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BIOLOGICAL CHARACTERS OF SNAKEHEAD GUDGEON (*Giuris margaritacea* Valenciennes, 1837) IN TONDANO LAKE, MINAHASA, NORTH SULAWESI, INDONESIA

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Abstract

Snakehead gudgeon (Giuris margaritacea) or Payangka in Indonesian's local name, has a high population and been used as a consumption fish mainly by people around Lake Tondano, not only the consumption size, but also the juvenile (it called Nike) are preferred. The fish resources are the essential source and need to keep their sustainable in the future. The research was carried out in 2015. The study was aimed to identify and record some aspects of snakehead gudgeon fish biology in Lake Tondano Minahasa Regency of North Sulawesi. Fish samples were obtained from fisher's catch. The morphometric and meristic character was measured, and also was performed surgery to observe reproduction and food. The results showed that the growth pattern of Giuris margaritacea was positive allometric with sex ratio 1: 1.41. The fish was spawning whole year with fecundity between 36,892-90,102 eggs, and diameter of the egg was 0.285 mm on average. The size of the first mature female was 10.75 cm gonads. Snakehead gudgeon was a carnivorous fish with shrimp as the primary food, and the relative length of the digestive tract was 82.88%.

Keywords :Morphological, Biological, Snakehead Gudgeon, Giuris margaritacea, Tondano Lake

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1. Introduction

Indonesia has more than 500 natural lakes with a large category > 50 ha, characterized as "tropical island lakes" with total areas of 5,000 km2s or about 0.25% of the land area. Indonesian's lakes have a huge of fish germplasm, 25% of the world's germplasm. Unfortunately, the inventory and identification of fish are still not much carried out.

Tondano Lake is located in North Sulawesi, covers an area of 44-48 km2s, with an average depth of 11.35 meters [1]. The fish caught from this lake is dominated by introducing fish such as tilapia, snakehead gudgeon, and marble goby.

The snakehead gudgeon is the most exploited species to catch in North Sulawesi, especially in Minahasa. This species is essential to the local peoples as a dish fish, not only the consumption size but also the juvenile (called Nike) are preferred. The fish resources are the essential source and need to keep their sustainable in the future. The analysis of biological characteristic is necessary to provide the information for making the management plan. The data is required for maintaining or restoring fisheries sustainability and stock sizes and improving local and global food security.

The morphology of fishes has been the primary source of information for taxonomic and evolutionary studies. There are numerous characters available for morphological study. These characters are commonly divided into two categories:

1) Morphometric characteristics are to describe the body shape and refer to measure structures such as fin length, head length, eye diameter, or ratios between such measurements; and

2) Meristic characters include almost any countable structure occurring in series, including fin rays, scales, gill rakers, and so on.

These characters are the most commonly used for differentiation of species and populations [2]. Morphometric and meristic study are vigorous tools for measuring distinctness of the same species [3]. Fish biology is necessary mainly to understand morphometry, length-weight relationship, condition factor, reproduction, food, and feeding habit.

This research is aimed at identifying the snakehead gudgeon by recording the morphological characteristic and fish biological (reproduction, food, and growth) habited in Tondano Lake, North Sulawesi.

2. Materials and Methods

The research was conducted in Tondano Lake, Minahasa Region, North Sulawesi Province (Figure 1). Fish sampling was carried out by four periodical sampling along the year of 2015 (February, May, August, and October). Identification of fish species was conducted by morphological characteristic (morpho-metric and meristic), and fish biology was analyzed by measuring the length, weight, reproduction, and food.

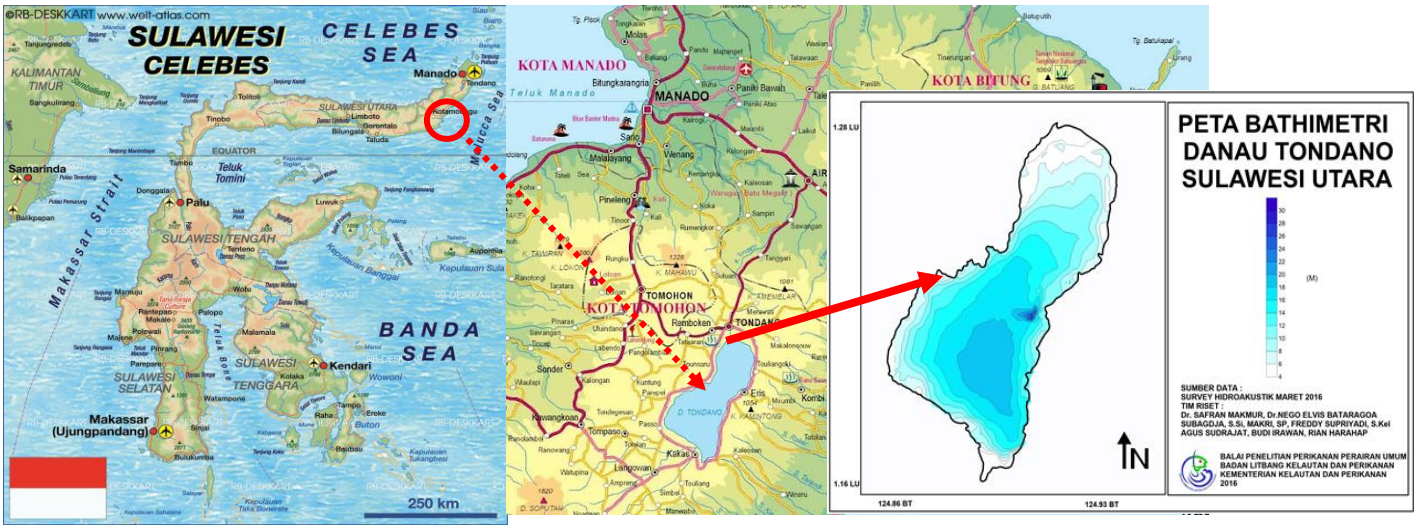

Figure 1. Research site and bathymetry of Tondano Lake

2.1 Identification

The morphometric measure was done by using a digital caliper with 0.1 mm accurate, while meristic characteristic manual was counted by using the loop. The measurement was done to 32 of morphological characteristic, at the left side of the fish body [5], while the comparison of morphological characters refers to [6]. Morphometric and meristic were recorded using reference books [7][8]. The gastrointestinal tract and gonads were observed to identify the reproduction aspects, i.e., gonadal maturity grade, fecundity, eggs diameter, and size of first-grade mature fish.

2.2Sex Ratio

Sex ratio is analyzed by the comparison between male and female captured [4]:

$$Nk = M/F$$

Where:
Nk = Sex ratio
M = Total number of male fish (individuals)
F = Total number of female fish (individuals)

2.3Fecundity

Fecundity of fish is calculated to know the female fish gonadal maturity grade using the gravimetric method [4]:

$$F=G/Q \times N$$

Where:
F = Fecundity (eggs)
G = weight of gonadal (gram)
Q = weight of gonadal samples (gram)
N = Total number of eggs for each gonadal samples (eggs)

2.4 Size of first gonade mature fish

Gonad maturity stage of fish was determined morphologically based on the criterion of fish gonad maturity index by [9]. i.e., quiescent/ undevelope (stage 1), develope

(stage 2), early mature (stage 3), ripe (stage 4) and spend (stage 5).

Gonad maturity is divided into two categories, immature (1st and 2nd stage) and mature (3rd and 4th stage).

Size at first mature is estimated by using the Spearman-Karber method [10] as follows:

$$M = (Xk + X/2) - (X, \Sigma pi)$$

where:
M = log size of fish at first mature;
Xk = last log size at which 100% of fish are fully mature;
X = log size increment;
pi = proportion of fully mature fish in its size group;
thus, the mean size at first mature was given by antilog (m).

2.5 Diet

The Index of Preponderance formula is used to find out the main diet of fish. The index is a combination of the Frequency of occurrence and Volumetric method (Volumetric Analysis Index), determined by the preponderance index based on [11]:

$$IP = \frac{V_i \times O_i}{\sum(V_i \times O_i)} \times 100$$

where:
V_i = percentage of the volume of one kind of food
O_i = percentage of occurrence frequency of one kind of food
$\sum(V_i \times O_i)$= Total number of $V_i \times O_i$ of all food
IP = index of preponderance (%).

2.6 Length body and length of gut relationship

The relationship between total length and the total gut length system was analyzed by linear regression used:

$$Y = a+bX,$$

where:
X = total length and
Y = total length of the gut system [12].

3. Results and Discussion

3.1 Results

3.1.1 Morphological Characteristics of Snakehead Gudgeon

3.1.1.a Morphologic

Based on the morphometrics, male and female of snakehead gudgeon were not so different in the percentage of the total length, such as the percentage between standard length to the total length of male fish were 81.04%, while the females were 81.66%. The body depth of male snakehead gudgeon to the total length percentage was 19.30% while female snakehead was 20.43%. Likewise, the other morphometric characters to the total length of males and females were not so different (Table 1 dan 2).

3.1.1.b Meristic

The results of several characters of male and female snakehead gudgeon fish calculation showed in the same numbers range between males and females. The forecast were for the number of spines on the dorsal fin (DSF), dorsal fin soft spines (DSR), anal fin spines (AS), the total number of pectoral fins (TPR), the number of scales at the top of the lateral line (SABL), the number of scales below the lateral line (SBLL), the number of scales before the dorsal fin (SBDF), the number of scales around the tail stem (SACP) (Table 3).

Based on morphometric and meristic characters, snakehead gudgeon inhibited in Lake Tondano is a species of Ophieleotris aporos, or Ophiocara aporos, Order of Gobiiformes and Family of Eleotridae (Figure 2).

Figure 2.Snakehead gudgeon *Giuris margaritacea* Valenciennes (1837)

Table 1. Morphometric characteristic of snakehead gudgeon male (N=5) in Tondano Lake

Morphological Characteristic	Code	min	max	mean±sd	TL%/mean
Total Length (mm)	TL	137.85	142.45	142.21±4.58	
Standard Length (mm)	SL	110.5	116.95	115.24±2.42	81.04
Body Depth (mm)	BD	26.15	30.45	27.44±1.62	19.3
Caudal Peduncle Depth (mm)	CPD	10.6	15.45	14.32±1.87	10.07
Caudal Peduncle Length (mm)	CPL	21.3	24.5	27.69±1.03	15.96
Predorsal Length (mm)	PL	45.85	53.17	49.71±2.59	34.76
Length of Dorsal Base (mm)	LDB	15.45	17.45	16.14±0.96	11.35
Length of Anal Base (mm)	LAB	14.75	16.75	15.54±0.66	10.93
Height of Dorsal Fin (mm)	HDF	5.35	12.2	6.62±2.80	4.66
Height of Anal Fin (mm)	HAF	9.05	11.85	10.61±0.9	7.46
Length of Pectoral Fins	LPF	25.85	28.3	26.9±0.8	18.92
Length of Pelvic Fins (mm)	LPVF	21.15	23.95	22.14±1.03	15.57
Length of Longest Dorsal Spine (mm)	LLDS	13.1	17.05	14.61±1.33	10.27
Head Length (mm)	HL	35.2	38.1	37.12±0.99	26.1
Head Width (mm)	HW	20.15	24.2	22.53±1.53	15.84
Snout Length (mm)	SNL	7.09	9.5	7.73±0.75	5.44
Suborbital Width (mm)	SW	2.95	3.65	3.09±0.38	2.17
Orbit to Preopercle Angle (mm)	OPA	8.3	9.7	9.34±0.53	6.57
Eye Diameter (mm)	ED	4.7	6.45	5.99±0.67	4.21
Upper Jaw Length (mm)	UJL	5.75	7.85	6.63±0.83	4.66
Gape Width (mm)	GW	9.85	12.7	11.71±1.11	8.23

Notes: min=minimum; max=maximum; mean=average; sd = standard deviation; TL (%) = percentage of total length.

Table 2. Morphometric characteristic of female of snakehead dudgeon (N=5) in Tondano Lake

Morphological Characteristic	Code	min	max	mean±sd	TL%/mean
Total Length (mm)	TL	126.3	135.4	130.54±3.17	
Standard Length (mm)	SL	99.35	116.5	106.6±7.49	81.66
Body Depth (mm)	BD	24.8	28.25	26.67±1.32	20.43
Caudal Peduncle Depth (mm)	CPD	13.1	14.8	13.89±0.63	10.64
Caudal Peduncle Length (mm)	CPL	19.95	23.4	21.72±1.25	16.64
Predorsal Length (mm)	PL	46.35	50.69	48.53±1.39	37.18
Length of Dorsal Base (mm)	LDB	11.8	13.75	12.56±0.71	9.62
Length of Anal Base (mm)	LAB	12.45	14.75	13.57±0.78	10.40
Height of Dorsal Fin (mm)	HDF	5.79	8.9	7.49±1.4	5.74
Height of Anal Fin (mm)	HAF	81	10.35	9.23±0.8	7.07
Length of Pectoral Fins	LPF	20.7	26	24.02±1.85	18.41
Length of Pelvic Fins (mm)	LPVF	19.2	21	20.37±0.67	15.60
Length of Longest Dorsal Spine (mm)	LLDS	12.4	16.75	14.98±1.6	11.48
Head Length (mm)	HL	31.1	37.45	33.99±2.19	26.04
Head Width (mm)	HW	17.85	20.45	19.41±0.86	14.87
Snout Length (mm)	SNL	6	10.05	8.41±1.61	6.44
Suborbital Width (mm)	SW	2.59	3.5	3.16±0.43	2.43
Orbit to Preopercle Angle (mm)	OPA	8.2	8.8	8.99±0.74	6.89
Eye Diameter (mm)	ED	6.15	6.85	6.49±0.27	4.97
Upper Jaw Length (mm)	UJL	5.65	7.59	6.89±0.69	5.28
Gape Width (mm)	GW	9.43	10.85	10.19±0.34	7.81

Notes: min=minimum; max=maximum; mean=average; sd=standard deviation; TL (%) = percentage of total length.

Table 3. Meristic calculation of between male (N=5) and female (N=5) of snakehead gudgeon in Tondano Lake

Character	Code	Male	Female
Dorsal Fin Spines	DFS	VI / I	VI / I
Dorsal Soft Ray	DSR	9	9
Anal Spines	AS	I	I
Anal Soft Rays	ASR	9	9
Total Pectoral Rays	TPR	16	16
Scales Along LL	SALL	30	30
Scales Above LL	SABL	4 ½	4 1/2
Scales Below LL	SBLL	5 ½	5 1/2
Scales Before Dorsal Fin	SBDF	17	17
Scales Around Caudal Peduncle	SACP	20	20

Table 4. Distribution of gonadal maturity index for male and female of snakehead gudgeon in Tondano Lake

Gonadal Maturity	Male		Female	
	N	%	N	%
I	1	0.64	1	0.56
II	3	1.92	2	1.12
III	27	17.31	62	34.64
IV	125	80.13	112	62.57
V			2	1.12
Total	156	100	179	100

3.1.2 Fish Biology

3.1.2.a Length-weight relationship

Length-weight relationship of snakehead gudgeon in Tondano Lake (Figure 3 and 4) was estimated from 249 males and 353 females. Fish length of males varied between 10.7-19 cm (average 14.15 cm), while fish weight varied between 12.28-95.9 g with average 33.28 g. Similarly, a fish length of females has a variation between 10.5-20.5 cm (average 13.75 cm), and a fish weight range between 8.08-118.16 g (average 31.01 g). Determination coefficiency (R2) of males were 0.93, while females were 0.92. Based on the relationship, it showed that b = 3.27 for males and b = 3.38 for females. The value of b > 3.0 indicated that the growth follows the positive allometric pattern, informed a faster growth rate of body weight compared to the length.

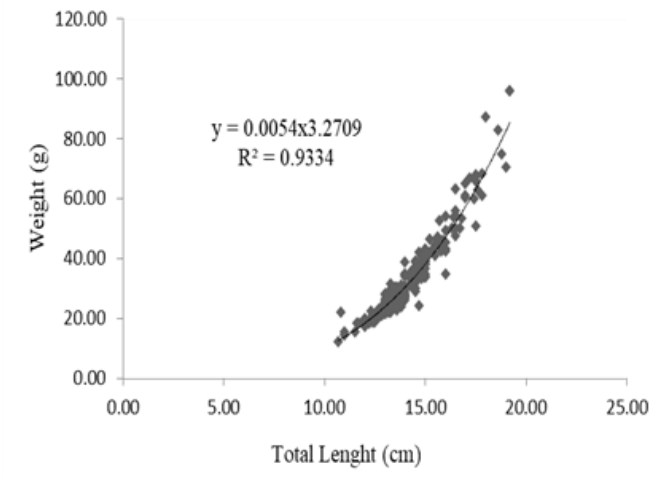

Figure 3. Length-weight relationship for male of snakehead gudgeon (N=249)

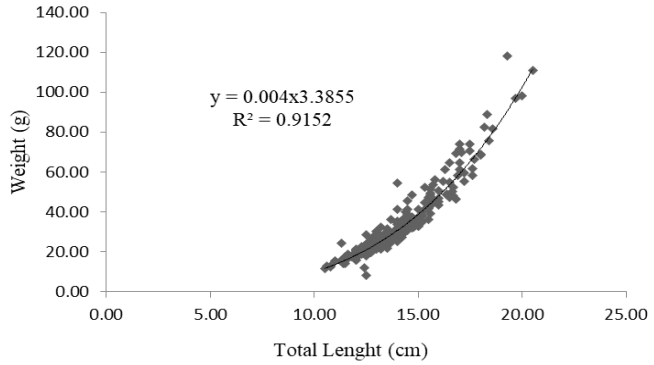

Figure 4. Length-weight for female of snakeheadgudgeon (N=353)

3.1.2.d Stage of maturity

The observation of gonad maturity index was done for female fish with gonad maturity3rd, 4th, and 5th stage. The index showed the increase from gonad maturity3rd (4.52%), gonad maturity 4th (6.53%) and decreased on gonad maturity 5th (5.29%) (Table 6).

Table 6. Range and average value of gonadal maturity index, based on gonad maturity level of snakehead gudgeon in Tondano Lake

Gonadal Maturity	N	Weight of fish (g)		Weight of gonad (g)		IKG (%)	
		range	average±sd	range	average±sd	range	average±sd
III	3	35.72-61.28	51.73±13.9	0.58-0.92	0.7±0.19	3.59-5.98	4.52±1.28
IV	112	12.42-118.16	40.27±21.72	0.2-8.76	2.41±1.79	0.8-24.15	6.53±3.9
V	2	22.72-35.15	28.94±8.7	1.04-1.92	1.48±0.62	4.8-5.78	5.29±0.69

3.1.2.b Sex ratio

Sex ratio is needed to know the ratio between the number of male and female; therefore, it can be recognized from the balance of the fish population in waters between males and females. The total of fish collected was 602 individuals, whereas 249 (41.36%) and 353 (58.64%) was males and females, respectively.

3.1.2.c Gonad maturity level

The gonad maturity level of snakehead gudgeon was dominated by gonad maturity 4th stage (80.13% males and 62.57% females) (Table 4).

The result showed that the snakehead gudgeon in Tondano Lake spawned whole years because it got the fish with gonad maturity 4th stage in February, May, August, and October). The range of male fish length with gonad maturity 4th stage was 10.8-19 cm, with average 14.24±1.57 cm, while the female was 6.7-20.5 cm, with average 14.56±2.35 cm. (Table 5).

Table 5. Total length range, based on gonad maturity level for mature male and mature female of snakehead gudgeon in Tondano Lake

Gonadal Maturity	Total Length (cm) Male		Total Length (cm) Female	
	range	r±sd	range	r±sd
III	11-17.5	13.9±1.28	10.6-17.7	14.19±1.62
IV	10.8-19	14.24±1.57	6.7-20.5	14.56±2.35
V			12.8-14.16	13.48±0.96

3.1.2.e Fecundity

The fecundity or total eggs of female snakehead gudgeon (N=25) with total length fish between 13-18.6 cm (average 15.45 ± 1.4), weight range between 26.89-81.68 g (average 46.48 ± 11.96), gonad weight range between 1.43-6.62 g (with average 3.74 ± 1.57) has fecundity between 36,892-90,102 eggs (average of 58,888 eggs). The fecundity is related to body weight, and gonad weight of female fish, usually the higher of fecundity will be the heavier of body weight and the weight of the gonad (Figure 5 and 6).

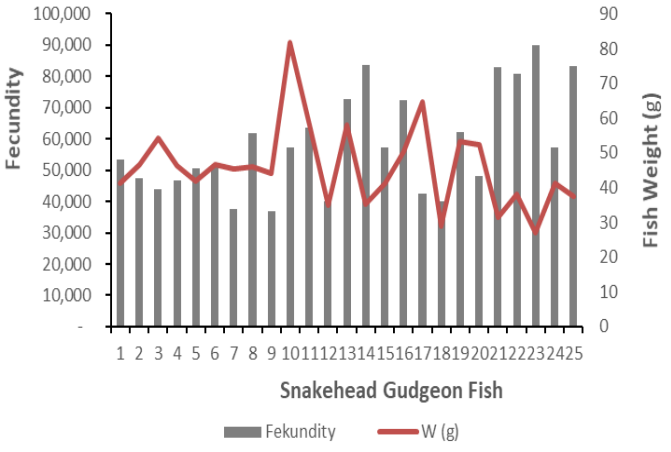

Figure 5. Fecundity and fish weight relationship of snakehead gudgeon

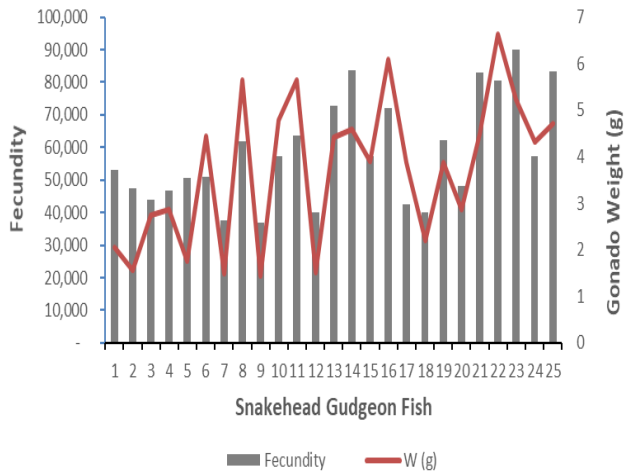

Figure 6. Fecundity and gonadal weight relationship of snakehead gudgeon

3.1.2.f Eggs Diameter

Eggs diameter of snakehead gudgeon ranged between 0.24-0.33 mm (average 0.285 mm). The result from amount of measured eggs diameter (N=1,349 eggs), dominated by eggs with 0.29 mm diameter (24.61%), followed by 0.30 cm diameter (14.60%) and 0.28 cm diameter (14.08%), while the smallest one 0.33 cm diameter (0.67%). (Figure 7).

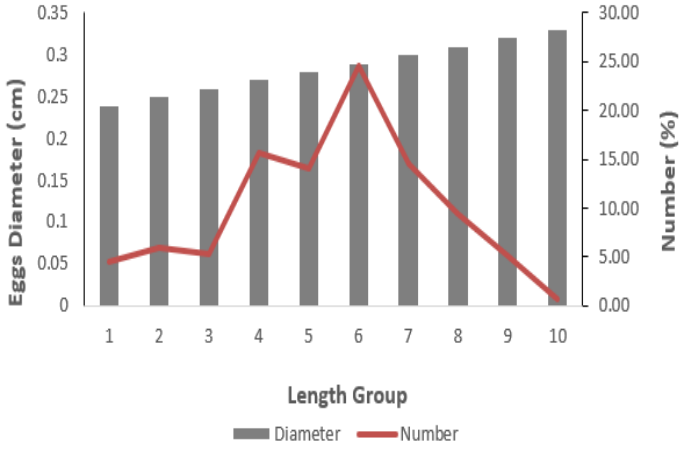

Figure 7. Percentage of egg diameter

3.1.2.h Length of the first maturity

The length of the first maturity of female snakehead gudgeon with gonad maturity 3rd, 4th and 5th stage, and have the total length between 6.7-20.5 cm (average 14.42±1.9 cm) was 10.75 cm (with threshold value 10.62-10.88 cm).

3.1.2.i Diet

The result of gut analysis of snakehead gudgeon in Tondano Lake was a carnivore fish. The mainly prey was shrimps (IP = 75%), snails (IP=12.5%) and worms (IP=12.5%) (Figure 8).

The total body length 11.6-15.2 cm (with average 13.360) has the total length of intestine 6-12.6 cm (average 9.41 cm). The ratio between total length of intestine and the total body length was 1:1.42. Linear regression equation between total body length (X) with total length of intestine was (Y); where a=0.2591, b=0.5409, so Y=0.5409x + 8.2591 with correlation coefficient value was R^2=0.8866 or 88.66% (Figure 9).

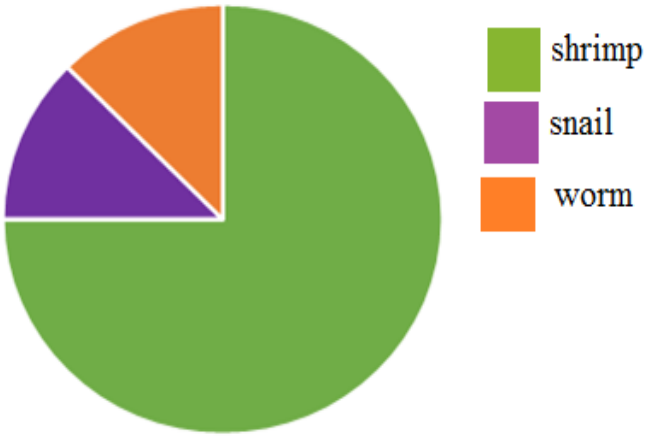

Figure 8. Index Preponderance of snakehead gudgeon in Tondano Lake

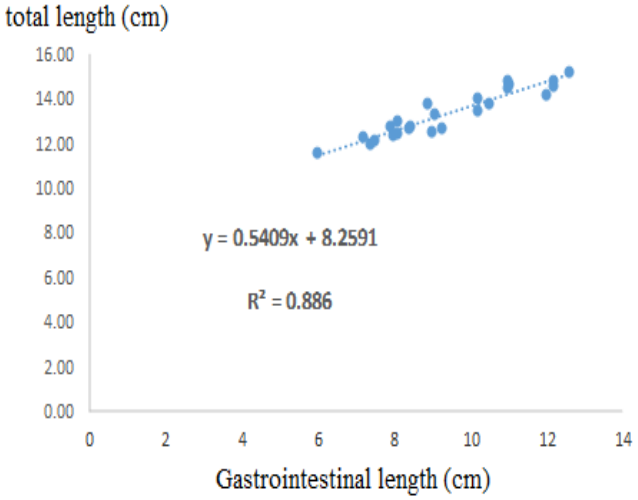

Figure 9. Linear regression of gastro intestinal length and total length of snakehead gudgeon in Tondano Lake

3.2 Discussion

As mentioned by [8], the formula for a number of snakehead gudgeon's fin is D VI; I,8-9 A I,9, lateral row scales 30. Based on FishBase.org the valid name for *Ophiocara aporos* Bleeker (1854) is *Giuris margaritacea*Valenciennnes (1837) with common name snakehead gudgeon. The distribution of *Giuris margaritacea* seems in Indonesia (Sulawesi, Papua), Papua New Guinea, Micronesia, Australia, South East Asia, Madagascar, Palau, New Caledonia, and Fiji. The habitat likely to inhabit was freshwater and marine water, with pH range is 7-8, and the

temperature range is 22-28 0C. According to the IUNC Red List of Threatened Species, the status of snakehead gudgeon is Least Concern. (www.FishBase.org; www.iucnredlist. org).

The growth pattern was allometric positive, informed a faster growth rate of body weight compared to the length, which b value comes from male and female [13]. According to [14], the factors, influencing growth pattern consists of internal and external factors. Example of internal factors is the diameter of egg size and genetic factor whereas external factors include temperature, light, chemical factors, water current, and niche.

Data on sex composition and sex ratio were recorded in Tondano Lake are 1:1.41, indicating there were one male and one female in one population. Although the proportion of females in a population tends more than the percentage of males, stated the population was in good stock. According to [15], the sex ratios of freshwater fish species are always changing depending on population and water quality. Therefore, the information regarding the sex ratio can vary depending on the situation.

In this experiment, fishing, the most fish caught were the males in gonadosomatic index IV. It happened because, in this research, the fish samples came from experiment fishing. The catch has used the gillnet with mesh size 1.75 inches. Since the fishers used the fishing gear, namely"sibu-sibu," the smallest snakehead gudgeon did not catch. The fishers used "sibu-sibu" to catch the seed of snakehead gudgeon or called "nike". "Sibu-sibu" is the fishing gear that has the smallest mesh size. The exploitation of this fish in Tondano Lake was very intensive, mainly to catch the seed or smallest fish every day. The fishers do this activity since the demand for nike for food consumption around the Tondano Lake, Minahasa and Manado were very high, as well as the biggest snakehead gudgeon.

Gonado somatic index (GSI) will increase along with gonadal development and will increase into the maximum stage when the fish is ready to spawn (GSI IV). The gonadosomatic will decrease while the fish was spawn (GSI V). The average gonad weight of female will increase 10-25% from body weight [4].

According to [16], fecundity increases logarithmically as long as growth or weight. There is a difference in the amount of fecundity due to differences in habitat or environment. Besides, fecundity is strongly influenced by genetic differences and the abundance of food available in each habitat. The diameter of the snakehead gudgeon fish varies in size; the width of the egg is also very much determined by the level of maturity of the fish gonads. Information on the development of egg diameter in fish gonads is beneficial to guess when spawning. The size of the first gonad mature varies considerably. Based on [4], the size of fish when gonads first mature is not always the same. And as mention by [6], the differences in size occurs due to differences in aquatic ecological conditions.

The relative length is the length of the digestive tract of fish which is expressed as a percentage of the total length [17]. Based on the ratio of the length of the gastrointestinal tract to the total length of the snakehead gudgeon fish, the length of the digestive tract has never exceeded its total length, or the relative length of the gastrointestinal tract to the whole length of the gudgeon snakehead fish is 82.88%.

4. Conclusion

Based on the morphometric and meristic, snakehead gudgeon inhibited at Tondano Lake is *Giuris margaritacea* Valenciennes (1837). The growth pattern of this fish is positive allometric, with 1:1.41 for sex ratio. The fish could spawn a whole year with fecundity around 36,892-90,102 eggs and average of egg diameter about 0.285 mm. The size of the first female matured was 10.75 cm gonads. Snakehead gudgeon was a carnivorous fish with shrimp as the primary food, and the relative length of the digestive tract was 82.88%.

5. Acknowledgement

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