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Some aspects of the biology of dominant fishes in blue Nile River, Ethiopia

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Abstract
The reproductive biology of dominant fish species below the Tisisat Fall of Blue Nile River was studied during the wet season (September-October, 2010) and dry season (March-April, 2011) using gillnets of stretched mesh size 6, 8, 10 and 12cm, monofilaments of different mesh size, castanet and hook and line. A biotic parameters, temperature, transparency, conductivity, pH and total dissolved solid of the river were taken. A total of 857 fish specimens were collected with the two sampling seasons from all sampling sites. Out of the total catch of specimens four dominant fish species was contributed 79 %. The length weight relationship of *L. intermedius, L. forskalii* and *M. kannume* were curvilinear and the relation was statistically significant (P<0.001).The mean Fulton Condition factor of *L. intermedius* and *M. kannume* were not showed significant variation (P>0.05) in both season and sex however, *L. forskalii* was statically significant (P< 0.01) in seasons only. Except *L. nedgia M. kannume*, *C. gariepinus* and *O. niloticus* species were collected from the Blue Nile river were significant difference (x^2, P<0.05) from the theoretical 1:1 ratio. The relationship between absolute fecundity with FL, TW and Gonad weight of *L. intermedius* was linear and significant (P<0.05). In general, absolute fecundity of *L. intermedius* was strongly positively correlated with FL, TW and GW.

Keywords: Condition factor, fecundity, Gonad-weight, length-weight, sex-ratio

1. Introduction
Ethiopia is endowed with a number of lakes and rivers, which are believed to be promising potentials of different fish stock. It has numerous water bodies including ponds, lakes, rivers, reservoirs and wetlands. Based on the estimation of FAO (2001) [6], the surface area of major lakes and reservoirs is 7,334 km^2 and the length of rivers is 7,185 km. Sustainable utilization of the aquatic resources particularly the fishery resources is necessary so as to support the increasing Ethiopian human population through inexpensive sources of animal protein (Tedla, 1973; Wudneh, 1998) [22, 28].

Ethiopia is rich in fish fauna; having a diversified species in the inland water bodies (Tedla, 1973; Getahun, 2002) [22, 7]. According to Tedla, (1973) [22], has listed 94 species of fish in Ethiopia. Although extensive review work is in progress, it appears that there are 153 valid indigenous fish species included in 25 families in Ethiopia freshwater (Getahun, 2002) [7]. According to Golubtsov and Mina (2003) [11], the total number of valid species in Ethiopia inland waters is about 168 to 183 including 37 to 57 countrywide endemics. There are also 10 exotic fish species introduced from abroad into Ethiopian fresh waters (Tedla and H/Meskel, 1981) [23]. Currently results of various studies indicate that the number of fish species could increase to 200 and above (JERBE, 2007) [12].

The Blue Nile basin is one of the tributaries of Nile and consists of 36 species (Getahun, 2007) [7] of fish of which 23 are endemic (Golubtsov and Mina, 2003; Getahun, 2007) [11, 7]. Most of the endemic species of Blue Nile basin occur exclusively in Lake Tana. The Blue Nile descends from Lake Tana to Tisisat Falls (ca. 40 m high), effectively isolating the lake's fresh water fauna from the rest of the Nile (Thieme and Brown, 2007) [27]. It was formed by a volcanic blockage that reversed the previously north-flowing river system. The isolation of the lake from all but inflowing rivers has led to an endemic freshwater biota. Some of the family of fish identified within the Blue Nile basin and its tributary rivers are: Cyprinidae, Clariidae, Bagridae, Mockokidae and Cichlidae. Some of the species were *L. intermedius*, *L. nedgia*, *C.gariepinus*, *Varicorhinus.beso*, *Oreochromis niloticus*, *Synod0ntis schall*, *R..loti*, *B. docmak*, *B. bajad*, *L. forskalii* and *H. longfillus* (MoWR, 1998) [15]. Even though Ethiopia is rich in fish diversity there is no clear, complete list and description of the diversity and biology of the fish fauna of Ethiopia. Many of the drainage basins especially the rivers are not exhaustively explored (Getahun, 2002) [7]. However, knowledge on diversity, population structure, distribution and population of the Ethiopian ichthyofauna and biology of fish species has been poorly known: relatively a number of small, medium and even some large rivers have not been well studied and explored (Getahun, 2005) [8]. The aim of this study is, therefore, to answer the following research question, 1). What is the biology (Length-weight relationship, condition factor, Sex ratio and fecundity) of the dominant fish species in the Blue Nile River?

2. Materials and Methods

2.1. Description of the study area

The Blue Nile River flows the Eastern outskirts of the city of Bahir Dar at the Southern end of the Lake Tana flows down approximately 35 km in a southeast direction where it forms the famous Blue Nile Fall to drop in to a gorge having a depth of about 45 m (Dile, 2009). Blue Nile River basin lies in the west of Ethiopia between latitude 7°45' and 12°45' N, and longitude 34° 05' and 39°45' E (MoWR, 2010) [16]. The present study was conducted in below the famous Blue Nile Fall of the Blue Nile River to the border between East and West Gojjam. It lies between West Gojjam (Yelimana Densa and Gonge Kolela districts) and South Gondar zones (Simada District), specifically the sites are Sefiana (10km after the Blue Nile fall), Abenaze (30km) and Wotetomider (60km) (Figure 1). The type of habitat, estimated distance from the Tisisat Fall and its coordination points of study area located in (Table 1).

Table 1: Sampling sites, estimated distance from the fall and coordinates in the river

Fishing Site	Distance from Tisisat fall(km)	Altitude(m)	Habitat	Width (m)	Coordinate (GPS)
Sefiana	8	1548	Clear water and rocky, sandy	350	11^0 27.7' 07" N;37 37.9' 60″ E
Abenaze	30	1528	Turbid muddy	250	11^0 24.3' 06" N; 37^0 40' 51" E
Wotetomider	60	1493	Clear water and rock gravel	200	11^0 31.5' 03" N; 37^0 52.9' 48" E

2.2. Field Sampling

Three sampling sites were selected by considering nature and velocity of the flowing river, accessibility, interference by human beings and other farm animals and substrate type of the sediments and suitability for setting gillnets, the coordinates of the sampling sites were determined using GPS (Figure 1 and Table 1). Conductivity, temperature, pH, Total dissolved solid (TDS) were measured using standard multi - meter and transparency was measured using secchi disk 20 cm in diameter. Fish samples were collected both in dry season (March-April, 2011) and wet season (September –October, 2011). Fish was sampled by an overnight setting of multifilament and monofilament gillnets. Multifilament gillnets had mesh sizes 6, 8, 10, 12 and 14 cm stretched bar mesh and a length of 25 m and a depth of 1.5 m. Whereas monofilament gillnets had mesh sizes of 5 mm - 55 mm and a length of 25 m and a depth of 1.5 m. Fish were identified to the species level using the keys developed by Nagelkerke (1997) [17]. Immediately after capture, a gentle pressure was applied on the abdomen to check whether reproductive maturity has occurred or not. Then total length, fork length, standard length, total weight and gonad weight of all specimens of fish were measured to the nearest 0.1 cm and 0.1 g precision for length and weight, respectively. After dissection, gonad maturity of each fish specimen was identified using a five-point maturity scale (Nikolsky, 1963) [18].

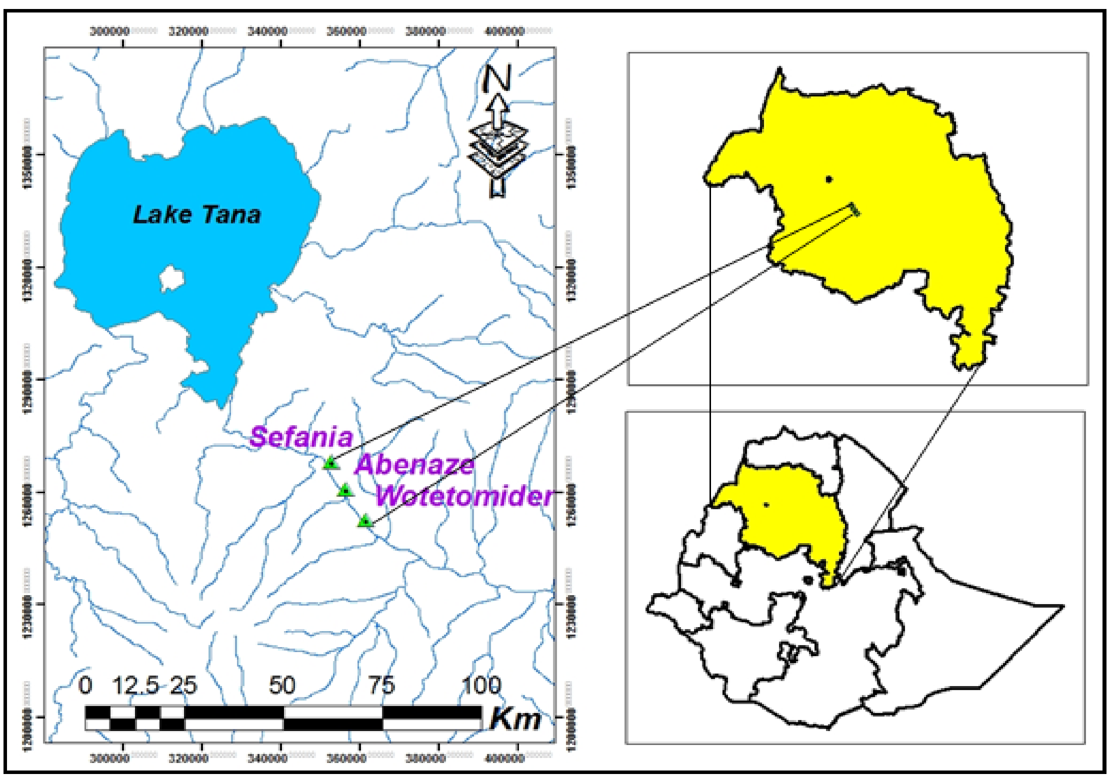

Fig 1: Map of the study area and sampling sites

2.3. Length-weight relationship

The relationship between total length and total weight of the most dominant fish species was computed using power function of $TW= a \times FL^b$ in Bagenal and Tesch (1978) [3], Where, TW= total weight (g); FL= fork length (cm); a= intercept of the regression line; b= slope of the regression line. The line fitted to the data was described by the regression equation for each species.

2.4. Condition factor (Fulton factor)

The well-being or plumpness of each dominant species of Blue Nile River was studied by using Fulton condition factor (Bagenal and Tesch, 1978) [3]. Fulton Condition factor (%) was calculated as:

$$FCF = \frac{TW}{FL^3} \times 100$$

Where, TW is total weight (g); and FL is fork length (cm).

2.5. Sex ratio

Sex ratio is the proportion of females and males, was determined using the following equation

$$Sex\ ratio = \frac{No. of\ females}{No. of\ males}$$

The chi-square (x^2) was used to test significance difference in sex ratios.

2.6. Fecundity

Fecundity is the number of eggs in ovary before spawning and it was estimated using gravimetric methods (Mac Gregor, 1957) [13] by weighing all the eggs from each of the ovaries of gravid fish species. Samples of eggs were taken from different size classes of each fish species on various ovary areas. These eggs were preserved in a labeled plastic jar containing 5% formalin in solution for fecundity estimation (Bagenal and Tesch, 1978) [3]. After ovarian membranes were removed mechanically using tap water from the preserved ovaries, eggs were counted. Three sub- samples of 1g eggs were taken from different parts of ovary and counted and the average was calculated. The total number of eggs per ovary was calculated by extrapolation from the mean calculated. The correlation of fecundity with fork length, total weight and gonad weight were done to determine the relationship of fecundity with morphometric measurements. This was done according to the following equation:

$F=aFL^b$, $F=aTW^b$ and $F=aGW^b$

Where F is Fecundity, FL is fork length (cm), TW is total weight (g), GW is gonad weight ais constant and b is exponent.

2.7. Data analysis

SPSS version 16 software was used to analyze the data. Physical and chemical parameters were analyzed using nonparametric test (Mann-Whitney U test). One –way ANOVA was used to analyze length weight relationship and Mann-Whitney U test to analyze condition factor. Sex ratio was tested using chi-square (x^2).

3. Results and Discussion

3.1. A biotic parameters

Physical and chemical parameters (temperature, transparency, conductivity and pH) that were taken from all sites in Blue Nile River were analyzed using nonparametric test (Mann-Whitney U test). There was no significant difference ($P>0.05$) in pH, temperature, transparency, conductivity and TDS among all sampling sites (Table 2). However, there was significant difference between dry and wet seasons in pH, conductivity, transparency, TDS and temperature in all the sampling sites ($P<0.001$) (Table 3). That means in wet season there will be flood and that increase the pH, conductivity, turbidity. A biotic factor land organisms, aquatic populations are also highly dependent upon the characteristics of the aquatic habitat, which support all their biological functions (reproduction, growth, feeding and sexual maturation).

Table 2: Mean±SE, a biotic parameters among the sampling sites both dry and wet seasons

Physico-chemical parameters	Sampling sites	Mean±SE	P
pH	Sefiana	5.56±0.69	0.251^{ns}
	Abenaze	5.96±0.09	
	Wotetomider	6.88±0.34	
	Average	6.14±0.32	
Temperature	Sefiana	20.9±0.700	0.063^{ns}
	Abenaze	23.3±0.50	
	Wotetomider	24.0±0.50	
	Average	22.73±0.65	
Transparency	Sefiana	37.50±12.50	0.935^{ns}
	Abenaze	32.00±8.00	
	Wotetomider	33.50 ±11.50	
	Average	34.33± 4.96	
Conductivity	Sefiana	176.32±4.67	0.144^{ns}
	Abenaze	193.60±5.00	
	Wotetomider	177.20±4.80	
	Average	182.31±4.12	
TDS	Sefiana	87.50±3.50	0.73^{ns}
	Abenaze	82.50±6.50	
	Wotetomider	87.30±3.70	
	Average	85.77 ±2.37	

***Note:** ns (P<0.05), (Average = Mean of mean)*

Table 3: Mean±SE, Physico chemical parameters of the river at sampling site both in dry and wet seasons

Physico-chemical parameters	Sampling sites	Mean±SE	P
pH	Sefiana	5.56±0.69	0.000***
	Abenaze	5.96±0.09	0.000***
	Wotetomider	6.88±0.34	0.000***
Temperature	Sefiana	20.9±0.70	0.000***
	Abenaze	23.30±0.50	0.000***
	Wotetomider	24.00±0.50	0.000***
Transparency	Sefiana	37.50±12.50	0.000***
	Abenaze	32.00±8.00	0.000***
	Wotetomider	33.50±11.50	0.000***
Conductivity	Sefiana	76.32±4.67	0.000***
	Abenaze	193.4±5.00	0.000***
	Wotetomider	177.20±4.80	0.000***
TDS	Sefiana	87.50±3.50	0.000 ***
	Abenaze	82.50±6.50	0.000 ***
	Wotetomider	87.30±3.70	0.000 ***

3.2. Length- Weight relationship

The relationship between total length and total weight for most dominant species of *L. intermedius*, *L. forskalii* and *M. kannume* were curvilinear and showed significant variation ($P<0.001$) (One-way ANOVA) and the line fitted to the data was described by the regression equation (Fig 2). The regression coefficient for most of the dominant species were near to the cub value (b=3). In fishes the regression coefficient b=3 describes isometric growth which means that weight increase at a rate of about a cube of increase in length (Admassu, 1994) [1]. However, fishes may also have 'b' values less than or greater than 3, a condition of allometric growth (Bagenal &Tesch. 1978) [3]. *L. intermedius* in the Blue Nile River showed nearly isometric growth, which means the weight of these fishes increases as the cub of length because the b value is nearly 3 for these fish species in river (Fig 2). This value agreement with Tesfaye (2006) [25], in Angereb and Sanja rivers, Anteneh (2005), in Dirma and Megech rivers, Getahun *et al*., (2008) [10] in Rib river, Tessema (2010), in Borkena and Mille rivers and Mohammed Omer (2010) [19], in head of Blue Nile river. On the other hand the b values obtained in this study area for *L. forskalii* and *M. kannume* show negative allometric growth unlike that reported by Tewabe (2006), in Gendewuha, Guang, Shinfa and Ayima Rivers and Tesfaye (2006) [25], in River Angereb. However, the regression coefficient of *L. forskalii* in Blue Nile River is in agreement with the values obtained by Berie (2009), from Gelegel Beles River.

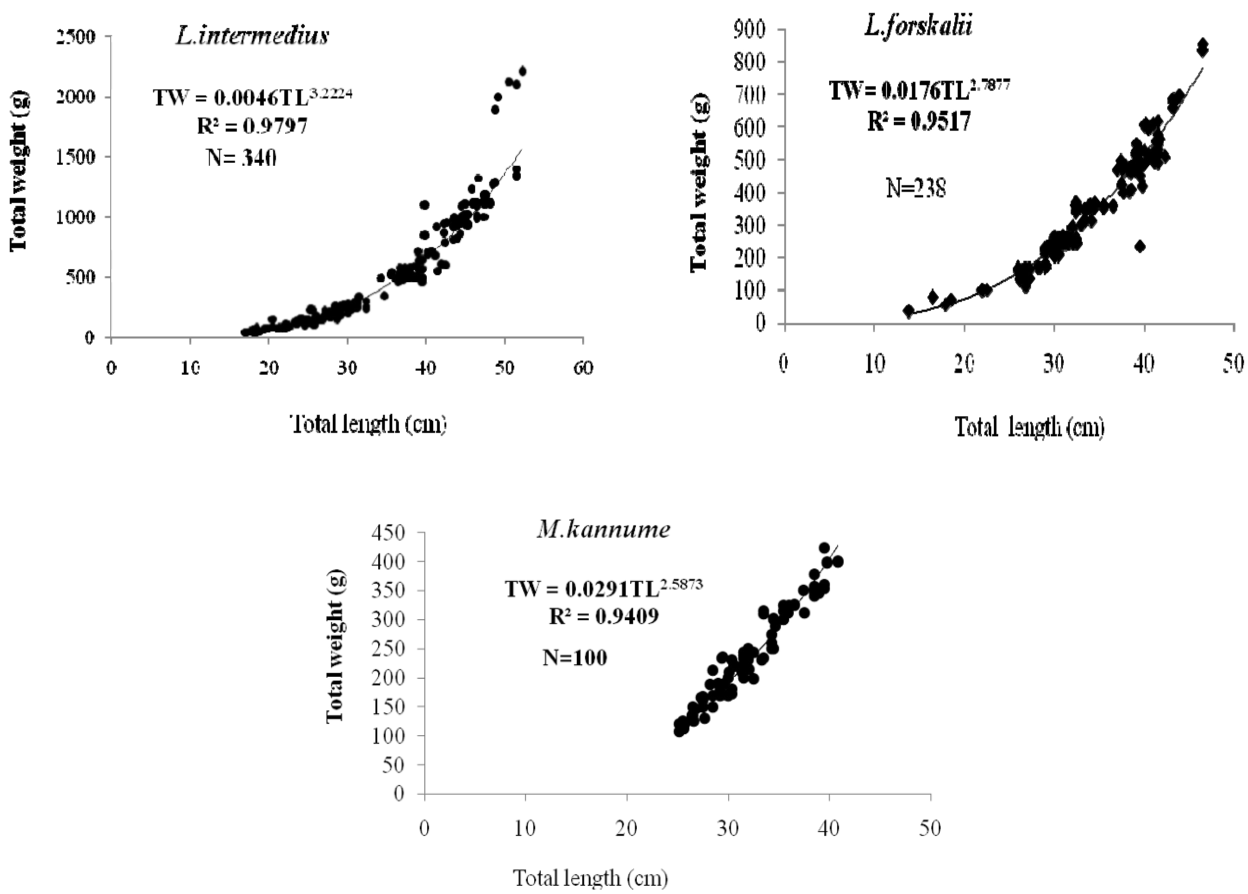

Fig 2: (a-c): Length- weight relationship of the three dominant species in Blue Nile River (340, 238 and 100 respectively). Note N is sample size (a) *L. intermedius*, (b) *L. forskalii* and (c) *M. kannume.*

2.3. Condition factor (Fulton factor)

Fulton condition factors for the tree dominant species (*L. intermedius, L.forskalii* and *M. kannume*) both by sex and spawning seasons in the Blue Nile River was done. The mean Fulton condition factor value of *L. intermedius* in the blue Nile river below the Tisisat fall was 0.99, (Table 4) which was less than the values reported by Genanaw Tesfaye (2006) [25], from Angereb and Sanja rivers with a value of 1.06, Dereje Tewabe (2008) [26], from Gendwuha, Guang and Shinfa rivers with a value of 1.12, Assefa Tessema (2010), with a values of 1.23 and 1.31 in Borkena and Mille Rivers. Nevertheless, it is higher than the result obtained by Omer (2010) [19], with value of 0.87 in a head of Blue Nile River. The Fulton condition factors value of *L. intermedius* was similar to that reported by Berie (2009), in Gelegel Beles River. The measurement of fish condition can be linked to the general health, fat and lipid content prey or food availability, reproductive potential, environmental condition and water level fluctuation. In general, higher condition is associated with higher energy (fat) content, increasing food base, reproduction potential or more favorable environmental condition (Pauker and Cottle, 2004) [20]. The mean Fulton condition factor of *L. intermedius* was not significant variation in sex and season, respectively (Table 4). However, it was significant variation in Fulton condition factor of *L. forskalii* between dry and wet season ($P<0.01$), but it did not showed significant variation between sexes (Table 4). Thus values in agreement with Tesfaye (2006) [25] in Sanja and Angereb Rivers. *Labeo forskalii* was showed in better condition in dry season than wet season. The mean Fulton condition factor of *M. kannume* was (1.49±0.05) and

(1.32±0.047) in sex and season, respectively. There was no significant variation between Fulton condition factor by sex and seasons. The low Fulton condition factor of fishes of the river is probably because of fluctuation in factors such as food quantity and quality, water level and flow rate and temperature.

Table 4: Mean ± SE of Fulton condition factor for most dominant fish species in the river by sex

Species	Sex	Mean ± SE	P	Season	Mean ± SD	P
L. intermedius	F	0.99±0.16	ns	Wet	0.97±0.14	ns
	M	0.97±0.09		Dry	0.99±0.16	
	Average	0.99±0.15			0.98±0.15	
L. forskalii	F	0.83±0.09	ns	Wet	0.80±0.06	0.000 ***
	M	0.86±0.18		Dry	0.850.12	
	Average	0.84±0.11			0.83±0.11	
M. kannume	F	1.00±0.00	ns	Wet	1.00±0.00	ns
	M	1.00±0.00		Dry	1.00±0.00	
	Average	.49±0.050			1.32±0.047	

Note ** =P<0.01, ns=P>0.05, (Average =Mean of mean)

2.4. Sex ratio

From the total of 857 species in blue Nile river below the Tiss Isat fall in the study period 619 (73.69%) were females and 221 (26.31%) were males. Seventeen (1.98%) specimens were unsexed. Generally females (619 in number) were more numerous than males (221 in number). Except *L. nedgia M.kannume*, *C. gariepinus* and *O. niloticus* species were collected from the Blue Nile river were significant difference (x^2, P<0.05) from the theoretical 1:1 ratio (Table 5). The imbalance of female to male ratio was most probably related to different biological mechanisms such as differential maturity rates, differential mortality rates and differential migratory rates between the male and female sexes (Sandovy and Shapiro, 1987; Matsuyama *et at*., 1988).

Table 5: Number of males, females, χ^2 values and the corresponding sex ratios of fish species in river (pooled data from all sampling sites)

Species	F	M	Sex ratio (F: M)	χ^2	P
L. intermedius	248	77	3.22:1	89.97	0.000***
L. forskalii	196	41	4.87:1	101.37	0.000***
L. nedgia	47	34	1.38:1	2.09	0.185 (ns)
M.kannume	51	49	1.04:1	0.04	0.841 (ns)
B.docmak	33	11	3.00:1	11	0.001**
L. crassibarbis	26	4	6.50:1	16.13	0.000*
C.gariepinus	13	4	3.25:1	4.76	0.225 (ns)
O.niloticus	5	1	5.00:1	2.67	0.102

*Note***highly significance (P<0.01), *** Very highly significance (P<0.001), (ns) not significant (P>0.05)

2.5. Fecundity

Absolute fecundities of the most dominant fish species (*L. intermedius*) was determined based on number of eggs per fork length, total body weight and gonad weight. Eleven specimens of *L. intermedius* with fork length ranging from 25.5 to 47.4 cm, mean and standard error of 38.7 and 2.35 had mean absolute fecundity (AF) of 3705 and ranged from 1345 to 7235 eggs. The relationship between AF with FL, TW and Gonad Weight of *L. intermedius* was linear. In general, absolute fecundity of *L. intermedius* was strongly positively correlated with FL, TW and GW (Fig 3).

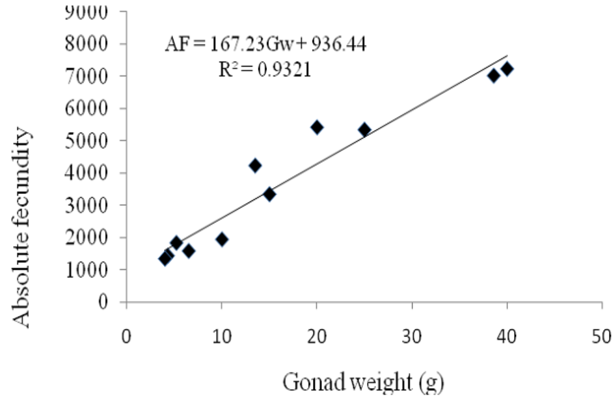

Fig. 3:(a-c): Relationship between absolute fecundity(total) and (a) Fork length, (b) total weight and (c) Gonad weight of *L. intermedius* in blue Nile river (N= 11, where N is sample size.

2.6. Conclusion

The length weight relationships for *L.intermedius*, *L. forskalii* and *M. kannume* were curvilinear. *L.intermedius* showed nearly isometric relation, but *L .forskalii* and *M. kannume* showed negative allometric relation. There was significant difference in Fulton condition factor for *L. forskalii* between dry and wet seasons (P<0.01). Fulton condition factor of *L. forskalii* in dry and wet seasons was (0.85±0.12) and (0.80±0.06), respectively. Therefore, *L. forskalii* was in better condition in dry season than wet season. The chi-square test analysis showed that there was significance variation in number of male and female of *L. intermedius* and *L. forskalii* with (P< 0.001). However, *M. kannume* did not showed significant variation in number of male and female. Fecundity was found to have linear relation with total length, total weight and gonad weight for *L.intermedius*.

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5. References

1. Admassu D. Maturity, fecundity, brood size and sex ratio of Tilapia (*Oreochromis niloticus*) in Lake Awassa, Ethiopia. SINET Eth J Sci. 1994; 17:1:53-69.
2. Anteneh W. The spawning migration of *Labeobarbus (*Cyprinidae: Teleostei) of Lake Tana to Dirma and Megech Rivers, Ethiopia. *M. Sc Thesis*, Department of Biology, Addis Ababa University, 2005.
3. Bagenal TB, Tesh FW. Age and growth. In**:** Methods for assessment of fish production in freshwater. Black well scientific publication, oxford, UK, 1978, 101-136.
4. Berie Z. Diversity, relative abundance and biology of fishes in Beles and Gelgel Beles Rivers, Abay basin Ethiopia, MSc. Thesis, Addis Ababa University, Ethiopia, 2007.
5. Dile Y. Hydrological Modeling to Assess Climate Change Impact at Gilgel Abay River, Lake Tana Basin Ethiopia, 2009.
6. FAO (Food and Agricultural Organization). FAO fisheries and aquaculture Ethiopia, 2001.

7. Getahun A. The Nile basin: Riverine fish and Fisheries, Department of Biology Addis Ababa University, Ethiopia, 2002, 19.
8. Getahun A. 2005. An over View of the diversity and conservation status of Ethiopian freshwater fish fauna. In proceeding of the Pan. Africa fish and fisheries society, Cotonou, Benin, Nov, 2003.
9. Getahun A. An overview of the diversity and conservation status of the Ethiopian freshwater fish fauna. J. Afrotropical Zoology special Issue, 2007, 87-96.
10. Getahun A, Dejen E, Anteneh W. Fishery Studies of Rib River, Lake Tana Basin, Ethiopia Final Report vol.2 Presented to the World Bank- financed Ethiopia- Nile Irrigation and Drainage Project Coordination Office, Ministry of Water Resources: January 2008 Addis Ababa, Ethiopia, 2008.
11. Golubtsov AS, Mina MV. Fish species diversity in the main drainage System of Ethiopia: Current status of Knowledge and research perspectives, Ethiop. J Natu Reso. 2003; 5(2):281-318.
12. JERBE (Joint Ethio-Russian Biological Expedition), 2007. Fish diversity in the main drainage systems of Ethiopia. Addis Ababa.
13. MacGregor JS. Fecundity of the Pacific sardine (Sardinops caerulea). Fish Bull Fish Wildl Serv U.S, 1957; 121: 427-449.
14. Matsuyama M, Adachi S, Nagahama Y, Matsuura S. Diurnal rhythm of oocyte development and plasma steroid hormone levels in the females red sea bream during the spawning season. Aquaculture. 1988; 73: 357-372.
15. MoWR (Ministry of Water Resources), Tekeze basin Integrated master plan project. Sectoral., 1998
16. MoWR. Assessment of Abay River Basin Master plans project and programs Hydrometeorology. Addis Ababa – Ethiopia. Report, Fisheries, 2010, 6.
17. Nagelkerke LAJ. The Barbus of Lake Tana, Ethiopia: Morphological Diversity and its Implication for Taxonomy, Trophic Resource Partitioning, and Fisheries. Thesis, Agricultural University, Wageningen, 1997.
18. Nikolsky GV. The ecology of fish pp1-600. London. Academic, Press, 1963.
19. Omer M. Diversity, Relative abundance and Biology of fishes in the head of Blue Nile River, Blue Nile Basin, M.Sc. Thesis*,* Bahir Dar University, Ethiopia, 2010.
20. Pauker C, Coot RSR. Factors affecting condition of Flanmelmout Suckers in Colorado River, Grand Canyon, Arizona. North American J. of Fish Management. 2004; 24: 648-653.
21. Sandovy Y, Shapiro DY. Criteria for the diagnosis of hermaphrodites in fishes. *Copeia* 1987; 1:136-156.
22. Tedla S. Freshwater Fishes of Ethiopia. Department of Biology. Addis Ababa University, Addis Ababa, Ethiopia, Pages, 1973, 101.
23. Tedla S, Meskel FH. Introduction and transplantation of freshwater fish species in Ethiopia. SINET: Ethiop J Sci. 1981; 4:69-72.
24. Tessema A, Mingist M, Dejen E. Diversity Relative Abundance and biology of fishes in Mille and Borkena Rivers, Awash Basin, Ethiopia J Fish Int. 2012; 7:70-76.
25. Tesfaye G. Diversity, Relative abundance and Biology of fishes in Angereb and Sanja Rivers, Tekeze basin, Ethiopia, M.sc Thesis, Addis Ababa University, Ethiopia, 2006, 89.
26. Tewabe D. Diversity, Relative abundance and Biology of fishes in Gendewuha, Guang, Shinfa and Ayima Rivers, Tekeze and Abay Basins, Ethiopia. MSc Thesis, Addis Ababa University, Ethiopia, 2008, 108.
27. Thieme ML, Brown A. Lake Tana. In: Fresh water Ecoregion of Africa and Madagascar, Pages, 2007, 180 - 181.
28. Wudneh T. Biology and Management of fish stack in Bahir Dar gulf, Lake Tana, Ethiopia, PhD Thesis, Wageningen institute of Animal Science, Wageningen Agricultural University, The Netherlands, 1998.