gonionotus.* Jornal of Bioligical - Science. 2006; 14:99-102.
25. Khokiattiwong S, Mahon R, Hunte W. Seasonal Abundance and Reproduction of the Fourwing Flying fish, *Hirundichthys affinis*, off Barbados. Environmental Biology of Fishes, 2000; 59:43. doi:10.1023/A: 1007647918255.
26. Kovalevskaya N. Superfluous reproduction and development of Flying fishes of the family Exocoetidae. Journal of Ichthyology, 1982; 22(4):48-54.
27. Storey KW. Aspects of the biology and fishery of the Flying fish, *Hirundichthys affinis*, at Barbados. MSc. Thesis, University of West Indies, Barbados, 1983, 161.
28. Cushing DH. A study in population dynamics. *Fishery Biology:* Madison, Milwaukee, and London. University of Wisconsin Press. 200, 1968.
29. Mann RHK, Mills CA, Crisp DT. Geographical variation in the life history tactics of some species of fresh water fish. *In:* Fish reproduction strategies and tactics, (Potts, G. W.; Wooton, R. J., ed. London, Academic press). 1984, 17-186.
30. Lewis B, Brundritt J, Fish A. The Biology of the Flying fish, *Hirundicthys affinis* (Gunther), 1962.
31. El Deyr ACA. *Biologia reprodutiva do peixe voador Hirundichtys affinis da região de Caiçara-RN*. Recife: Universidade Federal Rural de Pernambuco, Dissertação de Mestrado em Oceanografia, 1998, 92.
32. Araújo AS, Chellappa S. Estratégia reprodutiva do peixe voador, *Hirundichthys affinis* Günther (Osteichthyes, Exocoetidae). Revista Brasileira de Zoologia, 2002; 19(3):691-702. http://dx.doi. org/10. 1590/S0101-81752002000300006
33. Araújo AS, Oliveira MR, Campos CEC, Yamamoto ME, Chellappa S. Características morfométri casmerísticas, peso-comprimento e maturação gonadal do peixe voador, *Hirundichythys affinis* (Günther, 1866). *Biota Amazônia.* 2011; 1(2):33-40.