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Research Article

Comparison on some biological aspects of Labeobarbus intermedius Rüppell 1835 and Labeo forskalii Rüppell 1836 in Beles and Gilgel Beles rivers, abay basin, Ethiopia

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Keywords: Rivers; Beles; Gilgel beles; Length-weight relationship; Fulton condition factor; Fecundity; Sex ratio

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Abstract

Length-weight relationship, Fulton Condition Factor, Sex ratio and fecundity of Labeobarbus intermedius and Labeo forskalii of Beles and Gilgel Beles Rivers were studied. Fishes were sampled using gill nets of various stretched mesh sizes, and hooks and lines. A total of 548 Labeobarbus intermedius and Labeo forskalii fishs were caught in Beles and Gilgel Beles Rivers. Descriptive statistics was used to present the data. One way ANOVA was used to analyze the Fulton condition factor of fishes. The length-weight relationships were curvilinear for *L. forskalii* and L. intermedius in both rivers. *L. forskalii* showed isometric growth while L. intermedius exhibited positive allometric growth in Beles and Gilgel Beles Rivers. *L. forskalii* and L. intermedius were found to be in better condition in both rivers (ANOVA, $P < 0.05$). Females were in better condition than males in both rivers. *L. forskalii* had a better condition factor (FCF) in the dry than in the wet season (ANOVA, $P < 0.05$). However, L. intermedius had better mean FCF in wet than in dry season (ANOVA, $P > 0.05$). Females were more numerous than males in the total sexed specimens. Absolute fecundity of L. intermedius increased with an increase in fish size, and ranged from 1535 to 13864 with a mean of 3173 eggs. In general, *L. forskalii* and L. intermedius were found in better condition in Gilgel Beles and Beles Rivers, respectively. Therefore, sustainable utilization and conservation measures should be taken in the two rivers.

Introduction

Background information

Although Ethiopia has high production potential and diversity of fish fauna, satisfactory fishery investigations have been carried out only in a few of the numerous freshwater bodies. Substantial icthyofaunal information appeared in publication on Biology, Limnology and Ecology of the commercially important fish species in lakes and rivers: Lake Afdera [1], Lake Ziway , Lake Awassa [2], Lake Chamo Lake Hayq [3], Lake Tana [4,5], eco-regions, diversity and conservation of the freshwater fish fauna of Ethiopia [6] and introduction and transplantation of freshwater fish species in Ethiopia [7]. In addition, projects of the Joint Ethio-Russian Biological Expedition (JERBE) and the Wageningen Agricultural University, The Netherlands have explored the icthyofauna of Lake Tana and surrounding rivers [8]. JERBE [9,10] also assessed fish diversity in Beles and Gilgel Beles Rivers and found a total of 25 and 4 species of fishes, repectively. Beles and its tributary Gilgel Beles rivers contain large population of edible fish species. L. intermedius and *L. forskalii* were the most abundant species on these rivers.

As in many parts of the Ethiopia, human activities degrade fish habitat in numerous ways in study area. Wild fire, logging, impoundment, canalisation and agricultural activities are some

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of the major activities that degrade fish habitat. At present, we have no evidence of species extinction from Ethiopian freshwaters resulting from degradation of environment. One of the main reasons is a lack of definitive information on icthyofauna. The territory of Ethiopia seems to be among regions of the African continent which are least explored for their icthyofauna [11]. Beles and Gilgel Beles Rivers are flowing to the lower course of Abay in which adequate attention has not been given in the study of biology and economical potential of the fish fauna due to the presence of some inaccessible mountains and rugged geographical features. The absence of fishery data on these rivers triggers the researcher to conduct this study. Therefore, the study attempted to provide answers to the following leading research question: What does the biology (Reproduction, Condition Factor and Length- weight relationship) of L. intermedius and *L. forskalii* look like in of these rivers?

The general objective of this study was to generate base line scientific information/ data about fish biology of L. intermedius and *L. forskalii* for management and sustainable utilization of the resources, and recommend ways and means of conserving the diversity of the icthyofauna of the Beles and Gilgel Beles Rivers. Thus, the specific objectives of the study were to assess length - weight relationship of L. intermedius and *L. forskalii*, to compare the well - being of L. intermedius and *L. forskalii* with respect to sex and season and asses sex ratio and estimate fecundity of L. intermedius and *L. forskalii*.

Materials and methods

Site selection: A reconnaissance survey was conducted together with the research advisor to fix sampling sites. The survey was conducted in four sub areas along the Beles and Gilgel Beles Rivers. Two sampling sites were selected from each river taking into consideration the velocity of water, habitat type, altitude, depth of water, vicinity to road and substrate type (Table 1). These sub areas are namely; sub area I (Gilgel Beles at Mender hullet), sub area II (Gilgel Beles at College), sub area III (Beles at bridge) and sub area IV (Beles at Babizenda) (Figure 1). Babizenda sampling site is located below the confluence of the rivers.in Guba woreda.

Fieldwork: Three surveys were conducted to collect specimens from the sampling sites. The samples were taken in November, March and May. November and May were wet months while March was dry month. Gill nets with 6 cm, 8 cm, 10 cm, 12 cm and 14 cm mesh sizes were used to collect fishes. Monofilament gill nets were also used to collect juvenile and smaller sized fishes. Multiple hooks and lines were used in areas where gill nets were not suitable. The gill nets and multiple hooks and lines were set using swimmers across the river diagonally late in the afternoon (5:00 PM) and left in the rivers for about 15 hrs, and retrieved in the next morning (8:00 AM). However, monofilament gill nets were set for an hour during daytime.

Immediately after retrieval, fishes were removed and total length and total weight of each specimen were measured. Total length was measured to the nearest 0.1 cm and total weight was measured to the nearest 0.1 g. After length and weight measurement, each specimen was dissected and its sex

Table 1: Estimated distances from Gilgel Beles at Mender hullet, altitude and coordinates of sampling sites.

Site	Code	Distance from Mh	Elevation (a.s.l)	Coordinate (GPS)
Gilgel Beles at Mender hullet	Mh	-	1011 m	11^{0} 09′ 53.5″ N; 36^{0} 20′ 39.3″ E
Gilgel Beles at College	Coll	2 km	1007 m	11^{0} 09′ 35.1″ N ; 36^{0} 20′ 008″ E
Beles at bridge	BB	6 km	994 m	11^{0}11′ 56.7″ N ; 36 ^{0}19′ 31.7″ E
Beles at Babizenda	BAB	156 km	596 m	11^{0}07′ 54.8″ N ; 35^{0} 28′ 13.6″ E

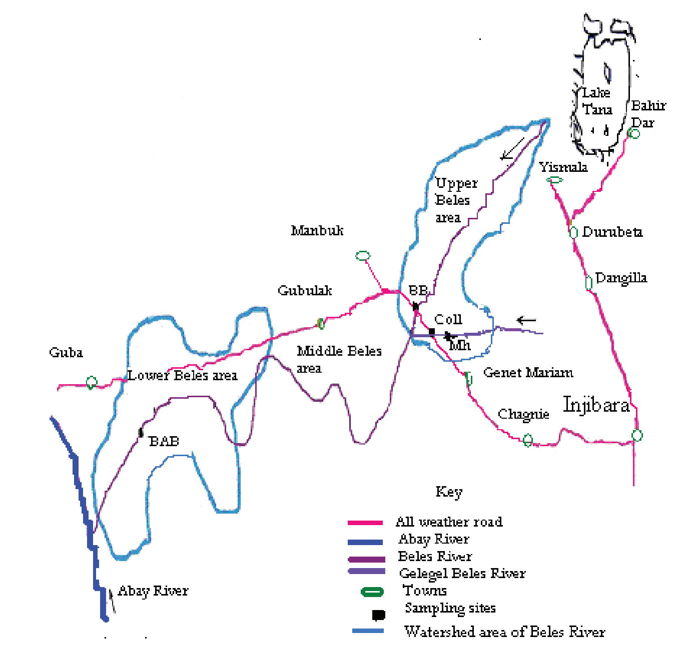

Figure 1: Map of Beles and Gilgel Beles Rivers (un scaled) (FDROE, MOWR, 2000).

determined by inspecting the gonads. Then, specimens and gonads of dominant species were preserved in 10 % and 5 % formalin, respectively.

During fieldwork, beam balance, measuring board, buckets, plastic bowls, collection bottles, strings, camera, syringe, GPS and other materials were used when required.

Laboratory studies: The specimens were soaked in tap water for a week to wash the formalin from the specimens. Then, they were transferred to 75 % ethanol.

Data analysis: Generally, SPSS for Windows (version 10) and MINITAB (version 14) were used to perform the calculations and statistical analysis.

Length- weight relationship

The relationship between total length and total weight was calculated using least squares regression analysis [12] as follows:

$TW = a * TL^{b}$

Where, TW = Total weight in grams

TL = Total length in centimeters

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a and b = intercept and slope of the equation, respectively.

Significance of the relationship was statistically tested using ANOVA.

Condition factor

The well-being or plumpness was studied by calculating Fulton condition factor [12,13]. Fulton condition factor (%) was calculated as:

$$FCF = \frac{W}{L^3} X100$$

Where, FCF= Fulton condition factor,

TW= Total weight in grams, and

TL= Total length in cms.

Estimation of sex ratio

Sex ratio (female: male) was calculated for total sample. Chi-square test was employed to test if sex ratio varied from 1:1 in the total sample.

Fecundity

Fecundity is the measure of reproductive potential in fishes. Absolute fecundity was estimated by the Gravimetric method [14]. Three sub-samples of 1g eggs were taken from different part of the ovary and counted, and an average of these was calculated. Then, the total number of eggs per ovary was calculated by extrapolation from the mean calculated. The total number of eggs was estimated by the following formula:

$$\frac{X}{N} = \frac{W}{w}$$

Where X = Total number of eggs to be calculated

N = Number of eggs counted in a sample of known weight

W = Total weight of all eggs

w = weight of the sample

Relation between fecundity and total length, total weight and gonad weight were analysed using regression analysis.

Results and discussion

Length frequency distribution of L. intermedius and *L. forskalii*

A total of 548 Labeobarbus Intermedius and Labeo forskalii fishs were caught in Beles and Gilgel Beles Rivers.L intermedius, the most abundant species had a total length range of 10.6 cm to 69.5 cm with a mean ± SD of 26.419 ± 7.563 cm. *L. forskalii*, the second most abundant species had total length range of 10.2 cm to 44.7 cm with a mean ± SD of 26.951 ± 7.477 cm length (Figure 2).

Some biological aspects of L. intermedius and *L. forskalii*

Length-weight relationship: The relationship between total weight and total length, for L. intermedius and *L. forskalii*, was curvilinear and statistically significant (ANOVA, P < 0.05) (Table 2). The line fitted to the data was best described by the regression equations shown in Table 2, and Figs. 2 and 3. In fishes, the regression coefficient b = 3 describes isometric growth. The value is exactly 3 if the fishes retain the same shape and their specific gravity remains unchanged during lifetime [15]. However, some fishes have value greater or less than 3, a condition described as allometric growth [12]. From Table 3, Figures 3,4, it can be seen that *L. forskalii* in Beles and Gilgel Beles Rivers show isometric growth, i.e. the weight of these fishes increases as the cube of length because the b value is nearly 3. The b-value obtained in this study for *L. forskalii* in Beles and Gilgel Beles Rivers are close to the value reported for *L. forskalii* in Sanja River [16] and L. horie from Lake Chamo [17]. From Table 3, Figures 3,4, it can be seen that L. intermedius in Beles and Gilgel Beles Rivers show allometric growth. The result obtained in this study for L. intermedius in Beles and Gilgel Beles Rivers were not in agreement with Demeke Admassu and Elias Dadebo [2] for the species in Lake Awassa, Wassie Anteneh [18] and Nagelkerke, et al. [8] for Lake Tana and Genanew Tesfaye [16] for Angereb River and Sanja Rivers. Observed differences in parameters b calculated in the present study when compared with those obtained by other authors are likely due to differences in the number of specimens examined, differences in the utilized length ranges

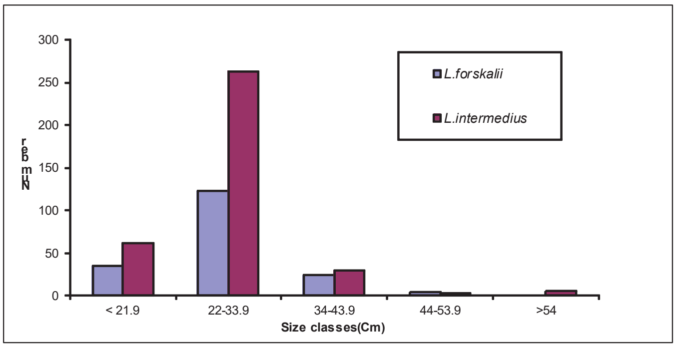

Figure 2: *Length frequency distribution of* L. intermedius *(N=362) and* L. forskalii *(N=186) from Beles and Gilgel Beles Rivers.*

Table 2: Length - weight relationship of *L. intermedius* and *L. forskalii* in Beles and Gilgel Beles Rivers.

Fish species	Rivers	Regression equation	r	P	TW Mean ±SD	TL Mean ± SD	N
L.intermedius	Beles	$W = 0.005TL^{3.24}$	0.97	0.00^s	226.0 ± 114.1	26.77± 3.71	40
	G. Beles	$W = 0.003TL^{3.36}$	0.97	0.00^s	252.1 ± 391.7	26.38 ± 7.91	322
L. forskalii	Beles	$W = 0.007TL^{3.09}$	0.98	0.00^s	217.6 ± 177.7	26.03 ± 8.68	96
	G. Beles	$W = 0.0157TL^{2.86}$	0.97	0.00^s	240.5 ± 151.9	27.93 ± 5.82	90

S- Significant

Table 3: Mean ± SD Fulton Condition Factor (FCF) for *L. forskalii* and *L. intermedius* in Beles and Gilgel Beles Rivers.

Species	Beles		Gilgel Beles			
	FCF Mean ± SD	N	FCF Mean ± SD	N	F	P
L. forskalii	0.9379 ± 0.14	96	0.9987 ± 0.11	90	10.32	0.002
L. intermedius	1.0970 ± 0.08	40	0.9971 ± 0.17	322	12.89	0.00

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or differing study seasons, food availability, feeding rate, gonad development and spawning period [12].

Fulton Condition Factor (FCF): *L. forskalii* and L. intermedius

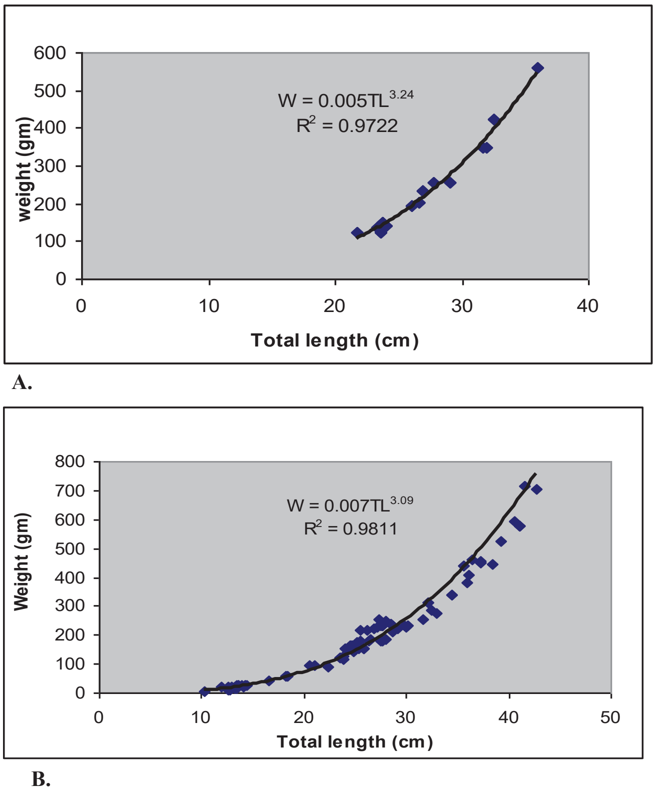

Figure 3: Length – weight relationship for A= *L. intermedius* and B = *L. forskalii* in Beles River.

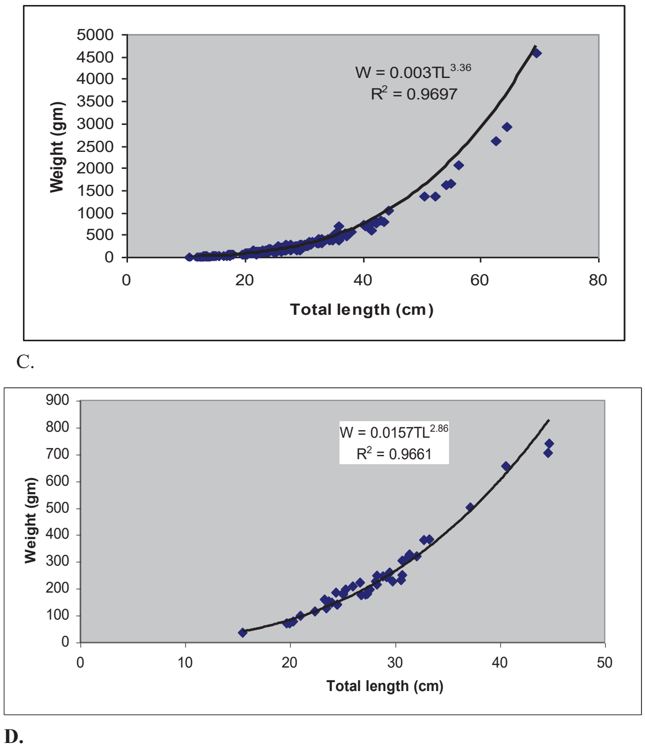

Figure 4: Length – weight relationship for C = *L. intermedius* and D = *L. forskalii* in Gilgel Beles River.

were found in better condition in Gilgel Beles and Beles Rivers, respectively. Fulton condition factor values of L. intermedius ranged from 0.93 to 1.23 in Beles River and 0.43 to 1.73 in Gilgel Beles River. Fulton condition factor values of of *L. forskalii* ranged from 0.79 to 1.26 in Gilgel Beles River and 0.49 to 1.29 in Beles River. There were significant differences in the mean Fulton condition factor for both *L. forskalii* and L. intermedius between Beles and Gilgel Beles Rivers (ANOVA, $P < 0.05$) (Table 3). Females were found in better condition than males in both Beles and Gilgel Beles Rivers (Table 5). The difference in mean Fulton condition factor for *L. forskalii* and L. intermedius was insignificant both in Beles and Gilgel Beles Rivers except L. intermedius in Beles River (ANOVA, $P > 0.05$) (Table 4). Fulton condition factor calculated for L. intermedius in Beles and Gilgel Beles Rivers were comparable to those reported of L. intermedius in Lake Awassa [2] and in Sanja River [16]. Fulton fondition factor calculated for *L. forskalii* in Beles and Gilgel Beles Rivers were close to the value reported for *L. forskalii* in Angereb and Sanja Rivers [16].

Mean Fulton condition factor of *L. forskalii* was greater in dry season than wet season (ANOVA, $P < 0.05$) (Table 5). However, mean Fulton condition factor of L. intermedius was greater in wet season than dry season (ANOVA, $P > 0.05$) (Table 5). Demeke Admassu and Elias Dadebo [2] also found insignificant variation (ANOVA, $P > 0.05$) in Fulton condition factor for L. intermedius between dry and wet seasons in Lake Awassa. However, Genanew Tesfaye [16] reported significant variation (ANOVA, $P < 0.05$) for L. intermedius and *L. forskalii* between dry and wet seasons in Sanja and Angereb Rivers.

The measure of fish condition can be linked to the general fish health, fat and lipid content, prey or food availability, reproductive potential, environmental conditions and water level fluctuations. In general, high condition is associated with higher energy (fat) content; increased food base, reproductive potential, or more favorable environmental conditions [19]. For instance, better FCF of *L. forskalii* and L. intermedius in dry and wet seasons respectively was associated with large ovarian development. The low FCF of fishes of the rivers is probably because of fluctuations in factors such as food quantity and quality, water level, flow rate and temperature.

Reproductive biology

Sex ratio: In general, females were more numerous than males in the total sexed specimens (Table 6). The sex proportions of each species were not significantly different (Chi-square, $P > 0.05$) from the theoretical 1:1 ratio except L. intermedius (Table 6). The imbalance was most probably related to vulnerability of fish to gears. Increased vulnerability of females by some gears due to increased ovarian development, as suggested by Tayler and Villoso (1994), can be the cause for the deviation from 1: 1 sex ratio.

Fecundity: Fecundity was determined in fish fork lengths of 18.4 to 46.7 cm, total body weights of 113 to 1215 gm and with gonad weights of 3 to 68.3 gm. In 55 female L. intermedius, fecundity varied from 1535 to 13864 with mean 3173 eggs (Table 7). Fecundity of L. intermedius increased with an increase in fish size (Table 7). Fecundity of L. intermedius was linearly related to total weight and gonad weight, and curvilinearly to

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fork length (Figure 5). The lines of best fit to the relationships were described by the following regression equation:

Log eggs = 2.06 Log FL + 0.6114 (R^2 = 0.8492)

F = 9.8138W + 497.35 (R^2 = 0.8491)

F = 189.13Gw + 1095.8 (R^2 = 0.8807)

Where Gw, W, FL and AF are gonad weight, body weight, fork length and fecundity, respectively.

The information about fecundity of large Barbus fish species in Africa is scarce [20]. There are few data on the fecundity of Ethiopian large Barbus. The most recent studies and publications were done these of Alekseyev, et al. [21] and Wassie Anteneh [18] from Lake Tana and its tributaries. Compared to Lake Tana Labeobarbus spp., a similar size of female L. intermedius in Beles and Gilgel Beles Rivers laid more eggs. The fecundity of L. brevicephalus and L. truttiformis ranged from 1284 to 4563 and 1732 to 8134 eggs, respectively in Lake Tana [18]. The average fecundity of the small (precocious) and big (normal), 'intermedius' was 4.6 thousand and 11.7 thousand eggs, respectively in tributaries of Lake Tana (Gelda and Gumara Rivers) [21]. Fecundity of Labeobarbus in other African lakes is moderately high [22]. A 30 cm female L. aeneus in Orange River drainage system carries about 30,000 eggs on average but a similar size female L. intermedius in Beles and Gilgel Beles Rivers lays about 4690 eggs. According to Oliva-Paterna, et al. [23,24], fast growth, early maturity and high fecundity are characterstics of unstable environment. Therefore, the main cause for the above variations might be due to genetic or habitat differences. Generally, the fecundity of L. intermedius in Beles and Gilgel Beles Rivers was strongly correlated with their gonad weight, body weight and length. Similar result was obtained by Alekseyev, et al. [20], in tributaries of Lake Tana.

Table 4: Mean ± SD Fulton condition factor (FCF) by sex *for L. intermedius* and *L. forskalii.*

Fish species	River	Females(FCF)	N	Males(FCF)	N	F	P
L. forskalii	G. Beles	1.026 ± 0.106	42	1.012 ± 0.09	38	0.19	0.666
	Beles	0.9699 ± 0.13	39	0.930 ± 0.15	46	1.56	0.215
L. intermedius	G. Beles	0.990 ± 0.148	180	0.98 ± 0.20	115	0.15	0.699
	Beles	1.145 ± 0.055	16	1.05 ± 0.108	16	7.92	0.009

Table 5: Mean ± SD Fulton condition factor (FCF) for *L. intermedius* and *L. forskalli* in Beles and Gilgel Beles Rivers during the two seasons (combined data).

Species	Season	N	FCF Mean ± SD	F	P
L. forskalii	Wet	81	0.8993 ± 0.1265	47.51	0
	Dry	105	1.0198 ± 0.1114		
L. intermedius	Wet	338	1.0107 ± 0.1712	1.15	0.285
	Dry	24	0.9726 ± 0.1243		

Table 6: Number of males, females and the corresponding sex ratios of fish species of Beles and Gilgel Beles Rivers (data from all sites pooled).

Species	Female	Male	Sex ratio (F: M)	X^2	P
L. forskalii	84	81	1:0.96	0.02	0.88
L. intermedius	196	131	1:0.67	12.92	0

Table 7: Mean absolute and relative fecundity of *L. intermedius* in relation to fork length.

Size class	N	Mean FL	Mean body weight (g)	Mean gonad weight (g)	Mean absolute fecundity	Mean relative fecundity
18.4-21.4	8	19.275	120.63	6.5	1918	16
21.5-24.4	19	21.226	161	6.789	2220	14
24.5-27.4	17	24.141	233.2	8.2	2809	12
27.5-30.4	3	28.167	390	14.67	3941	10
30.5-33.4	4	31.275	497.3	16.88	3786	8
>>33.5	4	40.6	963	43.1	10576	11

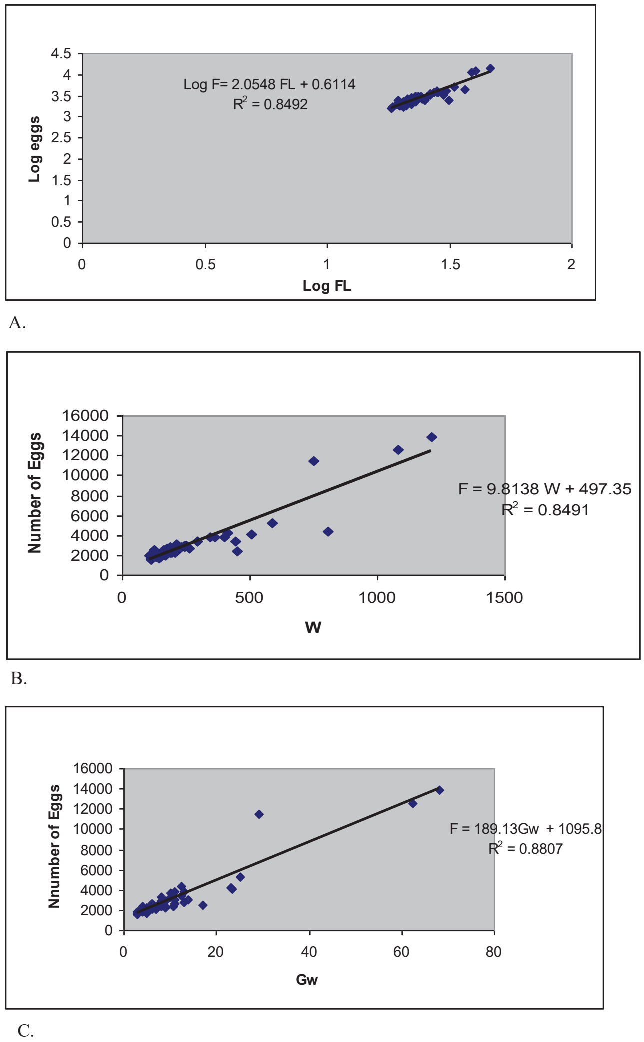

Figure 5: The relationship between (A) fecundity and fork length, (B) fecundity and body weight, and (C) fecundity and gonad weight in *L. intermedius.*

Conclusions and recommendations

Conclusions

The length-weight relationships were curvilinear for *L. forskalii* and L. intermedius in both Beles and Gilgel Beles Rivers. From length-weight relationship, *L. forskalii* showed isometric growth in both Beles and Gilgel Beles Rivers i.e. the weight of these fishes increases as the cube of length because the b value is nearly 3. However, L. intermedius exhibited positive allometric growth in both Beles and Gilgel Beles Rivers.

L. forskalii and L. intermedius were found in better condition in Gilgel Beles and Beles Rivers, respectively. *L. forskalii* was

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found in better condition in Gilgel Beles River than Beles River (ANOVA, $P < 0.05$). However, Mean Fulton condition factor for L. intermedius was greater in Beles River than Gilgel Beles River (ANOVA, $P < 0.05$). Females L. intermedius and *L. forskalii* were found in better condition than males both in Beles and Gilgel Beles Rivers. Mean Fulton condition factor of *L. forskalii* was greater in dry season than wet season. However, Mean FCF of L. intermedius was greater in wet than dry season. There was significant difference in the mean FCF for *L. forskalii* between dry and wet seasons in total catch (ANOVA, $P < 0.05$). However, there was no significant variation in FCF of L. intermedius seasons (ANOVA, $P > 0.05$).

Fecundity of L. intermedius was linearly related to total weight and gonad weight, and curvilinearly to fork length in the two rivers.

Recommendation

In order to have a better knowledge of biology and behaviour of most of the species are still lacking. Therefore, further studies are required on the biology and behaviour of fishes in the study area. In addition, detailed studies and investigations are required on diversity and abundance of fish species in Abay basin in general and in Beles and Gilgel Beles Rivers in particular, especially at the lower reaches of Beles River.

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