ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

DIVERSITY, RELATIVE ABUNDANCE AND BIOLOGY OF FISHES IN SOME RIVERS, AND CESTODE PARASITES OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*) IN SOME LAKES OF ETHIOPIA

BY

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DECLARATION

I, the undersigned declare that this thesis is my work and that all sources of material used for the thesis have been correctly acknowledged.

Name MOGES BELETEW

Signature ______________________________

Date of submission 07 August 2007

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ABBREVIATIONS

ABL –anterior barbel length

AFBL – anal fin base length

AFL – anal fin length

ASN – anal spine number

BD – body depth

CDL – caudal peduncle length

CDP – DR – caudal peduncle to dorsal root length

CPD – caudal peduncle depth

DSBL – dorsal spine barbel base length

DSH – dorsal spine shape

DSL – dorsal spine length

DSN– dorsal spine number

FBL – first barbell length

HL – head length

HSH – head shape

HW – head width

IMBL – inner mandibular barbel length IOL – interorbital length

LLS – lateral line scale

MBL – mandibular barbel length

MW – mouth width

MXBL – maxillary barbel length

NABL – nasal barbel length

OCC – occipit length

OD (ED) – orbit diameter (eye diameter)

ODFL – ossified dorsal fin length

OMNBL – outer mandibular barbel length

PBL – posterior barbel length

PECFBL – pectoral fin base length

PECFL – pectoral fin length

PEFL – pelvic fin length

PMXBL – premaxillary barbel length

PMXTW – premaxillary teeth length

PORL – Postorbital length

PREDL – predorsal length

PREOL – pre orbital length

RBL – rostral barbel length

SBL – second barbel length

SL – standard length

SNL – snout length

THDSP – thickness of dorsal spine

TL – total length

VTL – vomerine teeth length

ABSTRACT

Diversity, relative abundance and biology of fish species of Beshilo, Ardi and Dura Rivers were studied in November 2005, March and May 2006. Conductivity and dissolved oxygen showed significant variations among rivers ($P < 0.05$). The highest conductivity (415 $\mu.sm.cm^{-1}$) was observed in Beshilo River (BS1). The lowest conductivity (66.90 $\mu.sm.cm^{-1}$) was recorded in Ardi River (A 2). The lowest (4.04 mgl^{-1}) and the highest (7.03 mgl^{-1}) dissolved oxygen measurements were observed in Ardi River (A2). Fishes were sampled using gill nets of 6,8,10, 12 and 14 cm stretched mesh sizes, hooks and lines and monofilaments. Fish identification was done to species level by comparing the samples meristic and morphometric characters with taxonomic keys found in the literature and deposited specimens. Shannon diversity index and an index of relative importance (IRI) were computed to evaluate diversity and relative abundance of fish species, respectively. A total of 1060 fish specimens belonging to three orders, five families, ten genera and seventeen species were identified in Beshilo, Ardi and Dura Rivers. A higher number of species was recorded in Beshilo River (13 species) than Ardi (7 species) and Dura (5 species) Rivers. The diversity index was higher in Beshilo River (H' = 1.65) than Ardi (H' = 1.59) and Dura (H' = 1.12) Rivers. Cyprinids were the most dominant fish species in all studied Rivers. The Cyprinids *Labeobarbus intermedius*, *Varicorhinus beso*, and *Labeobarbus nedgia* were the most important fish species in the total catch. *Labeobarbus intermedius*, *Varicorhinus beso*, and *Labeobarbus nedgia* of Beshilo River had isometric growth while *Varicorhinus beso* exhibited positive allometric growth in Ardi and Dura Rivers. Both sexes of *Varicorhinus* *beso* and *Labeobarbus intermedius* in Beshilo River were in better condition while females of *Labeobarbus intermedius* were relatively in better condition than males.

Female to male sex ratio was 1:1 in combined catches with slight difference in *Varicorhinus beso*. But, females out number males in dry season while males show preponderance in wet season. Absolute fecundity increased as fish size increased. The L_{50} calculated for some fish species would help setting minimum mesh size for management in the riverine fishery development.

Key words / phrases/: ***Ardi, Beshilo, Dura, Relative abundance, Rivers, Relative importance (IRI), Species***

Part two

CESTODE PARASITES OF AFRICAN CATFISH (CLARIAS *GRIEPINUS*) IN SOME LAKES OF ETHIOPIA

ABSTRACT

An attempt was done to identify and compare differences and species composition of Cestode fauna in the African catfish from the three lakes (Lakes Awassa, Tana and Ziway). The infection, mean intensity (number of worms per fish), cestode site preference and relationship between cestode intensity and size of fish were studied. In the present study five cestode fish parasites were identified. These are *Polyonchobothrium clarias*, *Proteocephalus glanduliger*, Proteocephalidea. new. genus, *Proteocephalidea sp*. and *Caryophyllaeus sp*. All of them were found in Lake Tana while only *Polyonchobothrium clarias* was observed in Lake Awassa. *Polyonchobothrium clarias* and *Proteocephalidea sp* were identified in Lakes Tana and Ziway. From a total of 90 *Clarias gariepinus* fish examined, 65.56 % were infected and 34 .44 % were free. Of the infected hosts 35.56 % and 30 % were females and males respectively. The incidence of *Polyonchobothrium clarias* (that was dominantly found in the three lakes) was 86 % in the combined data. Lake Tana had more diverse cestode fish parasite fauna than Lakes Awassa and Ziway. Among the observed cestode parasites, *Polyonchobothrium clarias* and *Proteocephalus glanduliger* might be new to Ethiopia while Proteocephalidea. new. genus might be new to science. Generally, the present study disclosed five fish parasites that were categorized in Cestode.

Key words / phrases /: *Cestode, Clarias, Fish parasite,Infection, Incidence, Lakes, Polyonchobothrium, Proteocephalus*

The third drainage system is the Shebelle-Juba catchment. The Rivers Genale, Dawa, and Weyb in this catchment drain the southwestern parts of the eastern highlands. Rivers Shebelle, Fafan and their tributaries drain the eastern parts of the eastern highlands of Ethiopia. The principal rivers in this system originate from the Bale Highland Mountains and flow to the Indian Ocean (Roberts, 1975)**.** Some of the rivers are international and crossing the border of the country.

Furthermore, Ethiopian freshwater includes the Crater lakes, such as Lakes Bishoftu, Hora Arsede or Betemengist, Kuriftu, Babogaya, Ziquala at the top of Ziquala Mountain, Chitu and Beseka (Metehara).

There are also highland lakes of which Lake Tana is the largest that contains half of the country's freshwater by area. It is located in the North West highlands of Ethiopia (de Graaf *et al,* 2000). Lakes Garba Guracha and Orgona, Lakes Wonchi (Crater Lake) and Dandii, and Lakes Hayq (Lugo) (Crater Lake), Ardibo, Ashengie and Zengana are all highland lakes of Ethiopia located at different parts of the country. In addition to these, there are small natural ponds (most are in Gambella region] and artificial dams throughout the country (Abebe Getahun, 2005).

Most of these Ethiopian inland water bodies contain a number of fish species that are about 168 to 182 (Golubstov and Mina, 2003). Recently, some results of a study indicated that the number could increase to 200 and above (JERBE, 2007). However, knowledge on the diversity, distribution and population structure of the Ethiopia's Icthyofauna has been poorly known. Relatively a large number of small, medium and even some large rivers have not been well studied and exploited (Abebe Getahun, 2003, 2005). Therefore, further study on these Rivers is a time demanding phenomenon. The present study was conducted on the three Ethiopian Rivers that have not been studied so far. The Rivers are Beshilo in South Wello, Ardi and Dura in Ageawi zone (formerly Metekel province).

2. Literature review

2.1. Ethiopian freshwater Ichthyofauna

The Ethiopian inland water bodies (lotic and lentic) are endowed with edible fish resources that are of special interest to ichthyologists. This is because the fish species of Ethiopia's inland waters contain components of Nilo-sudanic, East African Ichthyofauna and endemic of the Ethiopian high lands (JERBE, 1995; Abebe Getahun and Stiassny, 1998)**.**

153 valid species and sub-species of fishes belonging to 12 orders and 25 families have been reported so far (Abebe Getahun, 2005). Some reports increase the number of the valid fish species to 168 - 183 in the Ethiopian fresh water bodies (Golubtsov and Mina, 2003)**.** A recent publication increases the valid fish fauna to 200 and above (JERBE, 2007).

Although the total number of fish species found in the country has not been exactly known, the fish species that have been described so far can be categorized as Nilo-Sudanic, highland East African and endemic forms (Roberts, 1975). There are also about 10 exotic fish species introduced from abroad into Ethiopian fresh waters for various purposes such as weed and malaria control (Shibru Tedla and Fisseha HaileMeskel, 1981). The number of endemic fish species of the country is estimated to range from 37 to 57 (Golubtsov and Mina, 2003).

The Nilo-sudanic fish species representatives are the dominant forms in Baro – Akobo, Omo – Ghibe, Tekeze and Blue – Nile basins. Some elements of these fish species are also found in the Shebelle – Genale system and Southern Rift Valley lakes (Abebe Getahun and Stiassny, 1998). These systems posses Nilotic fish elements due to the fact that the basins had past and have current link with the Nile and west and central African river systems (Roberts, 1976). Representative genera of these fishes are *Alestes, Bagrus, Barilius, Citharinus, Hydrocynus, Hyperopisus, Labeo, Malapterurus, Mormyrus, Polypteus, and Protopterus.*

The highland East African fish forms are found in north Rift Valley lakes (e.g. Ziway, Awassa and Langano) of Ethiopia, the high land lakes (Tana and Hayq) and the connected river systems and the Awash drainage basin (Abebe Getahun and Stiassny, 1998). These water bodies provide habitats for the representative genera of the East African fish species, *Labeobarbus, Barbus, Clarias, Garra, Oreochromis and Varicorhinus* (Abebe Getahun and Stiassny, 1998). The family Cyprindae dominates fish fauna of Ethiopian high lands (Tudorancea *et al.,* 1999). *Garra* species are wide spread in the lakes and rivers of Ethiopian highlands. Similar to *Garra* spp, *Varicorhinus beso* is common and by and large dispersed in the rivers and lakes of Ethiopian high lands (Eshete Dejen, 2003). Riverine fish species of Ethiopian highland as well look like South African and Arabian Peninsula fish forms. Skelton *et al* (1991) affirmed that some of the species of the Cyprinid genera for instance *Barbus species*: *Barbus Paludinosus* Peters 1982, *Barbus trimaculata* Lévêque and Daget 1984 and *Barbus radiatus* Lévêque and Daget 1984 are broadly distributed from South Africa through East Africa.

The saline lakes in the Afar region consist of fish fauna that are more similar to Red Sea and Mediterranean fauna since these lakes were extension of Red Sea. Lake Afdera in this case harbors *Lebias dispar* Rüppell 1827 and *Danakilia franchett*i Vinciguerra 1931, the former is found also in Red sea and Mediterranean and the latter is closely related to *Ironocichla hormuzensis* Coad 1982, which is found beyond the Arabian Peninsula in south west Iran (Trewavas, 1983). The diversity of fish, which have been identified previously in various inland water bodies are listed in Abebe Getahun, 2003, 2005.

Fish diversity studies have begun long time ago in unorganized (1520) or in organized forms (Rüppell work 1829 and 1836) (Golubtsov and Mina, 2003). Most of them have concentrated on the Rift valley lakes and Rivers that are the basins of these lakes and those nearby them. It is not only the scientific study, but also the fishery practice that has been developed intensively in these areas to the extent that it threatens the biodiversity of fish (Golubtsov *et al*, 2002; Golubtsov and Berendzen, 2005).

3. OBJECTIVES

3.1. General objective

- ❖ To collect baseline scientific data on fish diversity, relative abundance and biology of the dominant and commonly found fish species for the proper utilization and management of the fish fauna of Beshilo, Dura and Ardi Rivers

3.2. Specific objectives

- ❖ To identify fish species composition of the rivers,
- ❖ To find out relative abundance of the different fish species in the rivers,
- ❖ To identify length - weight relationship and condition factor of the dominant species and
- ❖ To examine reproductive behavior (maturity stage, fecundity) of the dominant species.

4. DESCRIPTION OF THE STUDY AREA

4.1. Beshilo River

All the Ethiopian rivers originate in the highlands and flow outward in many directions through deep gorges. Most especially is the Blue Nile, the country's largest river. The main river and its tributaries account 67.7 % of the Nile flow below Khartoum in Sudan (Wikipedia, 2007). Because of the general westward slopes of high lands, many rivers are tributaries of the Nile system, which drains a considerable area of the central portions of the plateau (Wikipedia, 2007).

Beshilo River is one of the six categories of the Nile basin and it is situated in the upper Blue Nile basin. The river originates from the upper land areas of Wello and its large Catchments (13,242 km^2**)** lies in Wadela Delanta province (now Tenta and Delanta Dawnt districts). The headwaters of the Beshilo River Catchments are highly dominated by steep mountainous parts with rugged topography and dissected features (MOWR, 1995, 1999).

The Beshilo River joins the Blue Nile River from a southwest direction. This river also has a number of tributaries, all of which flow in a deep gorge below the plateau area. Therefore, Beshilo River is a high order river. Most of them are temporary. Before the river gains its name, there are two rivers that contribute water to it. These are "Gerado" and "Terie" Rivers. They join in front of Ambasel Mountain foot just near the old bridge built by Italian across the Terie River. The name “Gerado” River stands for the combination of “Welano” (Teleyayegn) and Gerado River (that comes from the left side of “Welano” from Dessie high lands) at “Ziya” (a small village along the right side of the river). Then “Gerado” River goes down further receiving water from the small streams of the mountains from both sides. As a result, the river gets wider and larger and eventually joins with “Terie” River at the foot of Ambasel Mountain very close to the Old Bridge.

“Terie” River is again formed from Dry River (“Derek wenz”) and “Masoria” River. Both of them originate at the higher areas of Woldya. “Derek wenz” begins around Mersa and it is called ‘Workiju’ (the Gold hand). “Masoria” River is relatively big river that originates from the high lands of “Woldya” called “Anbesa Maseria”. When “Masoria” River goes down receiving water along its way, it gets larger and wider and now known as ‘Tirgia’ (meaning large and strong river). Tirgia and “Workiju” Rivers join and form “Terie” River at a distance of about 2 km from the origin of Beshilo River (Amare Kebede. Per.comm and Personal observation).

Beshilo River originates just Below “Gosh meda” very near to the junction of the road that lead to “Wegel Tena” and “Tenta” at the end of the “Ambasel” Mountain foot (Fig.1). Therefore, the origin of Beshilo is at the spot of the Old Bridge on “Terie” River and above the new bridge (319 m) built on Beshilo River itself. Beshilo River is 10 km, 26 km, 30 – 40 km and 75 km far away from “Gosh Meda” village, “Wegel Tena” town, “Tenta” town and “Dessie” town respectively.

In some literature it has been mentioned that the river originates near “Magdala” (“Makedela”) in the Amhara region, draining the Eastern portion of that region. However, the precise origin of the river is just as pointed out above in this study.
The new bridge (319 m long) built on Beshilo river joins the two districts “Tenta” and “Dilanta” and it is the first longest of all the bridges ever built in the country.

Beshilo River is very large river with a width of about 300 – 600 m. This varies from place to place along the length of the river.

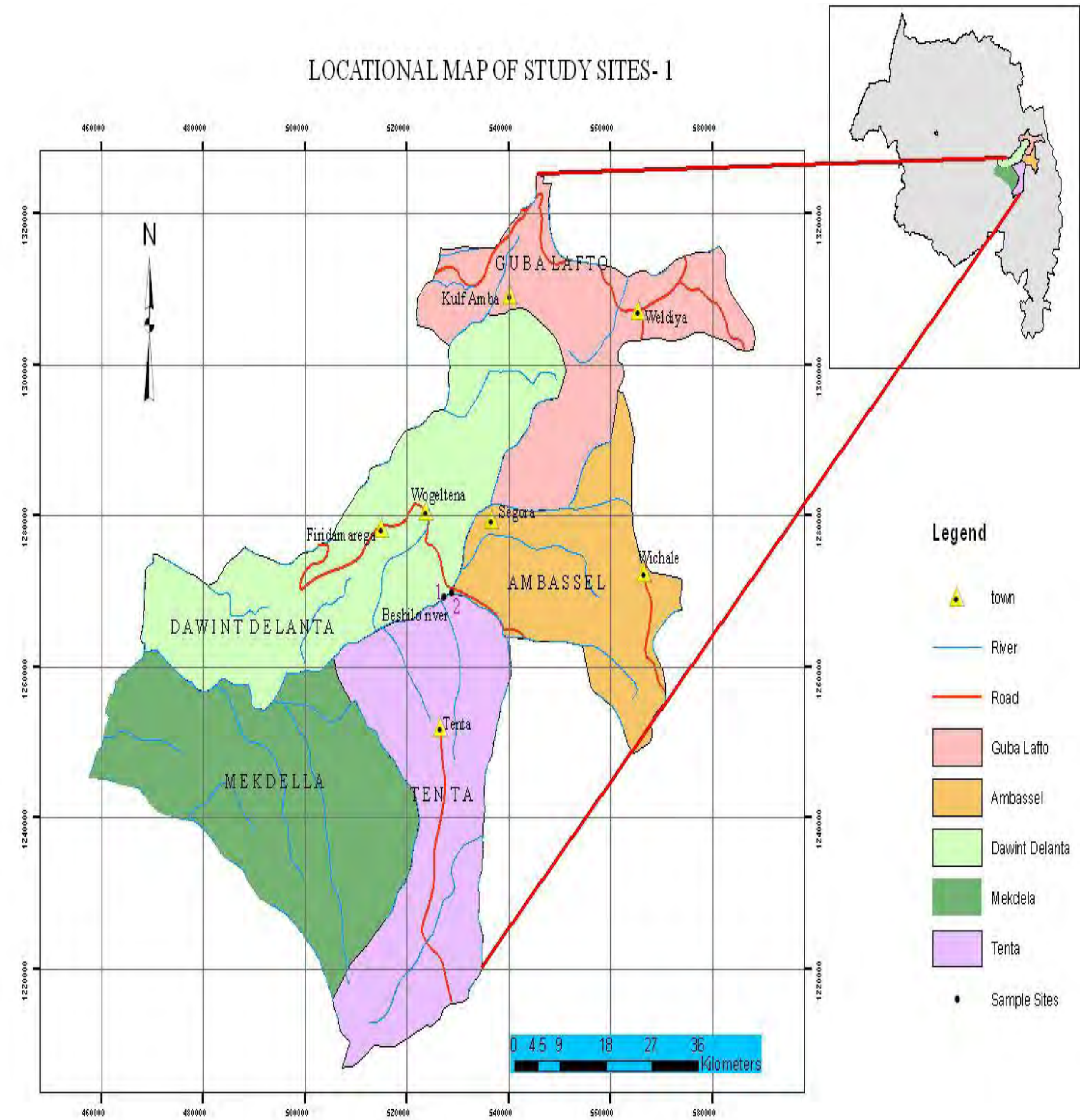


Fig. 1. Beshilo River location and sampling sites (1 and 2)

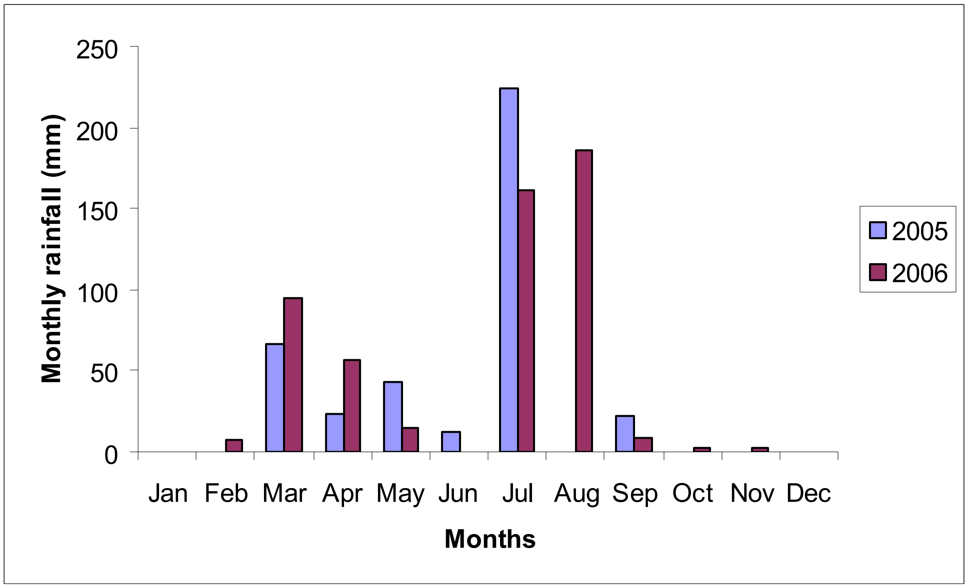


Fig. 2. Monthly rainfall (mm) of Goshmeda of Beshilo area (EMA, 2007)

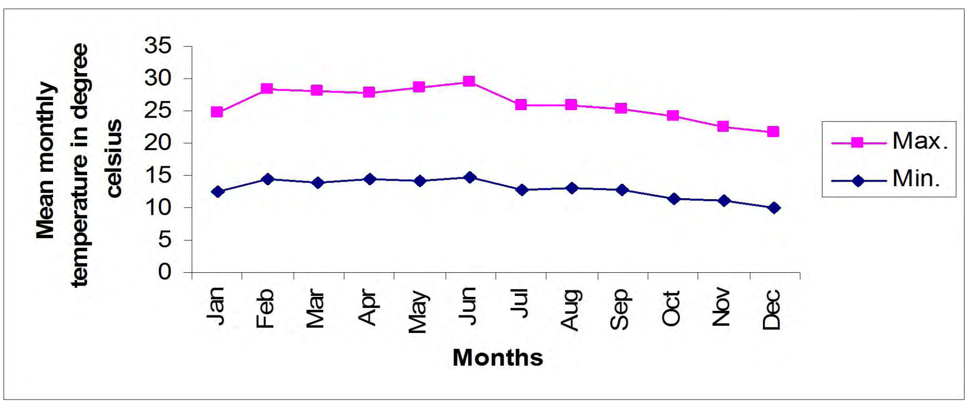


Fig. 3. Mean monthly temperature (°C) of Wegeltena station(EMA, 2007)

The river seems facing danger of water diversion for irrigation and farming along its banks. In May 2006 (pre-rainy season), the riverbanks were full of "Teff" and at the end of the rainy season in the beginning of November 2006/7 (dry season) these places were planted with green pepper and cotton. The riverbank was also used for growing various grains and vegetables (Fig.4). These exercises (diversion of water, canalizations of the river bank) and associated farming inputs (e.g. Chemicals; herbicides, pesticides, etc) would harm the fish health directly. These also destruct habitats of fishes in the river.

Fig.4. Ploughing of the riverbank of Beshilo River

4.1.1. Vegetation: the area is characterized with poor vegetation cover. The vegetation is patchy and some are situated at the riverbanks. The mountainous areas at both sides of the river are highly eroded and are almost bare. The sediment deposition and flood strength seems immense in the rainy season that all the site areas were covered with rocks, logs and silts. The area has the following flora: Tid (*Juniperus procera*), Tembelel (*Jasminum sp)*, Acacia (*Acacia tortilis; A. polyacantha*) Weira (*Oleana africana* sub.sp), Agam (*Carisa edulis*), Kega (*Rosa abyssinica*), Wanza (*Oliana africana*), Kitkita (*Dodonea viscosa), Warka (ficus vasta)* (Getaneh Belachew, 2006).

4.1.2. Fauna: the fauna in the area have not been well identified so far. Some of the most common birds which live in this area are: Abyssinian ground- hornbill, Fufted Guinea-fowl, Erckl's Francolin and Chestnut napped Francolin, Black breasted plover, Black winged plover, African pochard, Richard squa, Great white egret, Cattle Egret, Ruppel's long tailed Glossy starling, Hammer kop, Pied king fisher, Egyptian Goose, Black headed weaver, Red billed fire finch, Red eyed dove, African fish eagle, and King fisher.

Other animals that reside Beshilo River area are: Ape, Monkey, Klipspringer, Rock-Dassie, hyena, Crocodiles, Monitor lizards, different lizards and rodents.

The climate is classified as sub-humid with very wet and dry seasons. Distribution of rainfall is bimodal. Highest rainfall (mm) is from July to August ("Kremet" or "Meker") and the short rainy season ("Belg") is from March to May. The dry season lasts from October to January (Fig. 2).

4.2. Dura and Ardi Rivers

Dura and Ardi Rivers are found in Metekel zone or Agewawi Zone (formerly Metekel province), Guangua district. The town is 505 km far north–west from Addis Ababa. The distance from Chagni town to the study sites ranges from 2.5 (Dura River) to 17.5 km (Mentawuha i.e., junction of Ardi and Dura Rivers).

Dura and Ardi Rivers, originate from the high lands of Gojam (Agew Awi Zone). They are low order rivers. They get water from flood inflow during rainy season and some small springs. They lack flood plain up to their junction at Mentawuha. The river bed prevalently is rocky. Muddy and vegetated river bed is rare. They flow side by side separately towards the Chagni town. Ardi passes first at the town entrance site and again it leaves the town crossing it for the second time above the Chagni cattle development center. Dura and Ardi Rivers flow towards Southwest and remain parallel to each other for about 30 km before joining at the Southern end of the Chagni cattle development area (Fig.5).

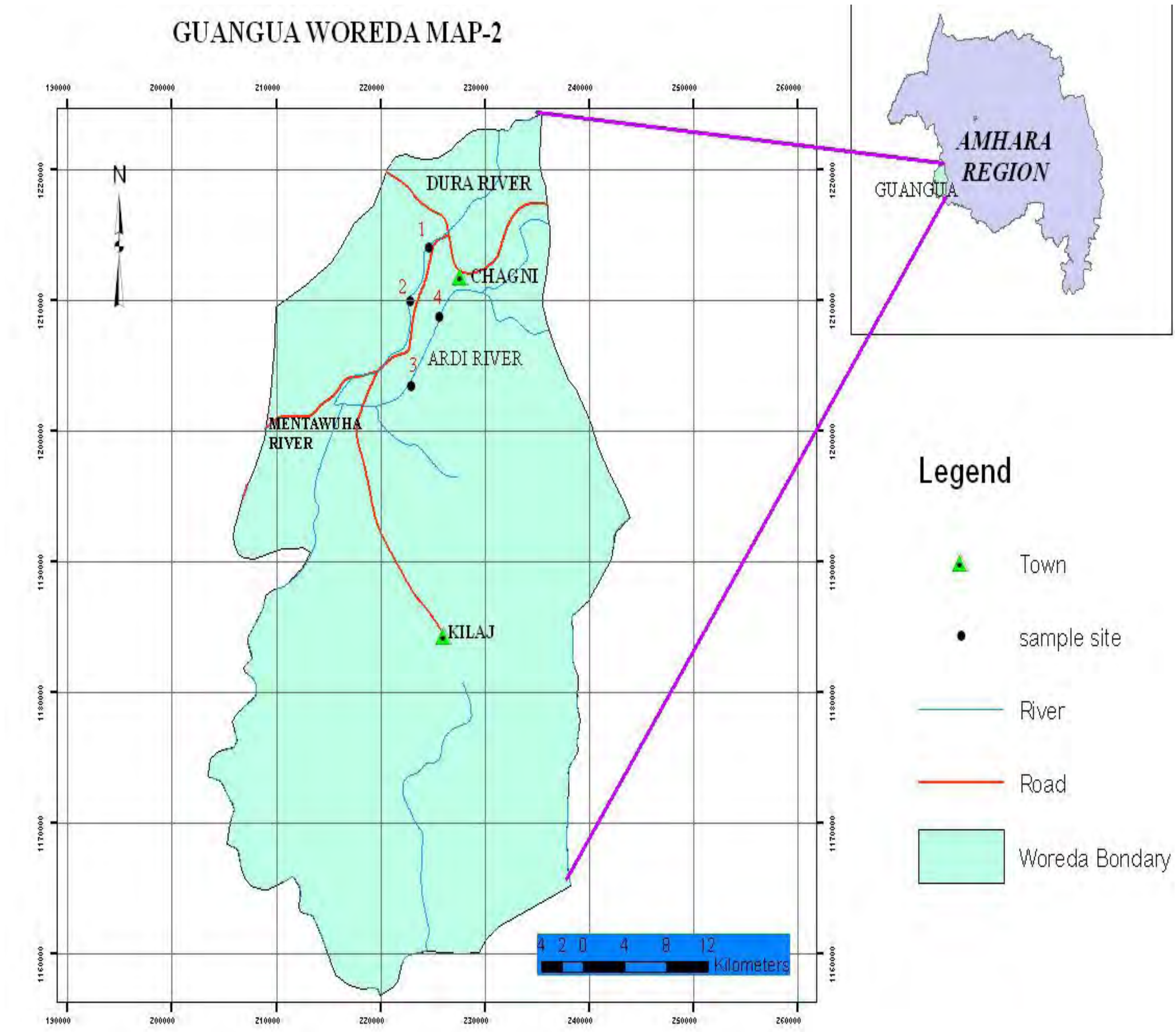


Fig.5. Dura and Ardi Rivers location in Amhara region, Guangua district and the sampling sites where fish specimens were collected.

Few natural springs are present that provide water resource to these rivers. Fishes such as *Garra* inhabit the springs that join Ardi River.

The two rivers are known by the bigger river name, Dura. The name Dura River stands for both the rivers after join at Mentawuha and until they reach the Blue Nile (Gilgel Abbay). Both rivers belong to the little Abbay (Blue Nile) basin (PDRE, 1988).

The climate can be classified as sub-humid, with very wet and very dry seasons. Rainfall distribution is bimodal, highest rainfall is from May to October [“Kremt” or “Meker”) and the short rainy season (“Belg”) is in February & April. The dry (“Bega”) season lasts from November to January (Fig.6).

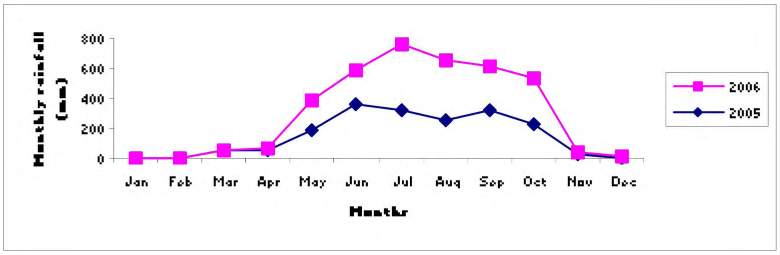


Fig. 6. Monthly rain fall (mm) of Chagni station in 2005 /6(EMA, 2007)

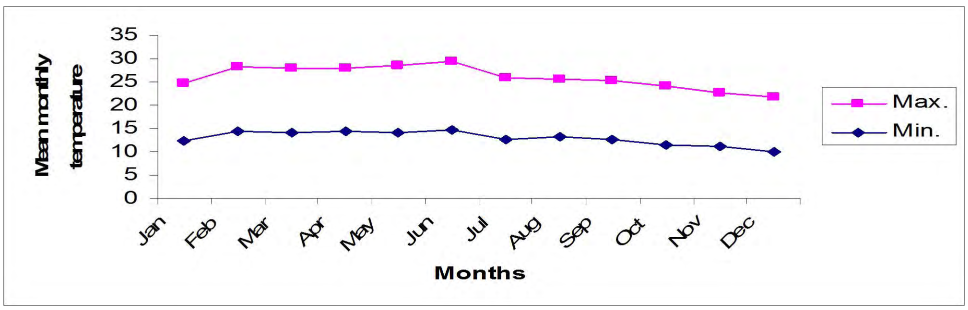


Fig. 7 Mean Monthly temperature (^{o}C) of Chagni in 2005 and 2006(EMA, 2007)

In May it was very difficult to collect gillnets from these rivers due to the heavy flood effect. The logs, leaves, root and seeds were trapped in the net that affected the fishing effort (Fig.8).

Fig. 8. The gillnet trapped leaves, logs, seeds, roots and very few fish specimens

The soil in the area is red, brownish red (lato soils) and dark brown derived from Basaltic rocks and have moderate drainage. The soil pH ranges from 5.2 to 6.1. (PDRE, 1988).

4.2.1. Vegetation: The riparian vegetation at the riversides is relatively better. Most of the riverside along the length of both rivers possess good vegetation cover. *Acacia abyssinica, Cordia africana, Syzgium guineense, Borasive aethiopium, Phoenix reclinata* and *Ceibia Pentandra* and *Dodonea viscosa* are common to the area. Vegetation on either side of the riverbank are mainly trees and some herbal plants. Some trees grow hanging their branches down to the water. The vegetation cover of Dura River bank is much better than Ardi River.

4.2.2. Fauna*:* Monitor lizards, frogs, Ape, and Abyssinian ground- hornbill, were prominent animals in the study area.

4.3. The physico-chemical characterstics of the rivers

The physico-chemical (abiotic) parameters of all sites on the three rivers were measured during all the sampling times. These measurements were taken three times (November, 2005, March and May, 2006) from Dura and Ardi rivers whereas two times (November and May, 2006) from Beshilo River. The water level of Ardi and Dura showed little variation from time to time. In November 2005 and May 2006, the water was very turbid. In May, the rivers were full of water and it was not easy to collect the gears set over night. River Beshilo was lightly turbid in May 2006. In November 2006, the water in this river was very clear. The water at this time was full of fish juveniles or (fingerlings). The fingerlings that were in the temporary pools and channels of the river became dead and were used as feast of birds when the floodwater subsides.

Dissolved oxygen content (mgl^{-1}) was measured (using Oxygen guard portable Probe), water transparency (Secchi depth) (using Secchi disc, pH (using pH meter) and conductivity (using conductivity meter).

4. 4. Fishing by local people [farmers or fishermen]

In all the rivers local fishermen practice fishing. They make use of several gears and traditional methods to catch fish. Mostly the fishermen utilize gillnets of various mesh sizes [4- 8 cm stretched], cast nets [4-5 cm mesh sizes], single hook and line, long stick and scoop net type sieve for capturing small sized fishes. All these gears are employed in

Ardi and Dura Rivers intensively whereas in Beshilo River the fishing practice is done using gillnets, cast nets and hooks. Besides, River fishing pressure is much less than the Dura and Ardi Rivers because there are few local farmers that practice fishing in limited times of the year only. This is because that they do not get gears from the nearby markets (local farmers per. comm.). There is no fish poisoning practice except the natural mass death of fishes at the beginning of flood in May. During this time the river gets water resources from its upper tributaries and becomes full. This rapid change of physical and chemical properties of water would have its own contribution to the effect happening every year. But this requires further study to justify. During this time inhabitants gather at the riversides to collect the fishes that float at the flood plain as well as in the river itself. After they collect them they dry the fishes using salt (local people. per. comm.).

In Ardi and Dura Rivers, some farmers divert water to the sides of the rivers for the fish to come. When they are sure the fishes are there, they release the water to the river. In the meantime, the scoop net type sieving at the mouth of the temporary channel captures the fishes. The fishermen collect some of the fishes that are left behind from the ground easily. The farmers also employ poisoning with the help of the seed powders of a plant called Birbira [*Milletia ferruginea*]. They use this unselective method every 2 or 3 or more years [fishermen. per. communication]. Farmers did this on Dura and Ardi Rivers and at the junction of both rivers one year before this study.

Some of the local fishermen who use this resource as part of their income oppose those who do poisoning. These local fishermen do fishing as part time work for two purposes:

- for household consumption, and
- for additional income [sale]

Even though intensive fishing takes place during fasting time in Dura and Ardi, the fishing activity begins at the early end of rainy season and continues until the beginning of the next rainy season. In Ardi and Dura Rivers it seems there is more number of local fishermen who use resources. It was very difficult to catch larger fish after November using larger mesh sized gears. It was only the monofilaments that could capture small sized fishes during the study time. Even the number of small sized fishes that were collected through out the study period was very small.

In this area some local farmers [part time fishermen] use *Garra sp.* and small *Barbus* for food in the form of stew ['wot'] and fish chips. To prepare Stew the fish are dried and crushed in small pieces in mortar and the meat flour is utilized as ingredient of the stew. These small fishes are fried and eaten as sweet dry fish chips [local farmers per. communication]

5. MATERIALS AND METHODS

5.1. SITE SELECTION

The site selection on the Dura and Ardi Rivers was done based on the information of local fishermen, the velocity and amount, the vegetation cover, the substratum and others. The selection was accomplished with the help of the advisor. The sites selected were two on each river. In Beshilo River, two sites were selected (Fig. 1) following similar criteria and procedures as mentioned above. The selected sites for the study are summarized in Table 1. The coordinates are taken by large and small Eagle view GPS.

Table 1. The study sites on Dura, Ardi and Beshilo Rivers

Site	Code	Distance between sites	Elevation (m)	Coordinate (GPS reading)
Ardi	A 1	A1– A2 (3.2 Km)	1617	N10º55″53.80′ E 36º 29″ 53.04′
	A2		1534	N 10º 53″ 22.98′ E 36 º 28″ 06.21′
Dura	D1	D1 – D2 (1.7 Km)	1604	N 01º 23.01″ E 36º 45″ 19.39′
	D2		1603	N 10º 56″ 40.82′ E36º30″35.50′
Beshilo	BS1	BS1 – BS2 (5 Km)	1661	N 11 º 28″ 27.78′ E 39 º 13″ 47.84′
	BS2		1638	N 11 º 27″ 17.61′ E 39 º 11″ 15.07′

5.2. SAMPLE COLLECTION

The fish samples were collected three times; November (2005), March and May (2006) from Dura and Ardi rivers and in May and November (2006) from Beshilo. The sample collection was done in the dry and wet seasons in all rivers. However, sampling was performed once for each season in Beshilo River while two times from Dura and Ardi in the dry season and once in the wet season.

Gillnets (6, 8, 10, 12 and 14 cm mesh size stretched) were used in November in Ardi and Dura Rivers. In March and May sampling, monofilaments of 4 and 5 cm mesh size and multiple ones were also employed. The gear setting and collecting time was from 3:40 – 6:00 p.m and 7: 00- 9: 20 a.m respectively. Weight, total length, fork length and standard length were measured to the nearest 0.1 gm and 0.1 cm respectively. Then some of the fish of the same form were preserved in 10 % formalin for fish species identification purposes. The preserved fishes were transported to the Addis Ababa University fisheries Laboratory in plastic jars. The rest of the fish were dissected and their gonad maturity examined. The matured gonad weight was measured to the nearest 0.1g. The eggs were preserved immediately in 5% formalin for further study.

5.2. LABORATORY WORK

5.2.1. Diversity of fish species

Before the fishes get transferred to 75 % pure alcohol preservative, the formalin was removed using tap water in the laboratory. Removal of formalin was done for several days. Then the fishes fixed in formalin were transferred to 75 % pure alcohol. Fish species identification was done using various keys (Boulenger volume I –IV (1909,1911,1915 and 1916), Abebe Getahun, 2000; Golubstov *et al*., 1995; Shibru Tedla, 1973; Bishai and Khalil, 1997; Eschmeyer, 1998, 2007; Trewavas, 1983; and Skelton, 1993). The color of the fishes was described from both fresh specimen and preserved ones. Morphometric and meristic characters were taken mostly from preserved specimens.

Shannon index (H’) was utilized to evaluate species diversity of fishes in each river. The Shannon diversity index (H’) is a measure of the number of species weighted by their relative abundances (Begon *et at.*1990). The index can express both the relative abundance and variety of species (Naesje *et al.*, 2004). The H' was computed as:

H' = - Σ pi ln pi, where pi is the proportion of individuals found in the i^{th} species. Shannon's diversity index (H') was used to point out diversity at different rivers. A high value designates high species diversity. Significance of differences in species diversity and relative abundance between rives was tested using ANOVA test.

5.2.2. Description of fish species

External morphological, morphometric and meristic data were used in species diagnosis. Measurements were made using a digital caliper and flexible transparent plastic ruler to the nearest 0.1 mm and 0.1 cm respectively; specimens representing different size groups were selected and measured for description of species. The principal dimensions used for describing a fish were as follows: **Total length** was measured from the end of the snout to end of the longest rays of the caudal fin; **Fork length** was measured from the tip of the snout to the end of the middle ray of the caudal fin; **Standard length** was measured from the tip of the snout to the origin of the central caudal rays, excluding the fin itself; **Head length** was measured from snout tip to posterior edge of gill cover; **Depth of body** was measured where depth is greatest. **Caudal peduncle dept**h was measured where dorsoventral dimension of the caudal peduncle is minimum. **Caudal peduncle length** was measured as the distance from the base of the last ray of the anal fin to the origin of the central caudal rays (Jubb, 1967; Skelton, 1993). Scales are characteristic features of most fishes although catfish has no scale (Crass, 1963). The most useful scales counted for identification of fishes were lateral line scales, round the caudal peduncle scales, scales between lateral line and center of belly, scales between lateral line and the origin of the dorsal and scales between lateral line and origin of ventral fins. The lateral line scales were counted from base of the caudal fin, excluding scales that cover the base of the caudal rays, forward to the upper edge of the gill opening. Caudal peduncle scales were counted as the number of rows round the narrowest part of the peduncle. Scales between lateral line and the origin of the dorsal, origin of ventral fins, and the center of the belly were counted in a transverse line (refer to the figure below).

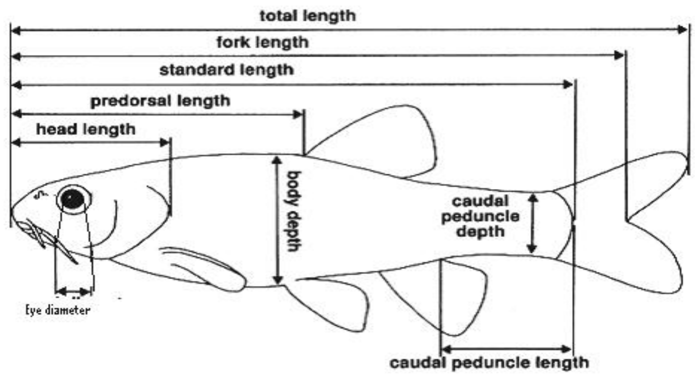


Fig.9 Morphometric measurements of fish (Source: Skelton, 1993)

5.2.3. Relative abundance

An index of relative importance (IRI) was used to evaluate relative importance (abundance) of fishes in each river. Relative abundance estimation of fishes in Rivers Dura, Ardi and Beshilo was accomplished by making use of the contribution in number and weight of each species in the total catch in each sampling effort.

An index of relative importance is a measure of the relative abundance or commonness on the basis of number and weight of individuals, as well as their frequency of occurrence (Kolding, 1989; 1999). It was used to find the most important species in terms of number, weight and frequency of occurrence in catches from the different sampling localities. The index of relative importance gives better representation of the ecological importance of species rather than the weight, numbers or frequency of occurrence alone (Sanyanga, 1996). Index of relative importance (% IRI) was computed as:

$$\%\,IRI_i = \frac{(\%W_i + \%\,N_i)*\,F*100}{\Sigma\,(\%\,W_j + \%\,N_j)*\,\%\,F_j}$$

Where **j** = 1 to **S**, **% W**$_i$, percentage weight, **% N** $_i$, percentage number of each species (**i**) in the total catch ; **% F**$_i$ is percentage of frequencies of occurrence of each species in total number of settings , and **S** is total number of species . High value of this index shows the most important species.

5.2.4. Length – weight relationship

The relationship between total length and total weight of most dominant species was calculated using the power functions as in Bagenal and Tesch (1978) as follows:

$$\mathbf{TW = a \; X \; T \; L^b}$$

Where TW = Total weight (gm), TL = Total length (cm), a = Intercept of the regression line and b = Slope of the regression line.

5.2.5. Fulton Condition factor (FCF) of dominant fishes

The well being of the most dominant species was determined using Fulton Condition Factor (FCF) by the following formula suggested by Bagenal and Tech (1978):

$$\mathbf{FCF = \frac{TW\ 100}{TL^3}}$$

Where, TW = Total weight, TL = Total length, FCF = Fulton condition factor.

5.2.6. Sex ratio of dominant fishes

Sex ratio was determined using the following formula for the dominant fishes

$$\text{Sex ratio} = \frac{\text{Number of females}}{\text{Number of males}}$$

5.2.7. Fecundity of fish

The eggs preserved in 5% formalin were counted using Gravimetric method. It was calculated for the species *Varicorhinus beso, and Labeobarbus intermedius* of the Dura and Ardi Rivers. One gram of the egg was measured from the total lot using the Sartorius sensitive balance. After the number of eggs in one gram in three replicate counts and the average has been known, the total eggs in the lot were extrapolated. The fish sampled at their peak maturity time were very few.

After calculating the relative fecundity by dividing the number of eggs per fish by its total body weight, the relationships of fecundity to some morphometric measurements were determined.

This was done by relating fecundity to total length, total weight and ovary (gonad) weight as in Demeke Admassu (1994) using the following formulae: -

$$F = a \times TL^b$$

$$F = a \times TW^b$$

$$F = a \times bGW$$

Where F = Fecundity, TL = Total Length (cm), TW = Total Weight (gm) , GW = Gonad Weight (gm), a = constant and b = exponent

5.3. Maturity at L_{50}

The average length at first maturity (FL or TL_{50}) is the mean length at which 50 % of all individuals of a fish species become sexually mature (Willoughby and Tweddle, 1978). L_{50} was determined for females and males. Eggs in stage III and above were considered as mature. The relationship between the percentage of mature fish (P) per length class and length (FL) was described with a logistic curve: a is intercept, and b is slope of the logistic regression: $P_i = \dfrac{e^{a + b \, FL \text{ or } TL}}{1 + e^{a + b \, F \text{ or} TL}}$ where Pi = estimated proportion of mature fish, FL = total fork length (cm), 'a 'and 'b' = coeffient of regression. The L_{50} was then estimated by:

$$FL = \frac{a}{-b}$$

5.4. Data analysis

PASGEAR II and MINITAB (version 14) were used to perform the calculations and statistical analysis.

6. RESULTS

6.1. The abiotic (physico –chemical) parameters of the rivers

Environmental parameters such as transparency, dissolved oxygen, pH, Secchi depth, water depth and conductivity were compared among the rivers. There was no significant difference ($P > 0.05$) among the rivers.

Table 2. The physico- chemical parameters of Beshilo (BS 1 and BS 2), Dura 1and 2 (D 1 and D 2) and Ardi 1 and 2 (A 1 and A 2) with their mean ± SD.

River	O_2 (mgl^{-1})	Cond. ($\mu S.cm^{-1}$)	Secchi (cm)	pH
Dura **1**	5.62 ± 3.62	135 .40 ± 81.89	34.75 ± 43 .98	8.05 ± 0 .39
Dura **2**	6.75 ± 0.92	154.35 ± 73 .90	93.75 ± 48 .54	8.05 ± 0.59
Ardi **1**	6.10 ± 1.52	96 .53 ± 21.74	40.50 ± 33.48	7.93 ± 0.66
Ardi **2**	7.03 ± 0.38	66.90 ± 49.88	22.50 ± 38.35	8.22 ± 0.29
Beshilo **1**	4.40 ± 0.48	415 ± 48.08	2.95 ± 2.9	8.31 ± 0.13
Beshilo **2**	4.86 ± 0.71	389.5 ± 13.44	10 ± 2.83	8.96 ± 0.13

Table 3. Pair wise comparison of abiotic parameters (Oxygen, Conductivity, Secchi, and pH) between sampling sites.

Sites	Parameters	Dura 2	Ardi 1	Ardi 2	Beshilo1	Beshilo 2
Dura 1	0xygen	0.517	0.836	0.639	0.593	0.796
	Secchi	0.597	0.438	0.357	0.308	0.382
	Conductivity	0.485	1.00	0.925	0.038*	0.042*
	pH	0.664	0.978	0.246	0.277	0.037*
Dura 2	0xygen		0.497	0.716	0.009*	0.058
	Secchi		0.422	0.247	0.159	0.196
	Conductivity		0.469	0.508	0.002*	0.001*
	pH		0.711	0.512	0.618	0.088
Ardi 1	0xygen			0.691	0.134	0.365
	Secchi			0.318	0.239	0.308
	Conductivity			0.506	0.002*	0.001*
	pH			0.453	0.553	0.179
Ardi 2	0xygen				0.008*	0.063
	Secchi				0.433	0.511
	Conductivity				0.024*	0.018*
	pH				0.760	0.130
Beshilo 1	0xygen					0.447
	Secchi					0.545
	Conductivity					0.133
	pH					0.036*

* Significant ($P < 0.05$)

Minimum dissolved oxygen (4.40 ± 0.48) and maximum conductivity (415 ± 48.08) were observed in Beshilo 1. The maximum dissolved oxygen (7 .03 ± 0.38) and minimum conductivity (66.90 ± 48.08) were recorded in Ardi 2. Beshilo 2 had maximum pH value (8.96 ± 0.13). There has been a considerable variation in conductivity between Beshilo River and the other two rivers (Ardi and Dura) ($p < 0.05$) (Table 3).

Beshilo 1 was inhabited by *O. niloticus*, *C. gariepinus* and *Bagrus bajad* fishes that are resistant to oxygen deficiency.

6.2. Fish species diversity in Beshilo, Dura, and Ardi Rivers

A total of 17 fish species were identified in this study. The number of fish species identified was listed in Table 4. Fishes are grouped in five families (Bagridae, Claridae Cichlidae, Cyprinidae and Mochokidae,), three orders (Cypriniformes, Perciformes, and Siluriformes). The family Cyprinidae was the most dominant with eleven species that comprises (62.5%) the total number of species.

The Shannon diversity index (H') calculated for fishes of Beshilo, Ardi and Dura Rivers was observed in Table 4. This index value indicated that the species diversity was highest in Beshilo River and lowest in Dura River.

Table 4. Shannon diversity indices of fish species in the three rivers

River	Beshilo	Ardi	Dura
N	13	7	5
H'	1.65	1.59	1.12

Table 5. Fish species identified from the study sites of Beshilo, Dura, and Ardi Rivers (X - present: Shaded- absent). Ardi 1 (A1), Ardi 2 (A 2), Dura 1 (D 1), Dura 2 (D 2), and Beshilo 1 (BS 1), Beshilo 2 (BS 2).

Fish species	A 1	A 2	D 1	D 2	BS 1	BS 2
Varicorhinu beso	X	X	X	X	X	X
Varicorhinus sp.						X
Labeobarbus nedgia	X	X		X	X	X
Labeobarbus intermedius	X	X		X	X	X
Labeobarbus degeni					X	X
Barbus humilis	X	X				
Barbus paludinosus	X	X				
Garra demebecha	X	X	X			
Garra dembeensis	X	X				
Labeo forskalii					X	X
Raiamas loati					X	X
Oreochromis niloticus					X	
Bagrus docmak					X	
Bagrus bajad					X	X
Hetrobranchus longifilis					X	X
Clarias gariepinus					X	X
Synodontis schall					X	
Total	**7**	**7**	**2**	**3**	**12**	**10**

Table 6. Fish species of Dura, Ardi and Beshilo Rivers

Order	Family	Species	Common name
Cypriniformes	Cyprinidae	*Labeo forskalii* (Rüpell, 1836)	Dome
		Varicorhinus beso (Rüpell, 1836)	Bezo
		Varicorhinus. sp.	
		Barbus nedgia (Rüpell, 1836)	Tsani
		Barbus degeni (Boulenger, 1901)	Birkirkit or nechassa
		Barbus intermedius (Rüpell, 1835)	
		Barbus humilis (Boulenger, 1902*)*	
		Barbus paludinosus (Peters ,1852)	
		Garra dembecha (Getahun and Stiassny, 2007)	Lumbi
		*Garra dembeensis (*Rüpell, 1836*)*	
		Raiamas loati (Boulenger, 1901)	
Siluriformes (Cat fishes)	Clariidae	*Hetrobaranhcus longifilis* (Valenciennes, 1840)	
		Clarias gariepinus (Burchell, 1822)	Ambaza
	Bagridae	*Bagrus docmak* (Forsskal, 1775)	
		Bagrus bajad (Forsskåll 1775))	
	Mochokidae	*Synodontis schall* Bloch & Schneider, 1801	
Perciformes	*Cichlidae*	*Oreochromis niloticus* (Forsskåll, 1775)	"Yeahyaassa" (Beshilo)

6.2.1. Fishes species description

I. *Varicorhinus beso* Rüppell, 1836

A

B

Fig.10. Lateral view of **A**.) *Varicorhinus beso* (Beshilo) and **B)** *Varicorhinus sp*. (Beshilo)

IA) Diagnosis: - The species has large keratinized tubercles on its snout. It has very much-developed labial fold forming sucker around the mouth. It has non-protractile, inferior mouth. Lower lip absent, replaced by sharp horny scraping border.

Description: - Body more or less compressed; its depth 28.13 to 32.73 % in SL. Snout is swollen with a distinct curved transverse groove above, its length longer than length of head. Lips strongly developed. A minute barbel concealed under folds of skin in the corner of mouth. Horny tubercles on the snout much developed in adult, more so in males than in females. Eye supero-lateral, its diameter 16. to 19.51 % in HL. It has wide mouth and its width 43 to 56 % in HL. Interorbital region is convex, its width 45.65 to 49.09 % in HL. Dorsal IV 10 (rarely 9) rays, upper edge concave. Its insertion little in advance of ventral. Longest rays of dorsal considerably exceeding length of head. Anal III 5 (rarely 6) rays, shorter than head length. Pectoral and pelvic fines nearly as long as head length. Caudal peduncle length as long as depth, it is forked. Scales 30-35. Total length 37.5 cm.

Coloration: - Dark olive above and on the sides and its caudal fin, slightly red on the lower part of pelvic fin, white beneath, grey on the edge of scales.

Distribution*:* Widely distributed in Ethiopian freshwaters.

IB) Diagnosis: It has very large keratinized tubercles on its snout and there are small tubercles that appear on its operculum and head. It possesses tubercles on anal branched fins in rows. Mouth inferior, lower lip absent, replaced by sharp horny scraping border.

Description: Body slightly cylindrical, its depth 26.41 % in SL. Snout is swollen, shorter than head length, its length 35.58 % in HL. One pair of barbels appears at the corners of its mouth, its length 21.32 % in HL and 61.04 % in OD respectively. Horny very large sized tubercles appear on its snout, it has some tubercles on its operculum and head, the tubercles also appears on the branched anal fins in rows. The number of the tubercles on the snout ranges from 56- 75 and the average size of the big tubercles in the examined specimen (Beshilo) was 1.5 mm. Diameter of eye 89.25 % in HL and its length 55.83 % in HL. It has relatively wide mouth, its width 6.52 % in HL and 1.24 % in SL. Interorbital region is convex, its width 40.02 % in HL and 9.67 % in SL. Dorsal IV, 10 rays, upper edge concave, its insertion is little in advance of vent. Head length is longer than the longest ray of dorsal.

Anal III, 5 rays, shorter than head length. Pectoral and pelvic fins nearly as long as head length. Caudal length is slightly longer than its depth. Caudal peduncle forked. Caudal peduncle scale rows 12. Lateral line scales 31. Scales from dorsal fin root to lateral line 6.5, from lateral line to belly 5.5, from lateral line to anal 3.5. Total length 22.6 cm.

Color: Dark olive.

Distribution: Beshilo River

II. *Labeo forskalii* (Rüpell, 1836)

Fig.11. Lateral view of *L. forskalii*

Diagnosis: -This species is distinguished from other species of the genus by the following characters: Labial folds well-developed forming sucker around the mouth, rostral flap large and horny tubercles on the snout

Description: - Body more or less compressed, its depth 24.84 to 26 .32 % SL. Snout is swollen with a distinct curved transverse groove above, its length 30.56 to 44.44 % HL. Lips strongly developed. Lower lip expanded and bordered in front by a fringe of papillae. Rostral flap large completely detached at the sides, its edge distinctly festooned. A minute barbel concealed under folds of skin in the corner of mouth. Horny tubercles on the snout much developed in adult, more so in males than in females. Dorsal IV 10 (rarely 9) rays, upper edge concave. Anal III 5 rays, shorter than head length. Pectoral (19.74 to 23.33 % of SL) and pelvic (14.38 to 19.33 % in SL) fins nearly as long as head length (18.42 to 24. 66 % in SL). Caudal peduncle length as long as depth. Scales 39 - 41, 16 - 20 round caudal peduncle. Total length up to 44 cm.

Coloration: - Dark olive above and on the sides, white beneath.

Distribution: - Blue Nile, Dabus, Angereb, Sanja, Tekeze, Omo, Gendewuha, Guang (Atbara), Ayima (Dinder) and Gibe Rivers.

III. *Synodontis schall* Bloch & Schneider, 1801

Fig.12. Lateral view of *Synodontis schall*

Diagnosis: - Spine of dorsal fin not serrated in front. Skin more or less distinctly villose on sides. Maxillary barbel is not broadly margined. Humeral process pointed, with out spine. Movable mandibular teeth, 28 to 32 in number.

Description: - Depth of body 31.30 % SL. Head a little broader than its depth. Snout is rounded and longer than post ocular part of head. Eye supero-lateral, 22.22 % in HL. Lips moderately developed. Band of premaxillary teeth not extending along the whole width of the mouth. Premaxillary teeth forming a short and broad teeth band.

Maxillary barbel with a narrow marginal membrane at base, reaching between base and posterior fifth of pectoral spine. Outer mandibular barbel about twice as long as inner, former with long slender branches. Like *S. serratus*, maxillary barbel not branched; gill-openings not extending down wards beyond root of pectoral spine. Occipito-nuchal shield rough like the occiput, with posterior processes pointed or truncate. Humeral process is longer than broad, very obtusely keeled, extending as far back as occipito-nuchal process.

Dorsal I 7 and anal III 8 rays. Dorsal spine sharp-edged and feebly serrated behind. Adipose dorsal length (6.5) is longer than depth (4. 8). Pectoral spine is longer than dorsal spine, its outer border very finely and inner border strongly serrated. Caudal deeply forked. Caudal peduncle length is longer than depth. Total length up 31.5 cm.

Coloration: - Grey, brown, or olive above; white beneath

IV. *Labeobarbus nedgia* Rüppell, 1836

Fig. 13 A**.** Lateral view of *L. nedgia*

Curled upper lip

Fig.13 B**.** Highly developed fleshy lower lip and the upper lip

Diagnosis: - *L. nedgia* is mainly distinguished by its highly developed lips with fleshy lobe of lower lip and large flaps of the upper lip. It has fleshy nose that curls back over the nose.

Description: - Mouth inferior, protractile, with a large upper jaw extension. Lower with a well-developed median lobe relatively short 2 pairs of circum-oral barbels present. The anterior barbell 7.36 % in SL and posterior 4.24 % in SL. Eyes are relatively small (diameter 13-18.18 % in HL). Head length is nearly equal to body depth. It has relatively short snout (its length is about 33.33 – 36.36 % in HL). Dorsal IV 9 (rarely 8); upper edge concave. Last simple ray very strong and not serrated, its length 23.58 % in SL. Its insertion is little in advance of ventral fin. Body covered with cycloid scales, 30-32 in the lateral line. Scales longitudinally striated. Caudal fin forked. Total length 55 cm.

Coloration: specimens'color variable, most of them is light yellowish. Other very common colors observed are brownish, olive-green and golden above and flanks. Preserved specimens have a bit dark dorsum and flanks, white beneath.

Distribution: Lake Tana (endemic, Nagelkerke, 1997). It was collected in Akaki and Gota, Beshilo River (2006), Beles River, Angereb and Sanja Rivers (Genanaw Tesfaye, 2006)

V. *Labeobarbus intermedius* Banister, 1973

Fig.14A**.** Lateral view of *L. intermedius*

Description: Head naked, variable in dorsal profile. Mouth inferior, lower lip is continuous with median lobe and discontinuous (interrupted) with no median lobe. Eyes small, about 14.15-20.83 % in head length. Barbels small, 2 pairs on the upper jaw only. Anterior barbel length 10.64-24 % % and posterior 15.87-31.25 % in HL. No teeth on the jaws (basic characteristics of cyprinids). Body variable in shape, covered with cycloid scales. Body depth is greater than length of head, its depth 23.20-33.14 % in SL. Dorsal usually IV 9 rays (very rarely, 8 and 10), border concave. The last simple dorsal ray is very strong and not serrated, its length 18.13-27.22 in SL. Anal III 5 rays, often reaching caudal. Caudal peduncle length is longer than deep (15-38.28 % > 11.2-14.28 % in SL). Scales longitudinally striated, 30-33, 10-12 round caudal peduncle.

Total length up to 55.5 cm

Some variations in the external morphology of the morphotyes:

Dorsal head profile: - 3 different profiles have been observed: straight, concave and convex

B

C

D

Fig. 14 B, C and D**,** dorsal head profiles of *L. intermedius*

Coloration: - Fresh specimens show extremely variable color but the most common color observed was light yellow and olive, slightly pelvic and pectoral fins reddish color, in some the fringe of caudal fin also has reddish color.

Distribution: - The species is widely distributed in Ethiopian fresh waters.

VI. *Oreochromis niloticus* (Linnaeus, 1757)

Fig.15 Lateral view of *O. niloticus* (Beshilo River)

Diagnosis: The species has single dorsal fin with many spines. Lateral line divided into upper and lower sections, with 31-34 scales. Only one nostril on each side of the snout. Faint traces of 8 dark vertical bars on the flanks and the caudal peduncle.

Description: Head naked, its length 30.95-32.56 % in SL. Snout rounded, straight or slightly convex, its length is 20.93-29.23 % in HL. Mouth moderately large and terminal, its width 26.32-30.95 % in SL. Outer jaw contains several teeth in 4 series rows. Eyes visible from the dorsal only (supero-lateral), its diameter 16.28-17.78 % in HL. Body somewhat compressed laterally. Caudal peduncle depth equal to length (CD =12.66 % and CDL = 13.05 % in SL). Scales cycloid. Lateral line interrupted. Dorsal with XVI-XVII 11-12; its length 30.95- 77.86 % in SL anal III 8-10 rays. Pectoral fin length 31.43- 39.07 % in SL.

Gill rakers on upper part of anterior arch are short and they ranged from 24 to 25.

Total length 30 cm

Coloration: Dark grayish color or dark olive above.

Distribution : Widely distributed in Ethiopian freshwaters.

VII. *Raiamas loati* Boulenger, 1901

Fig.16 Lateral view of *Raiamas loati* (Beshilo River)

Diagnosis: - The best characterstics that distinguish this species are the presence of 10-16 distinct bluish – black vertical bars on both sides of the body. No barbels, 52- 58 lateral line scales.

Description: Depth of body is less than length of head (depth 27.88-29.79 % in SL). Snout pointed and projected beyond mouth, its length 24.53-28.57 % in HL, its interorbital length, 31.11- 37.74 % in HL. Very small round tubercles appear on the nose and lower lip. They are dense on the front part of the head. They occur on ventral, pelvic and pectoral fins; denser on ventral spines. It has big eye with diameter 10-13.33 % in HL. Dorsal III 9 rays, its insertion is before vent. It is not strongly ossified. Anal III 14-15 rays notched and produce a convex anterior lobe. Pectoral fin pointed, its length 16.23-17.45 % SL. Caudal deeply forked. Caudal peduncle length is longer than its depth. Scales with radiating striae, lateral line scales 52-58, 12 – 16 caudal peduncle.

Total length up to 22 cm (Beshilo River).

Coloration: Slightly silvery- yellowish, pectoral fin yellowish, anal fin fringes pinkish.

Distribution: Tekeze, Guang, Gendewuha, Omo, Beles (Babizenda sites), Beshilo Rivers.

VIII. ***Hetrobranchus longifilis* Valenciennes, 1840**

Fig.17. Lateral view of *H. longifilis* (Beshilo River)

Diagnosis: The species has two dorsal fins; the first rayed and the second adipose. Adipose fin is shorter than dorsal ray. Dorsal 31-34 and anal 45-48 rays, anal fin and adipose dorsal fin are lengthened to the base of the caudal fin.

Description: Depth of body is less than length of head (depth 15.15- 15.66 % in SL). Head slightly depressed and its upper surface coarsely granulated. It has wide head (width, 34.74-401.91 % in HL) and small eyes (7.37-8.19 in HL). It has broader interorbital width (63.16-70.91 % in HL). Mouth width is a little less than interorbital width (MW = 45.45- 47.37 % > IOL = 63.16-70.91 % in HL). Maxillary, outer mandibular and inner mandibular barbels are found around the mouth. Maxillary barbel extends to the end of pectoral fins, its length 34.74-40 % in HL. Nasal barbel length is much greater than head length; its length 93.64-97.89 % in HL. The species has villiform teeth, occurring in band. It has short, 24–25 gill rakers in the lower part of anterior arc. Body somewhat elongated and non-scaled. Adipose fin originates immediately behind the dorsal fin and extends to the base of caudal fin. Pectoral fin short, (15 – 15.66 % of HL), its spine serrated on the outer border.

Total length up to 98 cm (Beshilo River).

Coloration: Mostly olive above, and creamy white beneath.

Distribution: Gambella region (Baro-Akobo basin), Sanja, Beles, Angereb, Beshilo Rivers.

IX. *Clarias gariepinus* Burchell, 1822

Fig.18**.** Lateral views of *C. gariepinus* (Beshilo River).

Diagnosis: - *C. gariepinus* has non-scaled skin. Head is highly flattened dorso-ventrally. It is easily distinguished by the lack of adipose fin. Dorsal 60 – 71.5 and anal 48 – 52 rays.
Description: Depth of body 15- 19.28 5 in SL. The mouth is quite large and sub-terminal in position. Four pairs (nasal, maxillary, outer mandibular and inner mandibular) of barbells are found around the mouth. The longest of these are outer mandibular barbels. Eye very small, 6.23 to 8.14 % of HL. It has wide interorbital width, 49.52 to 53.53 % of HL. Vomerine teeth forming a crescentic band, which slightly interrupted in the middle. Vomerine teeth band is wider than premaxillary teeth band. Maxillary barbel is much longer than head, reaching base of pectoral spine. Outer mandibular barbel is longer than inner, 78 to 94.58 % of HL. Total length 64 cm.
Distribution: Widely distributed in Most Ethiopian freshwaters.

X. ***Bagrus docmak* Forsskåll, 1775**

Fig.19. Lateral view of *B. docmak* Beshilo River

Diagnosis: **-** Body slightly elongated. Last ray in advance of vertical of inner rays of ventral. Maxillary barbels do not reach extremities of ventral fin.

Description: **-** Depth of body 24.86 to 26.47 % in SL. Head length is a little greater than body depth, it is much depressed and smooth above; occipital process long and narrow. Snout broadly rounded and projected beyond the lower jaw, 17 - 20 % HL. Eye small, 9-11.11 % in HL. Wide mouth, 55 -60 % HL. Premaxillary teeth band nearly as broad as vomerine teeth. Outer maxillary barbel length is much longer than head length. Outer mandibular barbel length is less than head length. Gill-rakers are long and widely set 10 - 11 on lower part of anterior arch (present study 9). Dorsal I 9 rays; spine relatively smooth. Anal II 8 or 9 rays. Pectoral about 14.86-16.47 % in SL, its spine relatively smooth and weakly serrated on inner side. Caudal deeply forked. Caudal peduncle length is longer than deep. Total length up to 45.6 cm (Beshilo River)

Coloration: - Grayish blue to dark olive above, white beneath.

Distribution: - Guang, Omo, Sanja, Angerb, Ayima, Beles, and Beshilo Rivers.

XI. Bagrus bajad Forsskåll, 1775

Fig. 20. Lateral view of *B. bajad.*

Diagnosis: **-**Last ray behind vertical of inner rays of ventral. Maxillary barbel reaching extremities of ventral fine.

Description: **-** Body depth 78.74 to 94.44 % in SL. Head much depressed and smooth above; occipital process long and narrow. Snout broadly rounded projecting beyond the lower lip, 13.33 to 16.88 % in HL. Eye small 7.79 % to 11.11 % in HL. Wide mouth 48 to 59.05 % in HL. Premaxillary teeth band is broader than vomerine teeth. Outer maxillary barbel is much longer than head length. Outer mandibular barbel length is less than head length. Gill-rakers are long and widely set 10- 13 on lower part of anterior arch. Dorsal I 9 (rarely 10) rays, its spine moderately strong. Last ray of dorsal found behind vertical of inner ray of ventral; anterior soft rays produced into filaments and the upper longer and pointed. Anal II 11-12 (rarely 8) rays. Pectoral about 3.70 to 4.91 % in SL, its spine relatively strong and weakly serrated on inner side. Caudal deeply forked. Caudal peduncle length is longer than deep. Total length up to 68 cm.

Coloration: - Olive dark brown above, white beneath, black dots appear on the caudal fin and below the caudal fin.

Distribution: - Guang, Omo and Angereb ,Beles and Beshilo Rivers; Lake Abaya,

XII. ***Labeobarbus degeni*** **(Boulenger, 1901)**

Fig. 21 Lateral view of *Labeobarbus degeni*

A.  B. 

The snout extends beyond the mouth

Fig. 21(A and B) Lateral and ventral view of mouthpart of *Labebarbus degeni*

Diagnosis: **-** Lips strongly developed, lower produced into a rounded median lobe and it is more elongated than wide. Snout produced into a triangular dermal flap over hanging the lip.

Description: **-** Depth of the body 31 to 35.20% SL. Snout produced into a triangular dermal flap over hanging the lip, 29.00 to 42 % in HL. Mouth inferior, its width 28.3 to 34.10 % in HL. Lips very strongly developed, lower produced into a rounded median lobe. Two barbells each side, anterior barbell 18.16 to 24.71 % in HL and posterior 20.15 to 28.88 % of HL. Dorsal IV 9 rays, border concave. Last simple ray is very strong and not serrated, 20.51 to 21.54% in SL. Anal III 5 rays, nearly reaching caudal. Caudal peduncle length is longer than depth. Scales longitudinally striated, 30 - 33, 12 - 14 round caudal peduncle. Total length up to 48.5 cm.

Coloration: - Dark yellowish green; fins steel-gray, pelvic and pectoral fins slightly blackish.

Distribution: **-** Lake Tana, Sanja , Angereb, Beshilo , Kassam and Beles Rivers.

XIII. *Barbus humilis* Boulenger, 1902

Fig. 22. Lateral view of *B. humilis* (Ardi River)

Diagnosis: Body depressed, small terminal mouth, non-serrated dorsal spine, dark spots on its lateral line near to the caudal fin starting below the dorsal fin insertion. They are small in size.

Description: Body depth 18.92-26.57 % in SL, length of head 20.87-27.21 % in SL. Snout round, shorter than eye, which is 15.65-23.45 % in HL; interorbital width 19.72-33.55 % in HL; mouth terminal; lips weakly developed; two barbells on each side, anterior about 86.24-148.37 % in ED, posterior 45.39- 85.94 % in ED. Dorsal III, 7 (rarely 8) equally distant from anterior border of eye and from caudal, border feebly concave; last simple ray not enlarged, not serrated, nearly as long as head. Anal III 5 not reaching caudal. Pectoral 59.22-78.36 % in HL, not reaching ventral; base of latter below anterior rays of dorsal. Caudal peduncle (CPL=14.41-20.73 %, CPD = 10.88-13.54 % in HL) nearly twice as long as deep. Scales radiately striated, 30-36, and 12-14 round caudal peduncle. Predorsal row 14-16.

and second and fourth were from (Ardi river

Color: Silvery, brownish on the back; an indistinct darker lateral band; fins whitish

Total length 13 cm

Distribution: Lake Tana, Ardi River

XIV. *Barbus paludinosus* Peters, 1852

A

Fig. 23. Lateral view of *Barbus paludinosus* (Ardi).

Diagnosis: Body slightly elongated, small terminal mouth, dorsal spine ossified and serrated, complete and incomplete lateral lines.

Description: Body depth 23.51 to 27.78 % of SL, length of head 24.79 % to 27.75 % in SL. Snout round, as long as or a little shorter than eye 3-61.66 to 88.37 % in HL; interorbital width 65.95 to 90.68 % in HL, mouth terminal, its width 65.18 to 69.09 % in HL; lips feebly developed, two barbels on each side, anterior about 62.47 to 100.71 % in ED, posterior 125.41 to 166.19 % in ED. Dorsal III, 7 (rarely 8), equally distant from eye or occiput and from root of caudal, border straight or slightly concave; last simple ray very strong, bony, strongly serrated, as long as or a little shorter (rarely a little longer) than head, little in advance of ventral (pelvic) fin. Anal III, 5 not reaching caudal. Caudal peduncle 17.19 to 19.88 % of SL. Scales radiately striated 34-39, 16-18 round peduncles. Scatter black spots appear on the caudal peduncle, two below lateral line and one on the lateral line on the left side of above anal fin end, and on the right side four spots on the lateral line beginning below the end of the soft dorsal rays. In some the black dots occur above the lateral line starting the upper end of the operculum until it joins the lateral line above the anal fin. Total length 12 cm.

Color: Silver white below, fins red; a black spot may be present at the base of the caudal.

Distribution: lake Awassa, Akaki, Awash, and Ardi Rivers.

XV. *Garra dembecha* (Getahun and Stiassny, 2007)

Fig. 24. Lateral view of *G. dembecha*

Diagnosis: This species has undeveloped disc (type A), few predorsal scales, it has post pelvic scales and belly scales, deep caudal peduncle (depth of caudal peduncle 8.8-12 %) of SL.

Description: Body dorsally depressed, body depth 16.7- 23.0 of SL. Head is also dorsally flattened or depressed; length of head 19.8-28.2 % of SL, width of head 57.5 – 80.9 % of head length, depth of head 50.0- 65.2 % of head length. Snout without tubercles; snout (25.2-50 %) of head length. Eye in the middle of the head; it is not seen from below but from above, diameter of eye 15.8-27.3 % of HL, inter-orbital width 33.3- 49.5 % of the head length, two pairs of barbels, rostral barbel 42-91 % in diameter of eye. Scales 37-38, scales from the origin of dorsal spine to the lateral line 5.5, pelvic to lateral line 3.5, predorsal region partially scaled, belly scales are few; more scales found near the pelvic fins, post pelvic scales almost full, very few or none around the anal opening that faces to the pelvic fin. Scales beyond the anal opening full. The base of dorsal fin possesses black dots (spots).

Dorsal fin with 4 unbranched, 7 branched, distance between origin of dorsal fin and tip of snout 45.3 - 50.4 % SL. Pectoral fin with 4 unbranched and 12 branched, length of pectoral 16.6- 22.3 of HL, anal fin with 4 unbranched and 5 branched rays. Pelvic fin with 3 unbranched and 6 branched rays, length of caudal peduncle 13.3 - 20.7 % SL, depth of caudal peduncle 8.8 –12 % SL, 12-16 circumpeduncle scales. Total length 12.9 cm (Dura River)

Colour: dark olive and light olive below.

Distribution: Widely distributed in the head freshwaters of Ethiopia

XVI. Garra dembeensis (Rupell, 1836)

Fig. 25 Lateral view of *Garra dembeensis*

Diagnosis: This species has developed C type disc none or 1-2 scales on predorsal region.

Description: Slender body, body depth 16.02 -17.94 % in SL. Length of head 16.94 to 18.26 % SL; width of head (57.57-66.27 %) of HL. Smaller circular tubercles in front of the nostrils while there are small tubular tubercles on the lateral side ventral to the eye. Eye is located at the middle of the head, diameter of eye 14.93 to 21.39 % of HL; interorbital width 40.10 to 45.77 of HL.

Disc very developed with free posterior end, rostral fold well developed; margins on the rostral fold little septated; papillae on the rostral fold not abundant; but abundant on lower lip and small around the disc; disc little wider than long; length of disc 27.77 to 37.06 % of HL; width of disc 50.38 to 66 % of HW; length of disc 72.74 to 92.27 % of its own width;

two pairs of barbels; rostral barbels are longer than maxillary barbels; rostral barbels 67.17 to 97.87 % of the diameter of the eye.

37 - 39 scales on the lateral line, 3.5 - 5 .5 scales from the lateral line to the origin of the dorsal fin; 3.5 - 4.5 scales from the lateral line to the origin of pelvic fin; 4 scales from the lateral line to the origin of anal fin. Dorsal fin with 4 unbranched and 7 branched rays.

Pectoral fin with 4 unbranched and 12 (in most) and 11 (in some) branched and 5 unbranched rays; pelvic fin with 2 unbranched and 6 branched rays. Position of vent far away from the anal fin. Length of caudal peduncle 11.40 – 14.98 % of SL; caudal peduncle depth 8.6 % - 9.66 % of SL; 12- 14 caudal peduncle scales.

Colour: light olive.

Distribution: Widely distributed in the head freshwaters of Ethiopia.

6 .2.2. Fish species diversity in dry and wet season

The number of fish species recorded from Beshilo River in the wet season was 10 while it was 12 in the dry season (Table. 6). *L. degeni, L. nedgia, V. beso, C. gariepinus, H. longifilis, R. Loati, O. niloticus, L. forskalii, B. paludinosus, B. humulis, G. dembecha* and G. *dembeensis* were collected in both seasons. *Synodontis schall* and *L. degeni* were sampled only in wet season and *L. degeni* were sampled only in dry season. There was very little difference in species composition of the dry and wet seasons in Ardi, Beshilo and Dura Rivers (Table 7).

Table 7. Fish species diversity index in dry and wet seasons

River	**Beshilo**		**Dura**		**Ardi**	
Season	dry	wet	dry	wet	dry	wet
H’	1.6	1.4	0.9	0.53	1.2	1.5
N	12	10	5	4	6	7

6.3. RELATIVE ABUNDANCE OF FISHES

6.3.1. Index of Relative Importance (% IRI)

In the total catch of 1060 fish specimens *Labeobarbus intermedius* (n = 337, 31.8 %), *Varicorhinus beso* (n = 264, 24.9 %) and *Labeobarbus nedgia* (n = 216, 20.4 %) were the abundant fish species. These fish species were the most dominant ones both in number and total weight, *Labeobarbus intermedius* (45. 44 kg), *Labeobarbus nedgia* (31, 71 kg) and *Varicorhinus beso* (19.31 kg) (Fig. 25 and Table 8).

The species *Labeobarbus intermedius* (34.1 %), *Labeobarbus nedgia* (27.1 %) and *Varicorhinus beso* (24.5 %) were dominant in weight Beshilo River. In Dura River the same fish species were dominant in number as well as in weight (Fig. 26 and Table 12). However, in Ardi River *Garra dembeensis* was the dominant (30.5 %) in number. Its weight was relatively higher than others in the total catch of Ardi River (Fig. 26 B and Table 8).

The index of relative importance indicates that species of the family Cyprinidae were the most dominant in the three rivers. The family contained 93 .8 % in Beshilo River and 100 % IRI in (Ardi and Dura) Rivers (Figs. 25 A – D) and Tables 8- 12). The species of the family Clariidae with 4.8 % IRI were the second important groups in the total catches of Beshilo River. Cichlidae (1% IRI) was the third important family. The least important family was Bagridae with (0.5 %) IRI.

Table 8. Index of relative importance for the fish species of all the rivers

Species	NO	% NO	W (kg)	% W	FRQ	% FRQ	IRI	% IRI
Labeobarbus intermedius	337	31.8	45.44	35.9	41	21.9	1485	38.2
Varicorhinus beso	264	24.9	19.31	15.3	54	28.9	1160	29.9
Labeobarbus nedgia	216	20.4	31.71	25.1	43	23	1045	26.9
Hetrobranhcus Longifilis	12	1.1	12.72	10.1	8	4.3	48	1.2
Clarias gariepinus	23	2.2	4.28	3.4	15	8	45	1.1
Labeo forskalii	24	2.3	1.98	1.6	13	7	27	0.7
Oreochromis niloticus	22	2.1	3.72	2.9	7	3.7	19	0.5
Garra dembeensis	66	6.2	0.29	0.2	5	2.7	17	0.4
Small *Barbus*	49	4.6	0.12	0.1	5	2.7	13	0.3
Bagrus bajad	5	0.5	4.87	3.9	4	2.1	9	0.2
Garra dembecha	25	2.4	0.11	0.1	7	3.7	9	0.2
Raiamas loati	12	1.1	0.69	0.5	8	4.3	7	0.2
Labeobarbus degeni	2	0.2	1.19	0.9	2	1.1	1	0
Bagrus docmak	2	0.2			1	0.5	0	0
Synodontis schall	1	0.1			1	0.5	0	0
Total	**1060**	**100**	**126.46**	**100**	**-**	**-**	**3885**	**100**

Table 9. Index of relative importance for the fish species of Ardi River

Species	No	% No	W (kg)	% W	Freq.	% Freq.	IRI	% IRI
Varicorhinus beso	40	21.4	2.751	53.9	14	73.7	5551	66.1
Labeobarbus intermedius	20	10.7	1.755	34.4	5	26.3	1187	14.1
Garra dembeensis	57	30.5	0.299	5.9	4	21.1	765	9.1
Garra dembecha	24	12.8	0.101	2	6	31.6	468	5.6
Small *Barbus*	43	23	0.115	2.3	3	15.8	399	4.7
Labeobarbus nedgia	3	1.6	0.079	1.5	2	10.5	33	0.4
Total	**187**	**100**	**5.1**	**100**	**-**	**-**	**8403**	**100**

Table 10. Index of relative importance for the fish species of Beshilo River

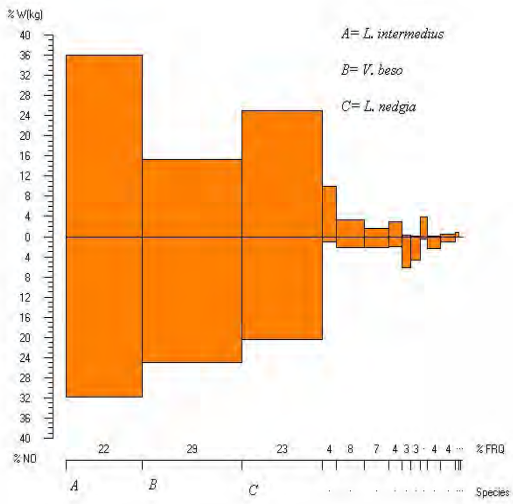
Species	No	% No	W (kg)	% W	Freq.	% Freq.	IRI	% IRI
Labeobarbus nedgia	201	27.1	29.48	31.7	35	25	1470	43
Labeobarbus intermedius	259	34.9	21.87	23.6	24	17.1	1001	29.3
Varicorhinus beso	182	24.5	12.19	13.1	25	17.9	672	19.7
Hetrobaranhcus Longifilis	12	1.6	12.72	13.7	8	5.7	88	2.6
Clarias gariepinus	22	3	4.28	4.6	14	10	76	2.2
Labeobarbus forskalii	23	3.1	1.82	2	12	8.6	43	1.3
Oreochromis niloticus	22	3	3.72	4	7	5	35	1
Labeobarbus bajad	5	0.7	4.88	5.3	4	2.9	17	0.5
Raiamas loati	12	1.6	0.69	0.7	8	5.7	14	0.4
Labeobarbus degeni	2	0.3	1.19	1.3	2	1.4	2	0.1
Barbus docmak	2	0.3			1	0.7	0	0
Synodontis schall	1	0.1			1	0.7	0	0
Total	**743**	**100**	**92.855**	**100**	**-**	**-**	**3418**	**100**

Table 11. Index of relative importance for the fish species of Dura River

Species	NO	% NO	W (kg)	% W	FRQ	% FRQ	IRI	% IRI
Labeobarbus intermedius	54	43.9	21.06	76.3	11	42.3	5087	62
Varicorhinus beso	41	33.3	4.36	15.8	14	53.8	2647	32.2
Labeobarbus nedgia	12	9.8	2.15	7.8	6	23.1	405	4.9
Garra dembeensis	9	7.3			1	3.8	28	0.3
Garra dembecha	1	0.8	0.01	0	1	3.8	3	0
Total	**123**	**100**	**27.59**	**100**	**-**	**-**	**8208**	**100**

Table 12. Index of relative importance (% IRI) for fish species caught from Beshilo, Dura and Ardi summarized in family

Family	Species	Beshilo River	Dura River	Ardi River
Cyprinidae	*L. intermedius*	29.3	62	14
	L. nedgia	43	4.9	0.4
	V. beso	19.7	32.2	66.1
	Small Barbus			4.3
	G. dembecha			5.6
	G. dembeensis			0.3
Clariidae	*C. gariepinus*	2.2		
Bagridae	*H. longifilis*	2.6		
	B. docmak	0		
	B. Bajad	0.5		
Mochokidae	*S. schall*	0		
Cichlidae	*O. niloticus*	1		



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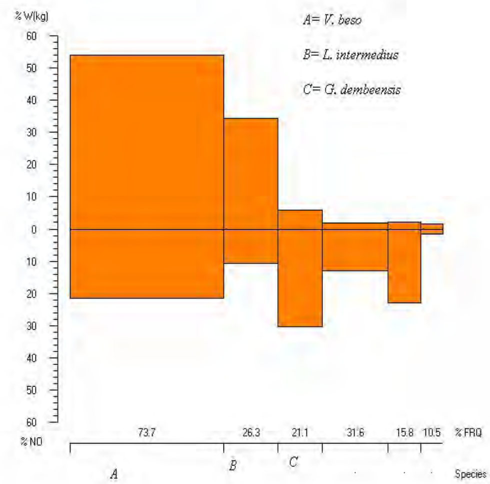

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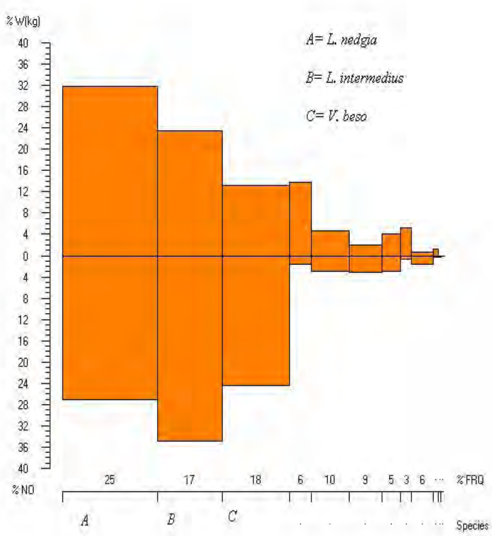

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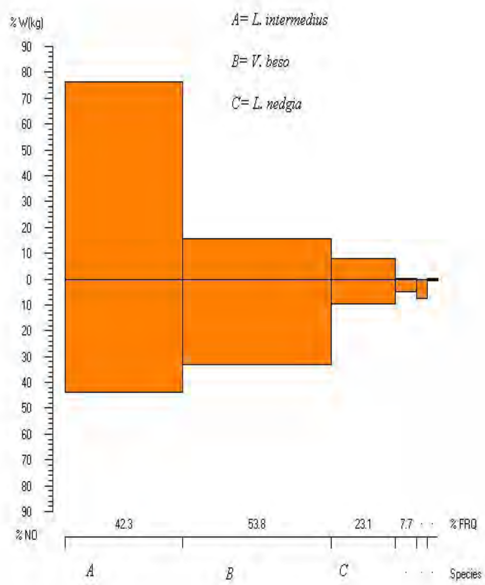

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Fig. 26. Index of relative importance for the fish species of :) A) the rivers combined, B) Ardi River, C) Beshilo River, and D) Dura River

6.3.2. Abundance in total catches in the rivers in wet and dry seasons

In the wet season, 158 specimens (14.6 %) of the total number of *Varicorihnus beso* were collected from Beshilo River. *Labeobarbus nedgia* (n =113,10.44 %) was the next abundant species in the same river. The number of specimens of *Labeobarbus intermedius* in Beshilo River was (n = 155, 14.33 %) making the species the most abundant in dry season. The second and third abundant species in the dry season were *Labeobarbus nedgia* (n = 90, 8.32 %) and *V. beso* (n = 25, 2.31 %) (Beshilo River). The smallest number of specimens was that of *Synodontis schall* from Beshilo River.

As it has been shown in Table.12 below *L. intermedius*, *L. nedgia* and *V. beso* were the most important fish species in the total catch. The total % IRI in the wet season was slightly higher than the dry season. These fishes also contributed considerable mass in the total weight combined. The total weight (kg) of fish was higher in dry season than in the wet season. The same result was observed in Ardi and Dura Rivers since fishes were sampled two times in the dry season and once in wet season. However, the weight of fish in dry season was lower than the wet season in Beshilo River with equal sampling time (once for both seasons). The variation between dry and wet season for % IRI and total weight was insignificant ($P > 0.05$) for Beshilo River and significant ($P < 0.05$) differences between seasons was observed in Ardi and Dura Rivers.

Table 13. The index of relative importance (% IRI) and the weight (kg) of fishes combined and the weight (kg) of fishes in each river in dry and wet seasons of the total catch

Species	IRI % pooled		Weight (kg) combined		Weight (kg) of fishes in each river					
					River					
	Seasons		Seasons		Ardi		Beshilo		Dura	
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Labeobarbus intermedius	37.3	45.5	42.83	24.87	19.2	5.9	20.7	10.2	20.2	0.9
Labeobarbus nedgia	26.6	31.2	42.11	25.7	--	--	40	24.9	2.5	
Labeobarbus degeni			1.2	--	---	---	0.5	--		
Varicorhinus beso	33.4	9.9	19.0	4.70	27.9	5.8	12.1	10	4.1	0.3
Garra dembecha	0	0.7	0.04	0.6	0.4	0.6				0.05
Garra dembeensis	0	0.7	0.3	0.4	2.6	0.4				
Small *Barbus*	0	1.9	0.00	1.2	0.3	1.1				
Hetrobranhcus longifilis	0.4	6.6	10.6	2.11			10.6	2.1		
Clarias gariepinus	0.4	1.6	4.20	15.5			4.3	8.3		
Bagrus docmak	0.4	0					----	---		
Bagrus bajad	0.4	0.3	3.61	0.56			3.6	0.6		
Raiamas loati	0.02	0.01	0.07	0.06			0.7	0.06		
Labeo forskalii	0.4	1.4	1.45	5.5			1.8	5.4		
Synodontis schall	--	--	--	---			---	--		
Oreochromis niloticus	0.6	2	3.72	4.13			3.7	1.6		
Total	**99.2**	**101.8**	**128.53**	**84.28**	**50.4**	**13.8**	**98**	**63.2**	**26.8**	**1.3**

6.3.3. Length frequency of the most dominant fishes of the rivers

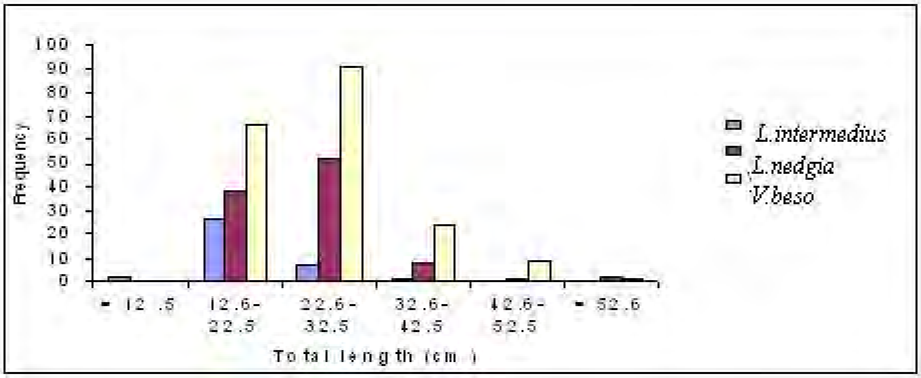


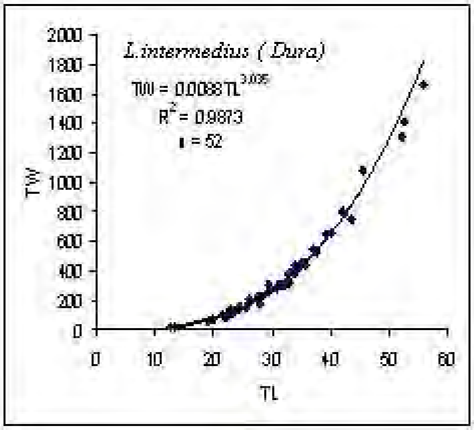
Fig. 27. Length frequency distribution of *Labeobarbus intermedius* (N = 337), *Labeobarbus nedgia* (N = 216) and *Varicorhinus beso* (N = 264).

Varicorhinus beso was the most abundant species that had a total length ranging from 22.6-32.5 cm. The second abundant fish species was *L. nedgia* with a total length range of 22.6-32.5 and followed by *Labeobarbus intermedius* with a total length of 12.6 to 22.5.

6.4. SOME BIOLOGICAL ASPECTS OF DOMINANT FISH SPECIES

6. 4.1. Length - weight relationship

The relationship between total length and total weight for L. *intermedius*, *L. nedgia* and *V. beso* was curvilinear and statistically significant ($P < 0.05$) Fig. 28. The line fitted to the data was described best by the regression equation shown in Table 13 and Figs. 28 A – F. In fishes, the regression coefficient $b = 3$ describes isometric growth. The value is precisely 3 if the fishes retain the same shape and their specific gravity remains unchanged during their life time (Ricker, 1975). It is isometric growth, which means that the weight is increased according to the fish length (Mansor Mat Isa S.A.S.A., 2001). However, some fishes have b value greater or less than 3; a condition of allometric growth (Bagenal and Tesch, 1978). From (Table .13 and Fig .28) it can be established that *L. intermedius*, *L. nedgia* and *V. beso* in Beshilo River had isometric growth. But *V. beso* of Dura and Ardi Rivers had positive allometric growth.



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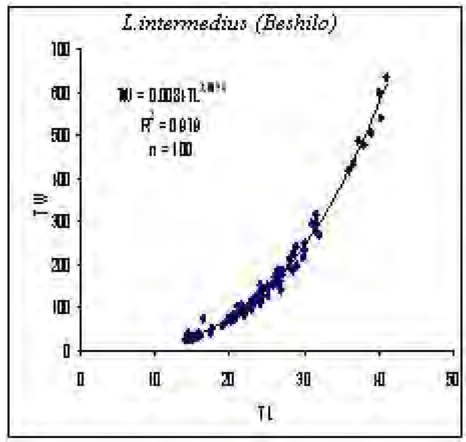

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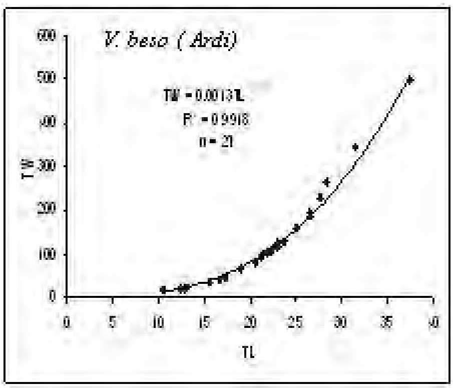

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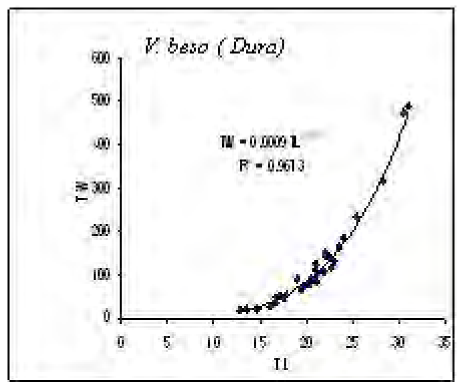

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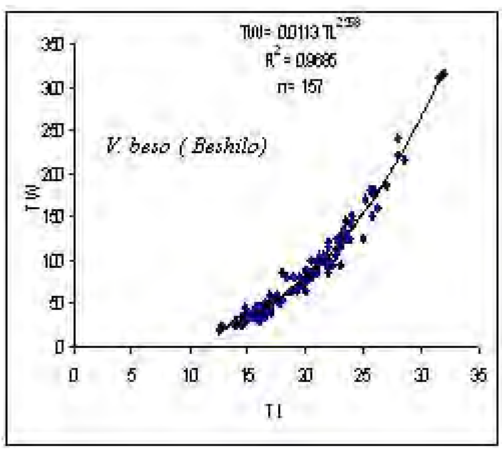

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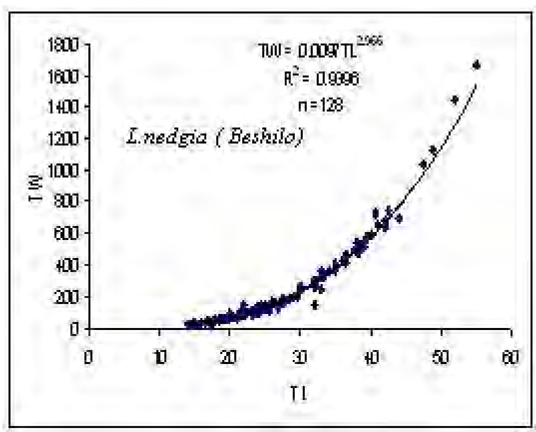


F

Fig. 28 Length-weight relationship of dominant fishes in the studied rivers.

Table 14. Length – weight relationship of the dominant fishes in the rivers

Fish species	River	Reg.equation	R^2	Means ± SDTW	Means ± SDTW
L. intermedius	Beshilo	$TW = 0.0084TL^{3.02}$	0.98	23.91 ± 6.47	152 ± 128.47
	Dura	$TW = 0.0088\ TL^{3.04}$	0.99	31.6 ± 9.00	399.8 ± 346
V. beso	Beshilo	$TW = .0113\ TL^{2.96}$	0.97	18 99 ± 3.85	77.21± 51.77
	Dura	$TW = 0.0009\ TL^{3.83}$	0.97	20.18 ± 4.23	113.5 ±107.6
	Ardi	$TW = 0.0013TL^{3.65}$	0.99	22.15 ± 6.26	137.3 ± 111.1
L. nedgia	Beshilo	$TW = 0.0097\ TL^{2.97}$	0.94		

* Significant

6.4.2. Fulton Condition factor (FCF)

The Fulton condition Factor was computed for *L. intermedius* of Beshilo, Ardi and Dura Rivers and *V. beso* of Ardi, Dura and Beshilo Rivers (Table 15)

Table 15. The Fulton Condition Factor for the dominant fishes with their means ± SD

Species	River	Mean FCF	Range	P- value
L. intermedius	Beshilo	1.01 ± 0.09		***
	Dura	0.90 ± 0.12		
V. beso	Ardi	1.02 ± 0.12		*
	Beshilo	1.00 ± 0.11		
	Ardi	1.02 ± 012		*
	Dura	1.10 ± 0.26		
	Dura	1.00 ± 0.11		***

* Insignificant ($P > 0.05$), *** very significant ($P < 0.05$)

Table 16.The Fulton Condition Factor by sex, of the dominant fishes with their means ± SD

Species	River	Female	Male	Range	P- value
L. intermedius	Beshilo	0.93 ± 0.16	0.86 ± 0.66		0.145*
V. beso		1.01 ± 0.01	1.00 ± 0.36		0.905*

* Insignificant (P > 0.05)

The FCF comparison of *Labeobarbus intermedius* and *Varicorhinus beso* between Beshilo and Ardi, Ardi and Beshilo, Ardi and Dura was insignificant. However Fulton condition factor of *V. beso* between Dura and Beshilo was very significant (P < 0.05).

The Fulton Condition Factor of *Labeobarbus intermedius* and *Varicorhinus beso* females and males in Beshilo River were insignificant (P > 0.05). Both sexes of *Varicorhinus beso* in Beshilo River were in better well-being, but females *Labeobarbus intermedius* were relatively in better condition than males.

6.4.3. Sex ratio

The sex –ratio in the dry season showed the predominance of females than males. But males out number females for *Oreochromis niloticus*. The sex ratio for *Labeobarbus intermedius* and *Labeobarbus nedgia* was significant (p < 0.05). In wet season males took preponderance over females and there was significant differences for *Labeobarbus nedgia* and *Varicorhinus beso* (P < 0.05). It was insignificant for *Labeobarbus intermedius* and *Orochromis niloticus* (P > 0.05).

The sex – ratio in combined data was only significant for *Varicorhinus beso* (P < 0.05) and insignificant for the rest of the species for which sex – ratio was determined (P > 0.05).

Table 17. Sex ratio estimation of the dominant fishes in Beshilo River during dry season

Species	Sex		Ratio	X^2
	Female	Male	F: M	
L. intermedius	46	18	2.6: 1	13.5 *
L. negia	54	35	1.54: 1	6.15 *
V. beso	52	53	0.98: 1	0.04 *
O. niloticus	6	14	0.43: 1	12.11 *

* Significant

Table 18. Sex ratio estimation of the dominant fishes in Beshilo River during wet season

Species	Sex		Ratio	X^2
	Female	Male	F: M	
L. intermedius	70	91	0.77: 1	0.75
L. nedgia	29	49	0.59: 1	4.67 *
V. beso	30	7	4.28: 1	9.48 *
O. niloticus	5	11	0.45: 1	1.94
C. gariepinus	6	11	0.54: 1	1.53

* Significant

Table 19. Sex ratio estimation of the dominant fishes in Beshilo River combined

Species	Sex		Ratio	X^2
	Female	Male	F: M	
L. intermedius	116	109	1.06:1	0.88
L. nedgia	83	84	0.99: 1	0.03
V. beso	82	60	1.37:1	14.07 *
O. niloticus	11	25	0.44:1	
C. gariepinus	6	11	0.54: 1	

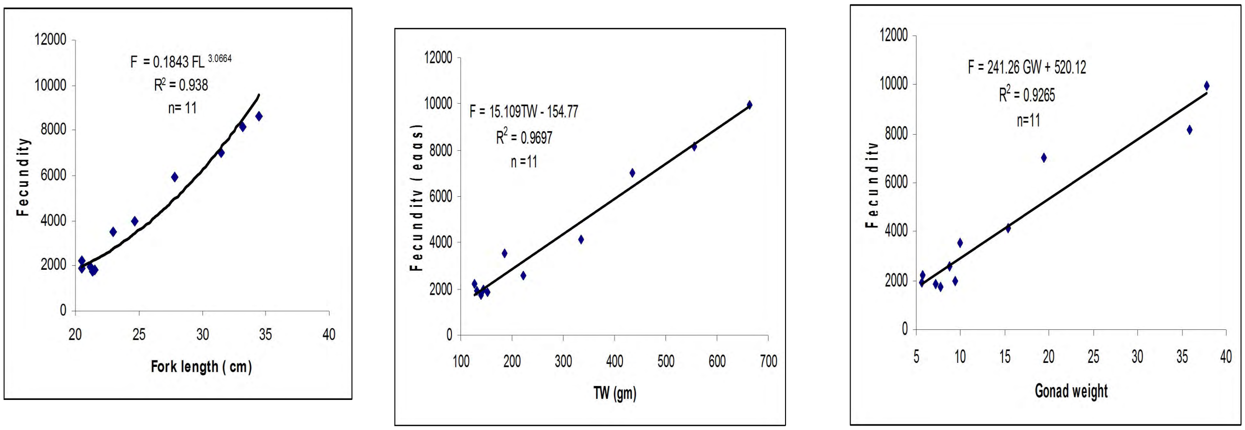
* Significant

6.4.4. Fecundity of fishes

Fecundity, as the number of ripe ova (eggs) in the female prior to the next spawning period, as defined in Ricker (1975) was computed for *V. beso* (n = 11) and *L. intermedius* (n = 7). The total length of *V. beso* female examined ranged from 20.5 cm to 33.2 cm; gonad weight ranged from 5.9 gm to 35.9 gm while the weight ranged from 127 gm to 556 gm. The total fecundity in the ovary ranged from 1731.6 to 9955.2 with a mean ± SD (4095.1 ± 2921). The total length of *L. intermedius* female observed ranged 30 cm to 46.7 cm, the gonad weight ranged from 8.2 gm to 68.3 gm and the body weight ranged from 445 gm to 1215 gm. Total fecundity of *L. intermedius* was in the range from 2408.4 to 13864.9 with a mean ± SD of (8011.1 ± 5162.2).

The highest fecundity was observed in the biggest specimens while lowest fecundity was observed in the smallest specimens.

The Fecundity – fork length, fecundity – total weight and fecundity total gonad weight relationships (Figs. 29A- C) were shown by the equations: **F = 495. 56 FL – 833.4, F = 15.109 TW – 154.77, and F = 241.26 GW + 520.12** respectively where F is fecundity or number of eggs in the ovary, F L is fork length (cm), TW is total body weight (gm) and GW is gonad (ovary) weight (gm).



A B C

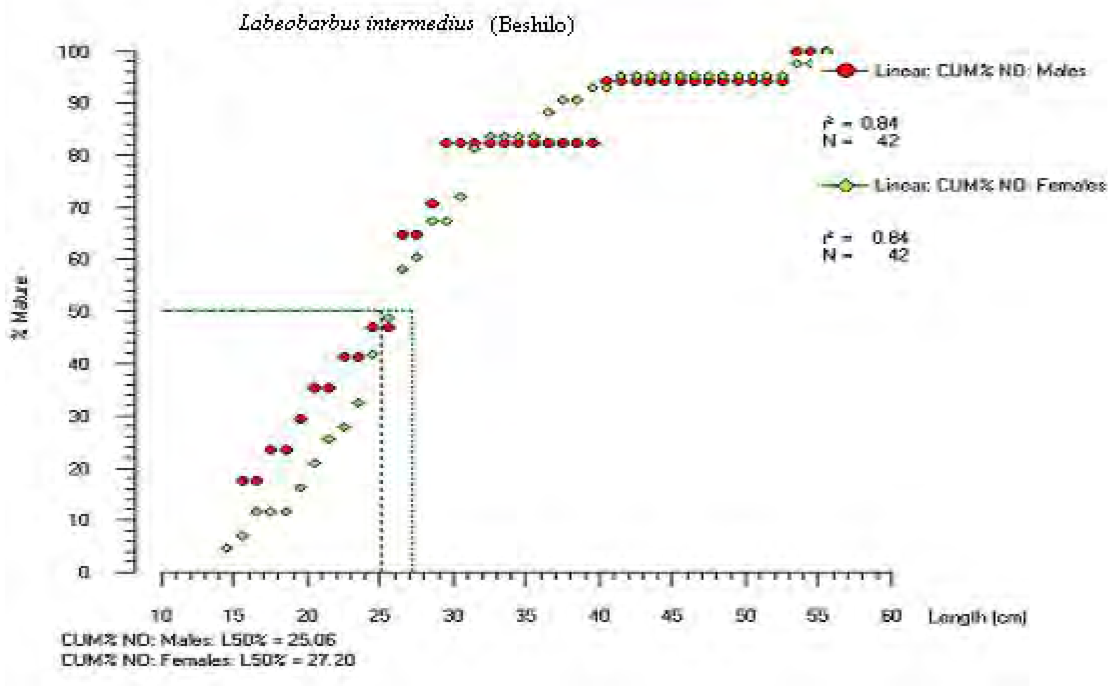
Fig. 29 A**)**. Fecundity - fork length (FL), **B)**. Fecundity – body weight (gm). **C)** Fecundity – gonad weight (gm) of *Varicorhinus beso* in Dura River

Table 20. Mean ± SD absolute, relative fecundity and total weight of *V. beso* in relation to fork length

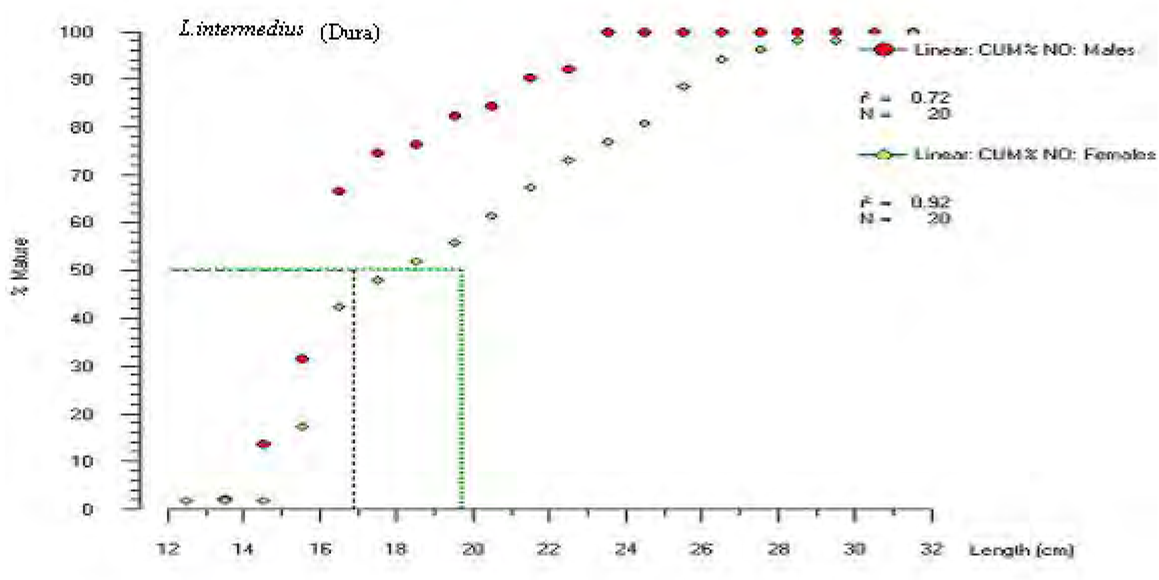
Size class Fork length	N	Mean body weight (gm)	Mean absolute fecundity	Mean relative fecundity
20 - 23	6	147 ± 21.3	2207.1 ± 670.3	295 .6 ± 70.2
24 – 28	2	296.4 ± 133. 3	3336 ± 1096.7	279 ± 16.9
29 - 32	2	495 .5 ± 85 .6	7586.1 ± 796.6	296.5 ± 95.6
> 32	1	664	9955.2	263.4

6.4.5. Maturity at L_{50}

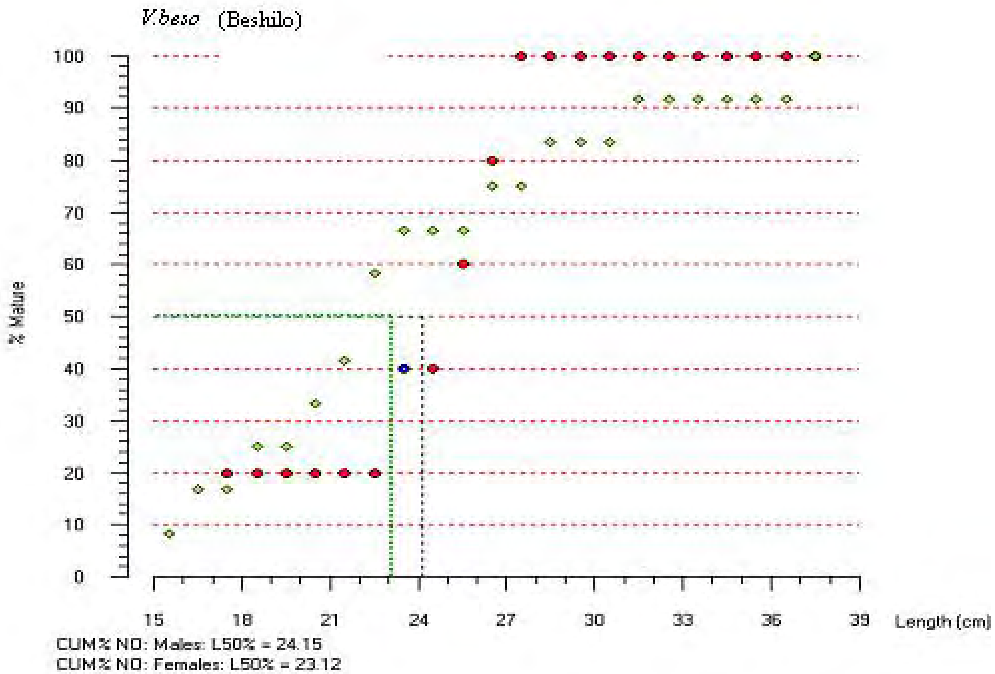
The L_{50} of *Labeobarbus intermedius* (Dura and Beshilo), *Varicorhinus beso* (Ardi, Dura and Beshilo) and *Labeobarbus nedgia* (Beshilo) were computed and the results shown hereunder.


Labeobarbus intermedius (Beshilo)
Linear: CUM% NO: Males
r² = 0.84
N = 42
Linear: CUM% NO: Females
r² = 0.84
N = 42
% Mature
Length (cm)
CUM% NO: Males: L50% = 25.06
CUM% NO: Females: L50% = 27.20

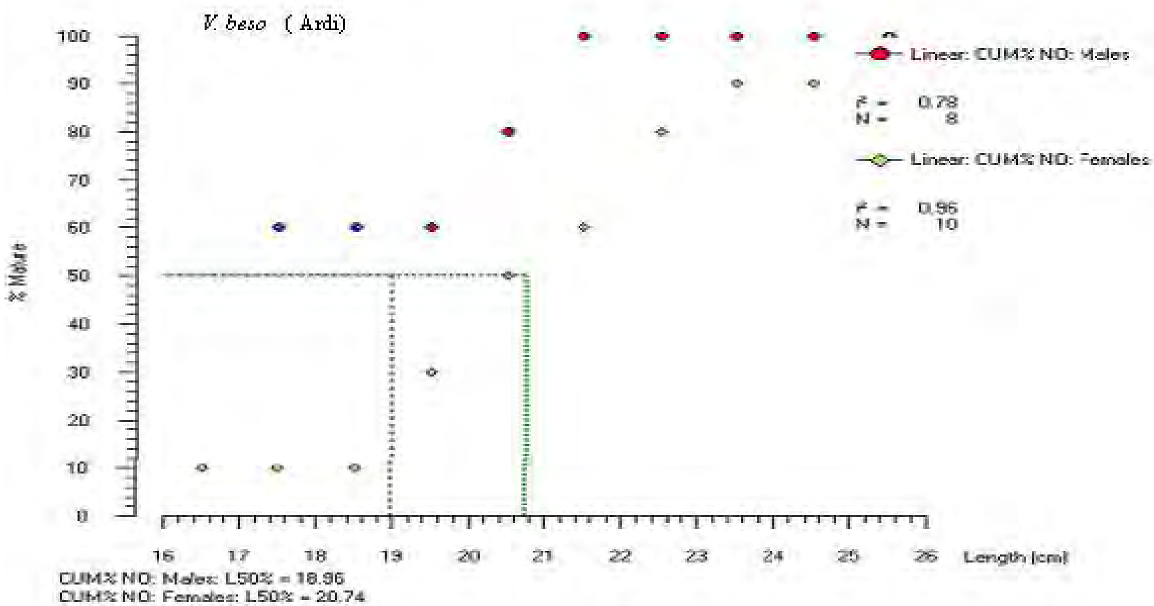
A


L.intermedius (Dura)
Linear: CUM% NO: Males
r² = 0.72
N = 20
Linear: CUM% NO: Females
r² = 0.92
N = 20
% Mature
Length (cm)

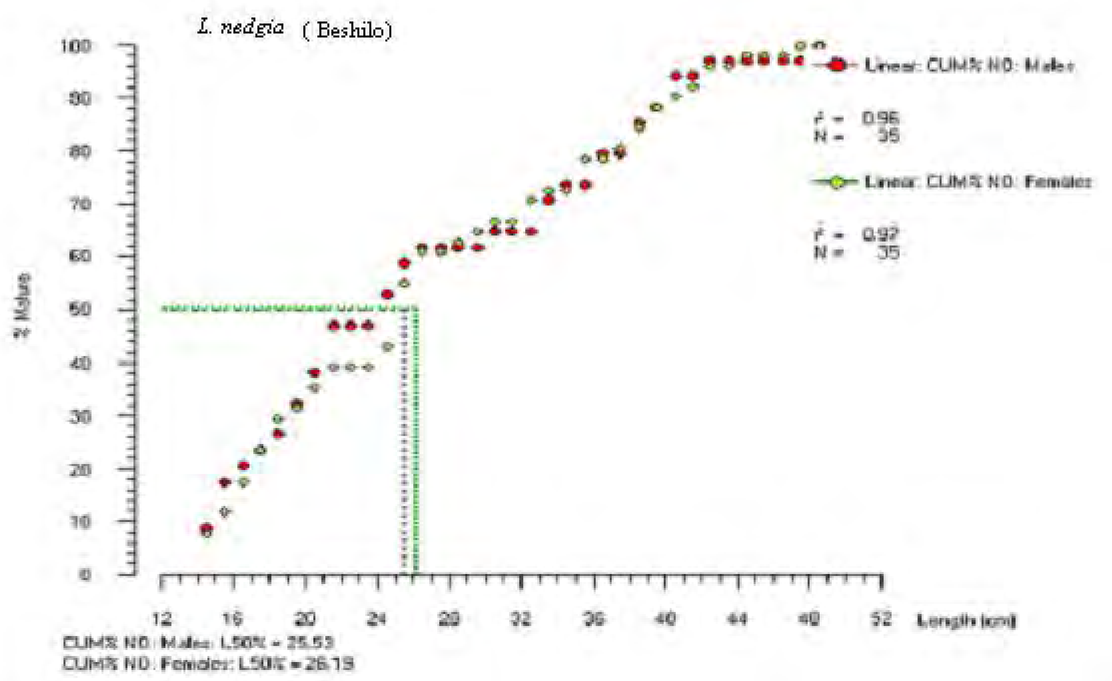
B


V.beso (Beshilo)
% Mature
Length (cm)
CUM% NO: Males: L50% = 24.15
CUM% NO: Females: L50% = 23.12

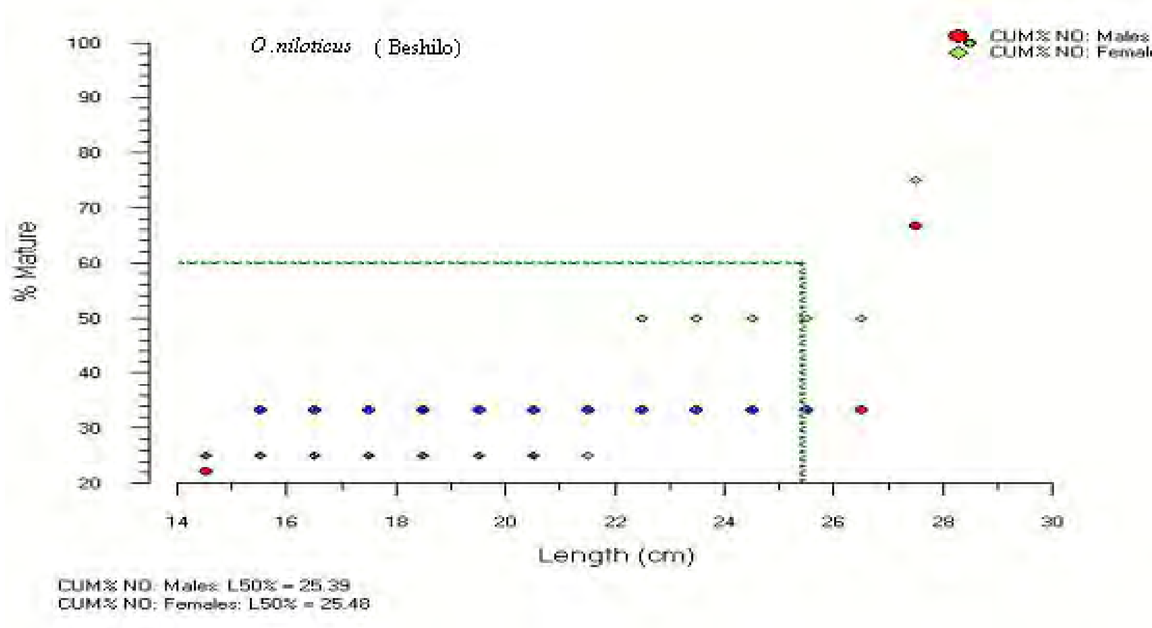
C


V. beso (Ardi)
Linear: CUM% NO: Males
r² = 0.78
N = 8
Linear: CUM% NO: Females
r² = 0.96
N = 10
% Mature
Length (cm)
CUM% NO: Males: L50% = 18.96
CUM% NO: Females: L50% = 20.74

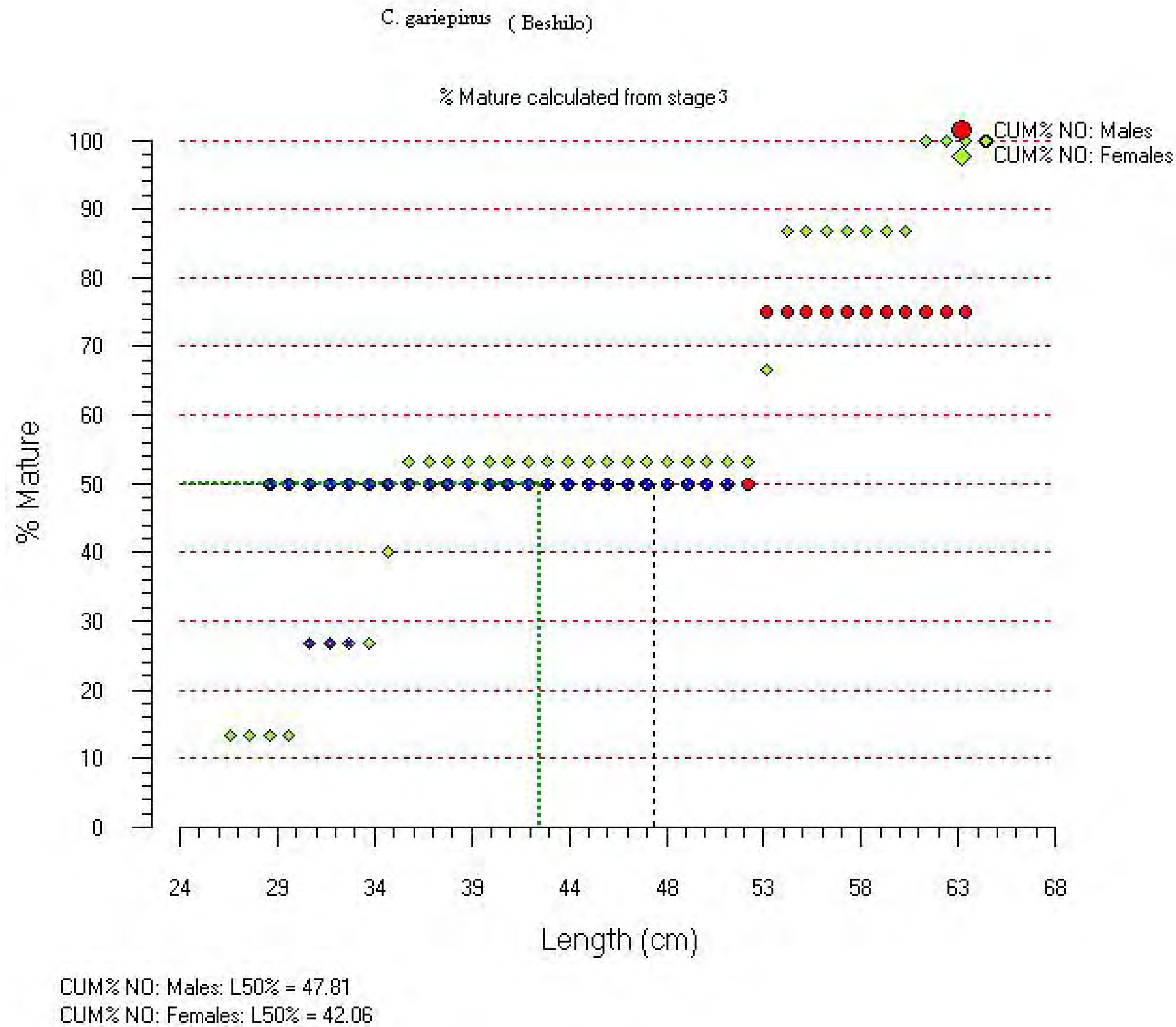
D.


L. nedgia (Beshilo)
Linear: CUM% NO: Males
Linear: CUM% NO: Females
% Mature
Length (cm)
CUM% NO: Males: L50% = 25.53
CUM% NO: Females: L50% = 26.19

E


O.niloticus (Beshilo)
CUM% NO: Males
CUM% NO: Female
% Mature
Length (cm)
CUM% NO: Males: L50% = 25.39
CUM% NO: Females: L50% = 25.48

F.



G

Fig. 30 The L_{50} results of A) *Labeobarbus intermedius* (Beshilo), B). *Labeobarbus intermedius* (Dura), *C). Varicorhinus beso* (Beshilo) , *D). Varicorhinus beso* (Ardi), *Varicorhinus beso* (Dura), E). *Labeobarbus nedgia* (Beshilo), F).*Oreochromis niloticus* (Beshilo), and G). *C. gariepinus* (Beshilo)

7. DISCUSSIONS

The diversity of fish fauna identified from the studied rivers contains a mixture of Nilosudanic and East African forms. Both fish forms have not been reported prior to this study in the three rivers. Their occurrence is most probably due to the connection (link) of the rivers to the Blue Nile basin (Abebe Getahun, 2005). Their presence in the Blue Nile (Abbay drainage basin) has been reported by Boulenger (1905), Nichols and Griscom (1917), Roberts (1975) and Banarescu (1995). The riverine fishes are very mobile, they move long distances up and down for various reasons such as spawning and search for food (Lowe-McConell,1977).

Labeobarbus intermedius, *Labeobarbus nedgia* and *Varicorhinus beso* were commonly recorded in Beshilo, Dura and Ardi Rivers while *Bagrus docmac, Bagrus bajad*, *Hetrobranchus longifilis*, *Clarias gariepinus, Raiamas loati, Oreochromis niloticus* and *Labeobarbus degeni* were confined to Beshilo River in this study. Small *Barbus* (*Barbus humilis* and *Barbus paludinosus*) and *Garra dembeensis* inhabited Ardi River only. *Garra dembecha* was common to Dura and Ardi rivers. However, the present study revealed that these rivers have significant diversity of fish species. The present study is contrary to the master plan study of MOWR (1999) that has reported, no valuable fish fauna in Beshilo River

Total *Garra* species so far described (78 species) are distributed through out Asia and Africa (Zhang, 2005) of which 17 are in Africa and 10 of them are in Ethiopia (Stiassny and Abebe Getahun, 2007). They are adapted to slow flowing and less polluted streams (Abebe Getahun and Stiassny, 1998) and they were identified from Ardi and Dura Rivers. *Garra dembecha* and *G. dembeensis* were collected from Ardi River, whereas only *G. dembecha* was sampled from Dura River.

The small *Barbs*, (*B. paludinosus* and *B. humilis*), which inhabit fast flowing floodwater were found in Ardi River. Even though, *B. paludinosus* was first reported from Bulbula River by Boulenger (1904), later its existence has been mentioned in different basins several times in various studies such as those reported from Akaki and Awash Rivers (Boulenger 1905, 1906), Awash River (Shibru Tedila, 1973), Rift valley (Greenwood, 1962) Lake Ziway (Eyualem Abebe and Getachew Tefera, 1992), Gojeb River and Omo – Turakana basin (Dgebuadze *et al*, 1994). Similarly *B. humilis* was identified from Lake Tana (Eshete Dejen, 2003).

Fish species diversity of Beshilo and Ardi Rivers were almost equivalent to the Rift valley (15 species), Sanja and Wabishebelle (8 species and 13 species) (JERBE, 2004, 2005; Genanaw Tesfaye, 2006).

However, fish diversity of Beshilo River was relatively less diverse than Wabishebele _ Juba (31 species), Atbara –Tekeze (32 species) and Beles River (25 species) (JERBE, 1999, 2000). The diversity of Beshilo River contained up to 17 or more species if the species, which were reported by the Beshilo expedition team are, added to the present result. The team reported the presence of *Garra ignesti*, *Mormyrus kannume*, *Synodontis serratus*, and *Labeo cylidericus* from the same river (Akewake Geremew per. comm.).

The Shannon diversity index has confirmed the diversity of fish species in the rivers. The Shannon diversity index (H') was higher in Beshilo River (H'= 1.65) than in Ardi (H' =1.59) and Dura (H' =1.12) Rivers (Table 4). The diversity indices for species diversity in wet and dry seasons showed little variation for each river (Table 7).

The geomorphology of the riverine landscape in one way or another affect biodiversity pattern (Wardle, 1998). The river width, catchments area, habitat and substrate structure (rocky, sandy, muddy, gravel, vegetated), distance from the source, and depth have also influence on the diversity of fishes (Toham and Teugels, 1998). These authors and EDDS (1993) in India have reported the direct relationship between river width and species diversity increment. The discharge of water to a river seems influential in Ethiopian river fish diversity (Golubstov *et al.*, 2002). Although, further study is required, the diversity of Beshilo might be associated to its relatively complex habitat and substrate structure, large flood areas, high amount of water discharge from its tributaries and its width (300 –600 m).

The cyprinid *L. intermedius*, *L. nedgia* and *V. beso* dominate in all the rivers studied. They dominate in weight and number in the total catches and in each river. Percent of IRI indicated that 93.8 % of the total catches were composed of the family *cyprinidae*. This family is the most important and dominant in the water bodies studied. Reports showed that Cyprinid fishes are the dominant fish species in Africa mainly in rivers (Lowe – McConell, 1977).

In both dry and wet seasons, the cyprinid fish *L. intermedius*, *L nedgia* and *V. beso* were dominant with slight differences between them. The total number and weight of fishes in the dry season was greater than the wet season. This might be due to uneven sampling of specimens. In Ardi and Dura Rivers, fish specimens were collected two times in the dry season and once in the wet season. In fish specimens sampled equally once in each season in Beshilo River, the weight of fish was greater in the wet season than in the dry season. The gill net efficiency and accessing all fish habitats may contribute to the catch differences in dry and wet season. In nature, the weight of fish (biomass) is higher in wet season than dry season since the wet season is the main feeding and growing time for most riverine fishes (Lowe – McConell, 1977). This is because the flood brings external source of nutrients (allocthnous) to a river to enrich it. The decomposition of materials favors the breeding of invertebrates that are the sources of food for fish. As a result, ovary or gonad develops; fat deposits increase and the fish become heavier or fatter in the wet season than dry season (Lowe – McConell, 1977).

L. intermedius (Beshilo and Dura Rivers), *L. nedgia* and *V. beso* (Beshilo River) had isometric growth. *V. beso* of Dura and Ardi Rivers had positive allometric growth. Despite the slight variation, the growth of *L. intermedius* and *L. nedgia* was in agreement to the *Barbus spp*. in Lake Awassa (Demeke Admassu and Elias Dadebo, 1997), L. *intermedius* in Sanja and Angereb Rivers (Genanaw Tesfaye, 2006), and in Lake Tana (Nagelkerke, 1997; Wassie Anteneh, 2005). The variation between this study and the prior studies could be the differences in food resources, study season, sampling frequency, the number of specimens used, the feeding rate, gonad development, and spawning period (Bagenal and

Tesch, 1978). Most of these factors are the results of the environmental ingredient differences where the fish adapt to survive.

Fulton condition factor of *L. intermedius* was in concurrence to the *Barbus spp.* in Lake Awassa (Demeke Admasu and Elias Dadebo, 1997) and *L. intermedius* in Sanja and Angereb Rivers (Genanaw Tesfaye, 2006).

The fish wellbeing of the fish can be affected by various factors such as environment, food quantity and quality, rate of feeding, disease (health of fish) and reproductive activity (Bowen, 1979; Getachew Tefera, 1987; Payne, 1986). High wellbeing is linked to more energy content; increased food reserve, reproductive activity, and favorable environmental conditions (Paukert and Rogers, 2004). The better fishes in rivers were associated to large gonad development and favorable environmental conditions within the rivers. Therefore, females were in better condition than males in Beshilo River.

In dry season, females fish out numbered male and in wet season, the males took the preponderance over females. In the total catches pooled the ratio female to male was nearly 1:1 which is in line with the natural proportion except very small deviation in *V. beso*. The unbalanced sex- ratio exhibited in wet and dry season of the present study may be associated to activity differences between sexes, the type of gears used, fishing sites (Demeke Adamssu, 1994) habitat and segregation during feeding and spawning.

The fecundity result of *L. intermedius* and *V. beso* indicated that fecundity increased as length and body weight increased. Fecundity of *L. intermedius* was similar to the results of the absolute fecundity of *L. brevicephalus* and *L. truttiformis* in Lake Tana (Wassie Anteneh, 2005). Fecundity and fork length (cm) were curvilinearly related for *V. beso* while the gonad weight – fecundity, fecundity –weight were linearly related (Figs. 28B and C) for V. *beso* of Dura River.

The determination of maturity length (FL or TL_M) is an indispensable feature to foretell the population to be fished and more significantly to put into practice management measures, such as mesh size – restrictions, in order to avoid the over exploitation of the reproductive portion of the fish population. In this study the dominant fishes of each river, *L. intermedius,* O *.niloticus* and *C. gariepinus* of Beshilo River was estimated. The result obtained is in agreement with Wassie Anteneh (2005) for *L. intermedius* but different from Tesfaye Wudineh *et al.,* (1999) for *L. intermedius*, *O. niloticus* and *C. gariepinus*. However, it is similar to (Lemma Abera per. comm.) for *C. gariepinus* in Babogaya Lake.

Length of maturity in many fish species relies on demographic conditions and is determined by genes and environment (Fryer and ILes, 1972; Lowe- McConell, 1987). Generally, fish in poor condition mature at small size than those in good condition (Lowe- McConell, 1958; 1959; 1987). It is also thought that fishing pressure is the major factor to cause the reduction in length at maturity (Cowx, 1990).

Table 21. Length at maturity ($FL_{50\%}$) of fish species as determined by different authors at different times.

Species	River	Present study		Tesfaye Wudneh *et al.,* (1999)		Wassie Anteneh (2005)		Demeke Admasu (1994)	
		Female	Male	Female	Male	Female	Male	Female	Male
L . intermedius	Beshilo	27.42	25.06		20.5		22.57		
	Dura	34.49	11.97						
V . beso	Beshilo	16.8							
	Dura	20.74	18.96						
	Ardi	23.12	24.15						
L . nedgia	Beshilo	26.19	25.53						
O . niloticus		25.48	25.39	18.1	20.7			18.8	19.8
C . gariepinus		42.06	47.81		36				

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. Conclusions

- In the present study, a total of 17 species were identified. The number of fish species that was identified was 13, 7 and 5 in Beshilo, Ardi and Dura Rivers respectively.
- The number of fish species recorded from Beshilo River in wet season was 10 while it was 12 in the dry season. *Synodontis schall* and *Bagrus docmac* were sampled only in wet season and *Labeobarbus degeni* and *Varicorhinus sp*. were collected only in dry season.
- The Cyprinid *Labeobarbus intermedius* (n = 337, 31.8 %), *Varicorhinus beso* (n = 264, 24 .9 %) and *Labeobarbus nedgia* (n = 216, 20.4 %) were the dominant fish species in the total catches. These fish species were dominant not only in number but also in total weight, *Labeobarbus intermedius* (45 .44 kg), *Labeobarbus nedgia* (31.71 kg) and *Varicorhinus beso* (19.31).
- *Cyprinidae, Bagridae* and *Claridae* were the dominant families with respect to numbers of species with 11, 2 and 2 species respectively. The genera *Labeobarbus* and *Barbus* were the dominant ones with a total of 5 species.
- Beshilo River is more rich and productive than Ardi and Dura Rivers, in terms of both total numbers of fish caught and numbers of species recorded. The species diversity was also higher in Beshilo River (H′=1.65) than in the Ardi (H′ = 1.59) and Dura (1.12) River for total catch. The species diversity was also higher in the dry than wet seasons for the total catch.
- *Cyprinidae* was the most dominant family in Beshilo, Ardi and Dura Rivers. This family comprised 93.8 and 100 % IRI of the catches in the Beshilo, and (Ardi and Dura) Rivers respectively. *Labeobarbus intermedius* was the most important species according to IRI (38.2 %), while *Varicorhinus beso* was second (29.9 %) and *Labeobarbus nedgia* third (26.9 %) in the total catch.

- From length-weight relationship, *Labeobarbus intermedius, Varicorhinus beso* and *Labeobarbus nedgia* of Beshilo River showed isometric growth while *Varicorhinus* *beso* exhibited positive allometric growth in both Ardi and Dura Rivers. The length-weight relationships were curvilinear for the three species.

- There were insignificant differences in the mean Fulton Condition Factor for *Labeobarbus intermedius* and *Varicorhinus beso* between Beshilo and Ardi, Ardi and Beshilo, and Ardi and Dura Rivers (ANOVA, $P > 0.05$). However, Fulton Condition Factor for *Varicorhinus beso* between Beshilo and Dura Rivers was significant (ANOVA, $P < 0.05$). The difference in Fulton Condition Factor of *Labeobarbus intermedius* and *Varicorhinus beso* females and males in Beshilo River was insignificant (ANOVA, $P > 0.05$). Both sexes of *Labeobarbus intermedius* and *Varicorhinus beso* in Beshilo River were in better condition, but *Labeobarbus intermedius* females were relatively in better condition than males.
- In the total catches the females and males were in 1:1 ratio except slight difference in *Varicorhinus beso*. Nevertheless, females out number males in dry season and the males took the preponderance over females in wet seasons.

- Fecundity was found to be curvilinear when related to fork length, and linear to total weight and gonad weight for *Varicorhinus beso* in Dura River.

8.2. Recommendations

The diversity and relative abundance of the fish fauna in Beshilo, Ardi and Dura Rivers is highly considerable. Detailed studies and investigations are required on Diversity and abundance of fish species along the whole stretch of Beshilo River. In addition to the use of morphometric methods for qualifying and quantifying population differences between the *Lebeobarbus*, small *barbus*, and *Garra* morphotypes, additional data from allozymes, nuclear and Mitochondria DNA and RNA are needed to solve the identification problems. The fish diversity in the studied rivers (mainly Ardi and Beshilo) need further study to make sure if they would contribute some more new *Varicorhinus sp* (Beshilo) and *Garra dembecha?* and small *Barbus* species (Ardi River). In addition, detailed knowledge on the biology and behaviour of most of the species are still lacking and hence need to be studied.

Any changes to the flood regime caused by factors such as siltation, farming activities, water abstraction, impoundment and canalizations on the floodplains can have serious negative effects on the functioning of the floodplain system. This is a new aspect which require scientific study to conclude their effects to fish assemblage in the rivers. The over fishing effects, and mass destruction using plant leaves need immediate solution in Ardi and Dura Rivers.

Therefore, sustainable utilization and conservation measures should be taken in the three rivers.

Part two

1. Introduction

Cestodes (Tapeworms) belong to the *Phyllum* Platyhelminthes that encompasses a variety of acoelomate organisms that are bilaterally symmetrical, dorso-ventrally flattened ribbon-shaped and generally longer than wide. Therefore, they are more commonly termed as flatworms (Tapeworms) (Wardle and Mcleod, 1952). Platyhelminthes consist of flatworm (tapeworms) species that reveal great diversity in habitat, anatomy, size, and reproduction history strategies (Blair *et al*., 1996 in Zehnder, 2000). The class Cestoda is, thus monophyletic with Monogenea and Trematoda. These Cestodes are internal (endo) parasitic Platyhelminthes that parasitize the vertebrates: fishes, amphibians and reptiles (Freze, 1965, 1969; William and Jones, 1994; Olson and Tkach, 2004; Kickman and Hickman, 1957). However, a few neotenic forms occur in Oligochaetes (i .e. Archigetes) (Scholz and de Chambrier, 2006).

The cestodes (tapeworms) particularly fish tapeworms (Platyhelminthes) have the pathogenic and veterinary importance causing harm in their hosts in various ways. Some of the harmful effects include introducing metabolic by products, acting as vectors of other pathogens, surviving in the expense of the fish (host) food, causing mechanical injury such as irritation; injury; and atrophy of tissues. Sometimes cestode fish parasites can negatively affect the health state of cultured fish and cause death to heavily infected; mostly of vulnerable young (fry, fingerlings) fish (Freze, 1969). Plerocercoids of *Pseudophyllidean*, *Ligula intestinalis* cause parasitic castration of fish mainly in cyprinid fishes (Eshete Dejen, 2002).

The Class Cestoda is composed of a number of orders, among them, the *Proteocephalidea* Mola, 1928. *Proteocephalideans* are very ancient cestode group (Freze, 1969). They are very common in freshwater bodies (Williams and Jones, 1994). The *Proteocephalideans* are divided into the families *Proteocephalidae* and *Monticelliidae*). There are about 300 species that have been known until recent times (Rego, 1998). Almost half of them occur primarily in Siluriformes from South America (Rego, 1994 and 1998). The definitive hosts of these cestodes are included in the following families and genera of Siluriformes with their own diversity, biology, ecology and geographical distribution. *Bagridae*, *Clariidae, Doradidae, Ictaluridae, Loricariidae, Malapteruridae, Mochokidae, Siluridae, Panganasiidae, Pimelodidae, and Trichomycteridae* are common Siluriformes serving as final host for *proteocephalidean* parasites.

It has been suggested that *Monticelliidae* are confined to Siluriformes. But its occurrence in Amphibians has been reported by de Chambrier and Vaucher (1992) and de Chambrier *et al*., (2006). The most dispersed proteocephalideans colonilize non-Siluriformes, for instance, cichlids, and characids, (Rego, 1996 and Woodland, 1937).

The infective stage of the *proteocephalidean*s reaches their final hosts through food chain (trophic level) relationship for their survival in the common habitats they live. It has been difficult to obtain well-compiled and studied documents about their life cycle. However, studies are available conducted in the subfamily representatives of *proteocephalideans* and a lot of Palaearctic *Proteocephalus* species complied by Scholz (1999).

Since the *proteocephalideans* are cestodes they require intermediate hosts usually the planktonic arthropods (e.g., Copepod) to complete their life cycles. Their life cycle consists of adult (monoecious and dioecious) (rarely) in the definitive hosts produces and releases eggs with oncospheres; the six-hooked (hexacanths larvae) get in water. Appropriate hosts should have ingested the oncosphere in the eggs. Once the oncosphere is in its suitable host (first intermediate host), it penetrates through gut lumen into the body cavity (parenteal site) where it metamorphoses and grows into procercoid or metacercoid (plerocercoid) (Freeman, 1973 and Scholz, 1999). The plerocercoid inturn grows and differentiates into various specialized organs or tissues characteristics of its species within its final host. If piscine host ingests the intermediate host, the plerocercoid survives in different tissues of the reservoir host until it gets transferred to its precise definitive host. The number of intermediate host requirement to proteocephalidean life cycles varies from species to species. Nevertheless, one intermediate and a final host is minimum (Kennedy, 1983 cited in Zehnder, 2000). Most of the time proteocephalideans prefer *Siluriforme*s fish especially for their final life cycle completion as described previously.

Proteocephalus species spread all over the world where Siluriformes are found, except in Australia and Indochina peninsula. The Siluriformes (Catfish species; *Synodontis, Bagrus, Auchenoglanis, Heterobranchus, Clarotes, Malapterurus* and *Clarias*) and inhabit freshwaters of Africa (Woodland, 1925, 1937, Golubstov *et al*., 1995, Boulenger, 1906, 1911, 1915, 1916; Khalil, 1963). The studies that have been carried out in these water bodies revealed the *Proteocephalus* species diversity in Africa (Table1).

Table 1. Proteocephalidean fish parasites identified in Africa

Serial No	Parasites	Host	Country (continent)	Site
1	*Corallobothrium solidum* Fritsch, 1886	*Malapterurus electricus*	North Africa	Nile
2	*Electrotaenia malapteruri* Fritsch, 1886	*Malapterurus electricus*	North Africa	Nile
3	*Marsipocephalus daveyi (Woodland, 1937)*	*Heterobranchus bidorsalis*	North Africa	Nile
4	*Marsipocephalus heterobranchus* Woodland, 1925	*Heterobranchus bidorsalis*	North Africa	Nile
5	*Marsipocephalus rectangulus* (Wedl, 1861)	*Heterobranchus anguillaris*	North Africa	Nile
6	*Marsipocephalus tanganyikae* (Fuhrmann & Baer, 1925)	*Clarias lazera*	Africa	Lake Victoria
7	*Proteocephalus beauchampi* Fuhrmann & Baer, 1925	*Chrysichthys sp*	Africa	Congo
8	*Proteocephalus bivitellatus* Woodland, 1937	*Tilapia sp*	N. Africa	
9	*Proteocephalus cunningtoni* Fuhrmann & Baer, 1925	*Dinotopterus cunningtoni*	Africa	Lake Victoria
10	*Proteocephalus dinotopteri* Fuhrmann & Baer, 1925	*Dinotopterus cunningtoni*	Africa	Lake Victoria
11	*Proteocephalus glanduliger* (Janicki, 1928) Fuhrmann, 1933	*Clarias anguillaris*	Africa	Nile
12	*Proteocephalus largoproglottis* Troncy, 1978	*Synodontis membranaceus*	Africa	Lake Chad
13	*Proteocephalus membranacei* Troncy, 1978	*Synodontis membranaceus*	Africa	Lake Chad
14	*Proteocephalus pentastoma* (Klaptocz, 1906)	*Polypterus bichir, P. endlicheri*	Africa	Nigeria, Sudan
15	*Proteocephalus sulcatus* (Klaptocz, 1906) La Rue, 1911	*Polypterus endlicheri, Clarotes laticeps*	Africa	White Nile
16	*Proteocephalus synodontis* Woodland, 1925	*Synodontis shall*	Africa	Nile
17	*Sandonella sandoni* (Lynsdale, 1960)	*Heterotis niloticus*	Africa	Sudan Nile

Ethiopia has enormous inland freshwater resources and about 168-183 fish species (Golubtsov and Mina, 2003). As compared to other ecoregions of Africa what has been explored about Proteocephalus species in siluriformes and cypriniformes of Ethiopian freshwaters is insignificant. There has been nothing done on fish parasite in the rivers Ethiopia and even in lakes insignificant attempts have been done. For example, in the preliminarily fish parasite investigation in Lake Tana, Lake Langano, Lake Awassa, Shelle River, Beshilo River, Omo- River and Beles River (Babazenda site (de Chambrier *et al.,* 2006*)* (unpub.data) has shown the occurrence of Cestodes, Nematodes and Trematodes and a new genus and species of proteocephalidea (Table.2).

Table 2. Fish parasites identified in 2006 in some rivers and lakes of Ethiopia .

Parasites		Host	Habitats	Sites
Cestodes	*Polyonchobothrium clarias*	*Clarias gariepinus*	Intestine	LakesTana,Langano,Chamo, Ziway, Awassaand Shelle River,
	Polyonchobothrium sp.	*H. bidorsalis*	Intestine	Omo river, omorate
	Ligula intestinalis	*Barbus humilis, B. brevicephalus, B. tsanensis, B. intermedius*	Body cavity	Lake Tana
	Botheriocephalus eughenogalanthii	*Barbus nedgia*	Body cavity	Beshilo River
	Paracamallanus cyathophyrnyx	*Clarias gariepinus*	Intestine	Lake Ziway
	Acanthocephalidea	*B .nedgia*	Body cavity	Beshilo River
	Eustrongylides sp.larvae	*Cyprinidae*		Lake Tana
	Proteocephalidea n. gen.	*Clarias gariepinus*	Intestine	Lake Tana
	Proteocephalidea sp.	*Clarias gariepinus*	Intestine	Langano lake
		H. bidorsalis	Intestine	Omo River, omorate
Trematoda	*Clinostomum complanatum* larvae	*B. brevicephalus*	Body cavity	Lake Tana
Nematoda	*Capillaridae sp.*	*B. humulis*	Liver	Lake Tana
	Camallanus sp.	*Clarias gariepinus*	Intestine	Lake Tana
	Philometra sp.	*B. humilis*	Mesentery	Lake Tana
		S. schall	Intestine	Babizenda (Beles) River
	Contracaecum sp larvae	*Oreochromis niloticus*	Pericardium	Lake Tana
Monogenea	Macrogyrodactylus clarias	*Clarias gariepinus*	Gill	Lake Tana
	Gyrodactylus sp.1	*Clarias gariepinus*	Gill	Lake Tana
	Gyrodactylus sp.2	*Clarias gariepinus*	Gill	Lake Tana
	Cichlidogyrus sp.1	*Oreochromis niloticus*	Gill	Lake Tana
	Gyrodactylus sp.1	*B. humilis*	Gill	Lake Tana
	Gyrodactylus sp.2	*B. humilis*	Gill	Lake Tana
	Gyrodactylus sp.3	*Garra tana*	Gill	Lake Tana
	Gyrodactylus sp.4	*Garra tana*	Gill	Lake Tana
	Gyrodactylus sp.5	*B. intermedius*	Gill	Lake Tana
	Gyrodactylus sp.6	*B. humilis*	Gill	Lake Tana

1.1.The parasite status of the Ethiopian lotic and lentic water bodies

It was only a few parasites of fish (*Macrodyctylus clarii* in *Clarias sp*. and *Aplectana Chamaeleopis* in *Tilapia nilotica*) that have been reported (Khalil, 1971) 30 years ago. Studies were undertaken in few lakes by several researchers such as in Awassa (Shibru Tedla and Gebreigzabiher, 1979), Lakes Chamo and Awassa (Amare Tadesse, 1986) Lake Tana (Tefera Wondim, 1990; Eshete Dejen, 2003) and Lake Ziway (Wudneh Tamirat, 1996 and Eshetu Yimer, 2000). Their results revealed different fish parasite species of Trematodes, Nematodes, Cestodes and Crustacean in a variety of species of fishes like Cyprinidae, Clariidae and Bagridae.

The Pseudophallidean fish parasites, *Botheriocephalus aegypticus* (Amare Tadesse, 1986) in *Barbus gregorii* and *Barbus nedgia*, *Ligula intestinalis* (Amare Tadesse, 1986 and Eshete Dejen, 2003) in *Barbus gregorii* and *nedgia* (Awassa) and *Barbus humilis* (Tana), *Botheriocephalus sp*. (Eshetu Yimer, 2000) in *Clarias gariepinus* (Ziway), 13 –25 mm long; unsegmented; monozoic Cestode – like worms (Teferra Wondim, 1990) in *Barbus surkis* and *Barbus nedgia* (Tana), *Botheriocephalus aucheilognathii* and *Acanthocephala sp*. (de Chambrier et al., 2006) in Cyprinid fishes (Beshilo River) and other water bodies were observed.

In the preliminary assessment of fish parasites in March and November 2006 in Rivers and lakes mentioned above about 23 fish parasite species were recorded (Table .2). This shows that very little has been studied so far (Amare Tadesse 1986 and Tefera Wondim, 1990) and further intensive fish parasites study is needed in the inland water bodies of the country. Therefore, the present study was designed taking into account the gap that exists in this field of study. The study was focused on the following objectives to contribute its share in the accumulation of knowledge in fish Parasitology.

2. OBJECTIVES

2.1. General objective

Compare the composition of the cestode fauna in the African fish (*Clarias gariepinus*) from three Ethiopian lakes.

2.2. Specific objectives

The specific objectives of the study are to:

1) Identify the species composition of tapeworms (Cestodes) in the African catfish (*Clarias gariepinus)* in Lakes Tana, Ziway and Awassa;

2) Compare differences in the species composition and distribution of fish cestodes in the lakes;

3) Estimate infection and mean intensity of the hosts (*Clarias gariepinus)* in different seasons of the year,

4) Assess relationship between Cestode (tapeworms) and size of fish, and

5) Identify site preference of cestodes in the intestine of the infected host.

3. MATERIALS AND METHODS

3.1. Description of the study areas

The study was conducted in Tana, Ziway and Awassa Lakes (Fig.1). Lake Tana is located in the Northwestern highlands of Ethiopia in Amhara region. It is located at 11° 35' N, 37° 24' E and with an altitude of 1830 masl. Lake Tana is the source of the Blue Nile, which is isolated from its lower basin by 30 m Blue Nile Water fall (Tis-Isat; Smoking fall) from its outflow (Fig. 2). The lake is formed through volcanic blocking of the Blue Nile River in early Pleistocene times. It is an Oligo-mesotrophic shallow lake (average depth 8 m, max. depth 14 m) with the surface area of 3150 km^2. It is the country's largest lake (Dejen *et al*., 2004). The lake provides habitats for several species of endemic barbs (*Barbus spp.*) and other cyprinids (*Nile tilapia*, *Oreochromis niloticus*; *Varicorhinus beso*; *Garra sp*p. and African catfish (*Clarias gariepinus*) (Abebe Getahun, 2000; Negelkereke, 1997; Boulenger, 1906, 1911; Negelkereke and Sibbing, 1996).

Lake Tana also provides habitats for Nile monitor (*Varanus niloticus*), Phyton (*Phyton sebae*), and aquatic birds; little grebe (*Tachybaptus ruficollis*), Great white pelicans (*Pelecanus onocrotalus*), Great and longtailed comorants (*Phalacrocorax carbo*, and *P. africanus*), Darter (*Anhinga rufa*), many species of heron, Hammerkop and African fish eagle.

Lake Ziway is situated in Oromia regional state, East Shewa zone, 165 km South of Addis Ababa (8° N and 38°. 40" E) at an altitude of 1840 masl. (Balarine, 1986; LFDP, 1995). Its surface area is 434 km^2, with average depth of 2.4 m. The most abundant fish species of the lake are *Oreochromis niloticus, Tilapia zilli, Barbus spp.,* C*larias gariepinus and Carp. sp.(*Eshetu Yimer, 2000). It also harbours the endemic fish species, *Labeobarbus aethiopicus*. This lake is also home to various birds (Pelicans and lesser flamingo and reptiles (Nile monitor) (Eyualem Abebe, 1990).

Lake Awassa is located in the South Nations and Nationalities Region, 275 km south of Addis Ababa, at an altitude of 1680 m. It has a surface area of 90 km^2, maximum depth of 23 m and mean depth of 10.7 m. The fish fauna consists of *Oreochromis niloticus, Barbus* *species, Barbus paludinosus (small Barbus), Clarias gariepinus, Labeobarbus intermedius, Garra* and *Aplocheilichthys.*

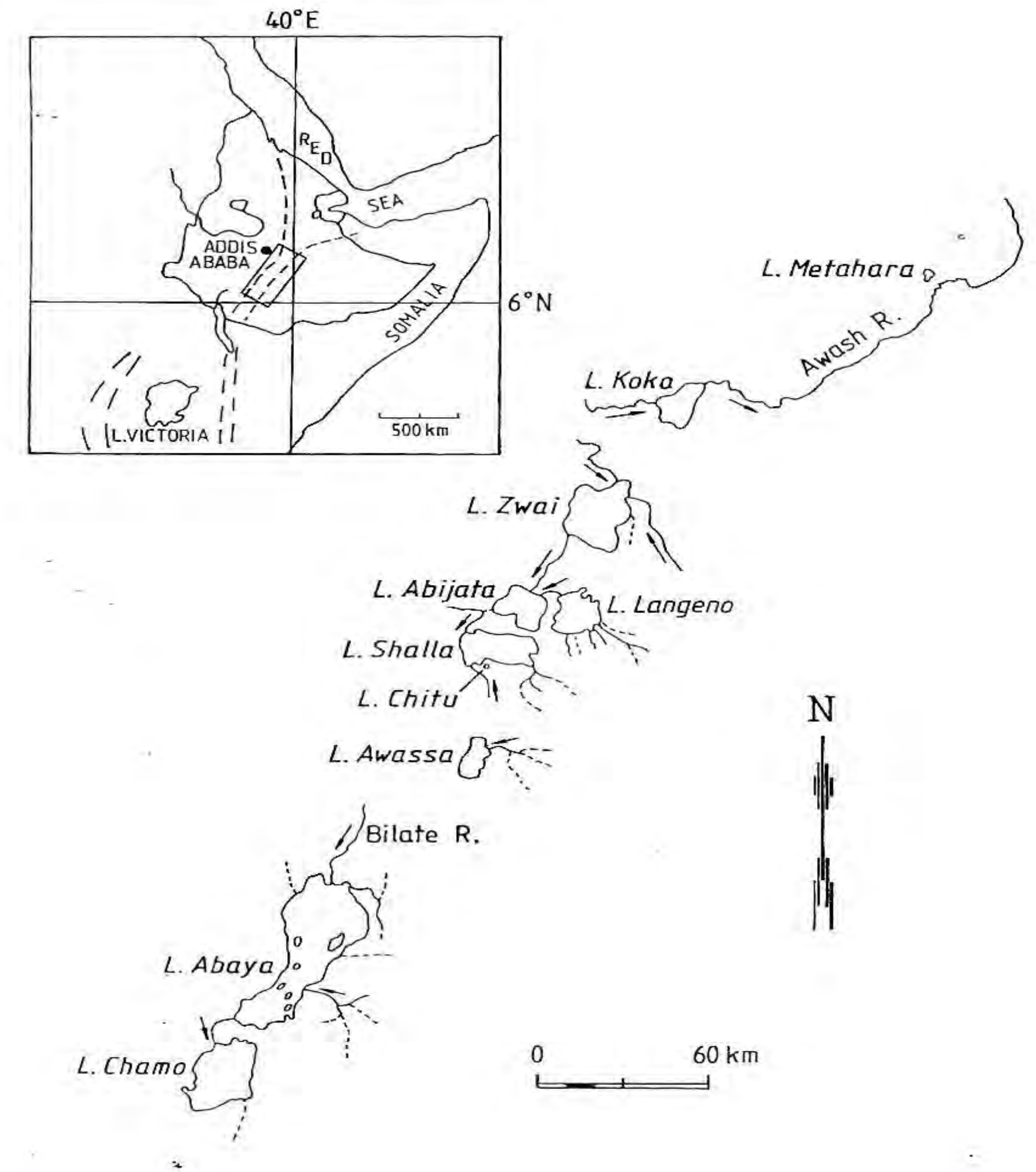


Fig.1 Lakes Awassa and Ziway, they are part of the Rift valley lakes in the Great Rift Valley of Africa (source: Elizabeth *et al., 1994*).

Fig. 2**.** The Blue Nile fall below 30 km of Lake Tana (photo taken in 2006)

3.2. Sampling of parasites

Clarias gariepinus specimens were caught with gillnets of 8, 10, 12 and 14 cm mesh size stretch and multiple long lines from the study areas. In all lakes some of the fishes were bought from local fishermen. All the fish examined were alive. The fish weight and length were measured immediately before dissection to the nearest 0.1g and 0.1cm respectively. A total of ninety fish specimens were collected during the study period. They were cut open starting from the anus to the end of the operculum where the oesophagus joins the stomach. After the intestinal mesentery tissues have been cleaned, the intestine was separated from the stomach and its length was measured. Then intestines were examined for the presence of cestodes using saline water, scissors, needles, petri dishes, labels, 96 % alcohol, 4% neutral formaldehyde solution, glasses, and black contrasting object.

The collected cestodes from the intestines were fixed immediately after dissection in 4 % hot neutral formaldehyde solution and in 96 % pure alcohol. The cestodes were sent to the Natural History Museum of Geneva for genetic analysis. Some of the samples from each were stained with Mayer's hydrochloric carmine, dehydrated in an ethanol series, cleared with eugenol (clove oil) and mounted in Canada balsam (de Chambrier, 2001).

3.3. Identification of Cestode parasites

The identification of the cestodes was performed at the Natural History Museum of Geneva. The parasites were identified based on their morphology, drawings, light microscopy and scanning electron micrography in the Museum. The following keys were used for identification (Yamaguti, 1958, 1959, and 1961, Freze, 1965, Schmidt, 1986, and Rego, 1964). The expertise and the researcher in the field did the classification. Some of the cestodes that are confirmed to be new genus are being characterized.

4. RESULT

4.1. **Cestode species composition**

The cestode parasites that have been identified from the examined hosts were *Polyochobotherium clarias, Proteocephalus glanduliger*, *Proteocephallidea. n. genus*. *Proteocephallidea sp.* and Caryophyllaeus *sp*. Trematodes, Nematodes and Argulidae were encountered when Cestodes were collected from the host intestine in Lakes Awassa and Ziway. Argulidae was encountered only in Lake Awassa. All the cestode parasites mentioned in Table 3 were found in Lake Tana. *Polyochobotherium clarias* was common in the three lakes and *Proteocephallidae sp. was* found both in Lake Tana and Ziway (Table. 3). The orders Caryophyllidea and *Proteocephallidea n. genus* were only collected from Lake Tana. The species identified can be grouped under three orders, five families, five genera and five species including the new genus and species that is being characterized (Table.4)

Table 3. The parasite composition in Lake Awassa, Tana and Ziway (+ = present, X = absent

Parasites	Lakes		
	Awassa	Tana	Ziway
Caryophillidea	X	+	X
Polyochobothrium clarias	+	+	+
Proteocephalus gladuligerus	X	+	X
Proteocephalidea sp.	X	+	+
Proteocephalidae. n.genus	X	+	X
Trematodes	+	X	+
Nematodes	+	X	+
Argulidae (*Dolop notranum*)	+	X	X

Table 4. Classification of cestode parasites identified from the three lakes (Awassa, Tana and Ziway)

Class	Order	Family	Genus	Species
Cestoda	Pseudophyllidea	Ptychobothrium	*Polyonchobothrium*	*P. clarias* Diesing, 1954
	Proteocephalidea	Proteocephalidae La Rue, 1911	*Proteocephalus* Weinland*, 1858*	*P. glanduliger* (Janicki, 1928)
		Proteocephalidae	new genus ?	New species ?
		Proteocephalidae La Rue, 1911	*Proteocephalus* Weinland*, 1858*	sp.
	Caryophyllidea	Caryophillidae	*Caryophyllaeus*	*Caryophyllaeus sp*.

4.2. Infection of Cestode parasites in the studied lakes

The total number of *C. gariepinus* examined was 90, 44 (48.89%, Lake Tana), 22 (24.44%, Lake Ziway) and 24 (26.67 %, Lake Awassa). Of which 59 (65.56 %) were infected and 31 (34.44%) were free. In the infected hosts 32 (35.56 %) were males and 27 (30 %) were females. Among the infected hosts 14 (15.56 %), 21 (23.33 %) and 25 (27.78 %) were in Lakes Awassa, Ziway and Tana respectively.

When the cestode parasites incidence was compared with the total parasite specimens collected it had the following figures. The incidence of *Polyochobothrium clarias* was 86.0 %, *Proteocephalidae. n. genus* (7.2 %), *Proteocephalidea sp.* (4.2 %), *Proteocephalus glanduliger* (2.12 %), and *Caryophyllaeus sp*. (0.42 %). With regard to their prevalence in each lake, the occurrence of *Polyochobothrium clarias* was 43.4 % (Lake Tana), 97.6 % (Lake Ziway), and 100 % (Lake Awassa). The incidence of *Proteocephalus glanduliger was* 9.4 % in Lake Tana. The prevalence of *Proteocephalidea sp*. was 13.2 % (Lake Tana) and *Proteocephalidea sp*. 2.4 % (Lake Ziway). *Proteocephalidae. n. genus* in Lake Tana was 32.1%.

4.3. Relationship between cestode intensity and size of fish (Total length, intestinal length and weight).

The relationship between total fish length and cestode intensity, intestinal length and Cestode intensity and weight and cestode intensity was significantly different ($P < 0.05$) for the combined data respectively.

The *Polyonchobothrium clarias* infection and intensity (load) per fish was not significant between females and males in the studied Lakes ($P > 0.05$). The intensity of *Polyonchobothrium clarias per* fish seemed higher in Lake Ziway (8 worms per fish). But it did not show significant difference statistically ($P > 0.05$).

4.4. Location of parasites in intestinal tract of *C. gareipinus*

Polyochobothrium clarias occupied the anterior (duodenum) of the intestine in all host examined in the three lakes. The *Proteocephalus glanduliger* inhabited both in the anterior and posterior portion of the host intestine in Lake Tana. However, the anterior, middle and posterior part of the host intestine was occupied by *Proteocephalus n. genus. Caryophyllidea sp.* was collected from the middle part of the intestine (Table**.** 5). In both Lakes Tana and Ziway sharing of the intestine habitat among two or more cestode parasites was observed. This was either in the same or different portion of the intestine.

Table 5. Cestode parasite location in the host intestine, number of fish infected intensity of Cestode species per fish in Lakes Awassa, Tana and Ziway.

Sites	Species	Location	Total number (intensity)	N	Intensity/fish
Tana	*Polychobothrium clarias*	Anterior	21	8	2.63
		Unlocalized	2	1	2
	Proteocephalus glanduliger	Anterior	4	2	2
		Middle	1	1	1
	Proteocephalidea sp.	Middle	3	1	3
		Posterior	1	1	1
		Unlocalised	3	3	1
	Proteocephalidea n. sp	Anterior	6	2	3
		Middle	8	3	2.67
		Posterior	3	3	1
	Caryophillidea sp.	Middle	1	1	1
Awassa	*Polychobothrium clarias*	Anterior	50	10	5
		Unlocalised	3	2	1.5
	Polychobothrium clarias larvae	Unlocalised	3	1	3
Ziway	*Polychobothrium clarias*	Anterior	120	15	8
		Unlocalised	4	2	2
	Proteocephalidea .sp	Middle	1	1	1
		Unlocalised	2	2	1

4.5. The parasite intensity (load) in the host intestine

The mean intensity of parasite (load) in the host ranged from 1 to 8 cestodes per fish or intestine. The highest mean infection load (intensity) per fish or intestine was observed in Lake Ziway by *Polyonchobothrium clarias* (i.e., 8 worms / fish or intestine) with a maximum of 38 worms per fish. The mean intensity of infection in Awassa was 5 worms per fish with a maximum load of 24 worms per fish. The mean infection intensity of *Polyonchobothrium clarias* in Tana Lake was 2.67 worms fish or intestine with maximum of 12 worms per fish. In the present study, this cestode parasite was the most abundant in all the three lakes and the highest has been found in Lake Ziway.

4.6. Mean intensity of cestode infection in dry and wet seasons

The mean intensity of *Polyonchobothrium clarias* per fish or intestine ranged from 2.56 (Lake Tana) to 5.7 (Lake Awassa) in dry season. In wet season the mean intensity per fish was 2 (Lake Tana) and 8.5 (Lake Ziway). *Polyonchobothrium clarias* larvae, *Proteocephalus glanduliger* and *Caryophillidea sp.* were recorded in wet season. *Polyonchobothrium clarias* was the most dominant in the three Lakes but highest mean intensity was observed in Lake Ziway in the wet season.

5. DISCUSSION

Polyochobothrium clarias Diesing, 1854 species is widely distributed in Silurioid fishes of African freshwater resources (Mashego; 2001). It has been identified from Nigeria in *Clarias laz*era (= *C. gariepinus*) (Cuvier and Valencinnes, 1840) and, from Egypt in *Clarias lazera* (=*C. gariepinus*) (Imam *et al*., 1990), from Gabon in Bagrid catfish *Chrsichthys thonneri*, Steindacher, 1912 (Khalil, 1973), in the mudfish, *Clarias angularis* (Linnaeus, 1758) and *Hetrobrancus bidorsalis* Geoffroy Saint-Hailaire,1909 from Senegal ,in *Clarias lazera* from lower Egypt (Faisal *et al*.,1989), in *C. angularias* from Egypt (Amin,1978), and in *Clarias mossambicus* (Peters), from Uganda lakes (Wabuke-Bunoti,1980). This species was also identified in *C. gariepinus* from several dams of South Africa (Barson, 2004). *Polyochobothrium clarias* infection was observed in brown squeakers, *Synodontis zambenensis* Peters, 1852 in Zimbabwe (Chishawa, 1991) and Dvuillou (1992). Further more, *Polyonchobothrium clariae* and *Polyonchobothrium polypteri* (Leydig, 1853) have also been reported from Nigeria in *Claias gareipinus* (Oniye *et al*., 2004) and from Sudan in *Polypteru*s species (Jones, 1980). Larvae of *P. clarias* were found in the copepod intermediate host. *Polyochobothrium clarias* Diesing, 1854 incidence in the three lakes was in agreement with the study results in African inland water bodies. It was the most abundant species in these lakes. In the present study *P. clarias* larvae were observed in *C. gariepinus* intestine in Lakes Ziway, Tana and Awassa.

Proteocephalus glanduliger was recorded in South Africa in *C. gariepinus* (Mashego *et al.,* 1989). No one has reported this species from Ethiopian freshwater fishes prior to this study. *P. glanduliger* (Janicki, 1928**)** was identified only in Lake Tana in the present study.

Caryophyllidea occurs in a wide range of fish families (Silurids and Cyprinids) (Williams and Jones,1994). Caryophyllidean tapeworms were identified from the intestine of Cyprinidae in Japan (Scholz *et al.,* 2001), Silurid Nile fish *Synodontis schall* (Ibraheem and Mackiewicz, 2006). The *Caryophyllaeus sp*.was observed once in Lake Tana catfish. The unidentified monozoic worms that have been collected by Teferra Wondim, 1990 *Barbus spp*. might be Caryophyllidea since both have similar features.

The present study contributed additional fish parasite diversity to what has been identified so far. There might be (Nematodes and Trematodes) that are new freshwater fish parasites identified in the preliminarily assessment in 2006. However, the Cestode *Proterocephalus clarias* and *Proteocephalus glanduliger* might be new to Ethiopian freshwater fish parasite. *Proteocephalidea n. genus* that is being characterized might be new to Science (de Chambrier per. Comm.).

The intensity of *Proterocephalus clarias* that has been observed in *Clarias greipinus* was 123 and 200 in South Africa (Mashego, 1977), and Nigeria (Aderounmu and Adenyi, 1972) respectively. However, intensity of *P. clarias* recorded in *Clarias lazera* of Egypt was 2-4 per fish (Dayhoum A.H.M. and Al-Bassel, 2003). The mean intensity (no of worms per fish infected) reported in *Clarias mossambicus* was 6.68 (Mabuke-Bunoti, 1980). The mean intensity of *Proterocephalus clarias* in the studied lakes was relatively greater than 2-4 worms per fish (Egypt) (2.67 to 8 worms per fish) while very much less than the South Africa and Nigeria fish infection and it was almost equivalent to 6.68 worms per fish (Sudan)(Mabuke-Bunoti, 1980) and the genera *Proteocephalus* (*Proteocephalus sulcatus* (klaptocz, 1906) 4.4 worms per fish (Sudan) (de Chambrier *et al*., 2007).

6. CONCLUSIONS AND RECOMMENDATION

6.1. **Conclusion**

An attempt has been made to identify fish parasites in some lakes of Ethiopia (Lakes Awassa, Tana and Ziway). A total of specimens of 90 *C. gariepinus* were examined; 44 (Lake Tana), 22 (Lake Ziway) and 24 (Lake Awassa). Of the fish examined 65.56 % were infected and 34.44 were free. Among the infected hosts 35.56 % and 30 % were females and males respectively. The cestode parasites identified were *Polyonchobothrium claria*s, *Proteocephalus glanduliger*, *Proteocephalidea n. genus* and species and *Caryophalidea sp*. The prevalence of *Polyonchobothrium clarias* was 86.0%, *Proteocephalidea n. genus 7.2 % and proteocephalidea sp.* 4.2 % in the pooled data. With regard to the incidence of *Polyonchobothrium clarias* in each lake it was 43.3 % (Lake Tana), 97.6 % (Lake Ziway*)* and 100 % (Lake Awassa*).*

The cestodes parasites of fish in Lake Tana were more diverse than Lake Awassa and Lake Ziway. Lake Ziway had only one species (*Polyonchobothrium clarias*). Some of the species (*Polyonchobothrium clarias, Proteocephalus glanduliger*) might be new to the country freshwater fish parasite fauna and one new genus and species that might be new to Ethiopia and science (de Chambrier per. comm.).

Generally, the present and the preliminary studies identified about 22 fish parasite. These fish parasites were categorized to Cestodes, Trematods, Nematodes and crustaceans.

6.2. Recommendations

The fish Parasitology study is still at its infancy to show the fish parasite potential of the inland water bodies of the country. The present and the previous studies have shown that the freshwater fishes of Ethiopia harbor diverse fish parasite species. The fish parasite diversity, life cycle of fish parasites, the effects of parasites to wild fish and farmed fish, parasite host relationship, and host specificity studies are lacking. Results of this kind of study would have great significance in elaborating control measures against the parasites. It is vital tool to take care of translocation of parasites from one water body to another as well as exotic fish parasites. Such studies should therefore be carried out in broad dimensions, as more fish production is being initiated through aquaculture in the future development plans of the country.

Parasites of the freshwater fishes of Ethiopia are not well known in most of the inland waters. It is difficult to outline conclusions about the parasite fauna of the country's freshwater fishes. Further intensive study is required in all the water bodies of the country.

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10. Appendices

I. MORPHOMETRIC AND MERISTIC FEATURES OF FISHES

Morphometric parameter	*Labeo forskalii*				
% SL	Average	Median	Standard deviation	Min	Max
BD	27.14	26.86	2.17	24.85	30.00
HL	22.83	24.12	2.95	18.42	24.66
PREDL	41.90	43.05	3.49	36.84	44.67

CPL	14.19	13.85	2.03	12.11	16.97
CPD	12.08	12.39	1.10	10.53	13.01
DSPL	25.52	25.06	1.74	23.97	28.00
PECFL	21.21	20.88	1.54	19.74	23.33
PELFL	21.21	20.88	1.54	19.74	23.33
AFL	17.28	17.70	2.16	14.38	19.33
DSBL	17.18	17.65	1.75	14.74	18.67
PECBL	5.08	5.06	0.37	4.74	5.45
PELVBL	4.87	4.76	0.44	4.47	5.48
ABL	7.02	6.76	0.66	6.58	8.00
PROL	11.97	12.53	1.71	9.47	13.33
% HL					
SNL	40.09	42.68	6.41	44.44	
OD	10.13	9.84	2.02	12.50	
HW	67.40	69.44	8.78	75.71	
IOL	46.29	46.47	1.12	47.22	
Meristic features					
LLS	39 --41				
LLS_ LLs	6-6.5				
LLS _ belly	5--7				
LLS-pelvic fin	4.5--6				
LLS -pectoral fin	3.5--6.5				
LLS -anal fin	5--5.5				
DSNO	III,10(9)				
AFLNO	III, 5				
DSH	Concave				
HSH	Straight				
Anterior barbel length	Very minute at the corner				

Morphometric parameters	*Hetrobranchus longifilis*					
%SL	Average	Median	Std	Min.	Max.	N
HL	22.45	22.45	0.63	22.00	22.89	2
BD	15.33	15.33	0.47	15.00	15.66	2
PRDL	30.46	30.46	2.18	28.92	32.00	2
CPL	4.07	4.07	1.32	3.13	5.00	2
CPD	9.32	9.32	0.45	9.00	9.64	2
PCFL	15.33	15.33	0.47	15.00	15.66	2
PELFL	11.44	11.44	2.21	9.88	13.00	2

AFL	41.12	41.12	1.24	40.24	42.00	2
DSBL	30.16	30.16	1.64	29.00	31.33	2
PCFBL	4.55	4.55	0.64	4.10	5.00	2
PELFBL	3.33	3.33	0.95	2.65	4.00	2
AFBL	35.97	35.97	1.46	34.94	37.00	2
Adipose FL	22.84	22.84	1.64	21.69	24.00	2
%HL						
OD	7.78	7.78	0.58	7.37	8.18	2
HW	37.82	37.82	4.36	34.74	40.91	2
IOW	67.03	67.03	5.48	63.16	70.91	2
SNL	29.59	29.59	3.15	27.37	31.82	2
ML	77.39	77.39	12.69	68.42	86.36	2
MW	46.41	46.41	1.35	45.45	47.37	2
NBL	95.77	95.77	3.01	93.64	97.89	2
MXBL	37.37	37.37	3.72	34.74	40.00	2
WTL	5.89	5.89	0.61	5.45	6.32	2
DSNO	31- 34					2
ASNO	45-48					2

Morphometric parameters	*Varicorhinus beso*					
%SL	Average	Median	Std	Min.	Max.	N
BD	30.49	30.81	2.08	28.13	32.73	5
HL	23.55	23.43	0.79	22.73	24.86	5
PREDL	47.99	48.64	1.53	45.95	49.58	5
POSDL	36.10	36.36	1.97	33.85	38.14	5
CPL	18.22	18.23	0.89	16.95	19.46	5
CPD	12.79	13.54	1.29	11.35	13.98	5

DSPL	19.25	18.38	1.56	17.80	21.35	5
DFL	20.87	20.57	1.34	19.49	22.92	5
PECTFL	20.93	20.83	0.57	20.34	21.82	5
PELFL	18.48	18.23	0.37	18.18	18.92	5
AFL	20.54	21.19	1.61	17.71	21.62	5
DSBL	17.95	18.23	1.69	15.45	19.92	5
PECBL	4.25	4.24	0.20	4.00	4.55	5
PELVBL	4.88	4.66	0.40	4.55	5.41	5
ABL	8.69	9.09	0.92	7.63	9.71	5
PREOL	8.82	8.90	0.36	8.33	9.19	5
%HL						
HW	79.15	81.82	11.40	60.98	88.89	5
SNL	34.81	33.33	9.65	22.73	48.00	5
IOW	47.68	48.78	1.70	45.65	49.09	5
OL	47.68	48.78	1.70	45.65	49.09	5
ED	17.77	17.78	1.27	16.00	19.51	5
%OD						
ODL	83.50	87.50	5.76	75.00	87.50	5
SNL	67.43	66.67	8.15	57.14	80.00	5
IOL	37.26	37.04	1.95	34.78	40.00	5
BL	55.00	50.00	11.18	50.00	75.00	5
Meristic features						
DSNO	IV,10(9)					5
ASNO	III,6(5)					5
Dorsal spine shape	concave ,straight					5
head shape	straight, convex					5
Later line scales	30-35					5
Caudal fin type	forked					5
Dorsal fin insertion	in advance of ventral					5

Morphometric parameters	*Labeobarbus nedgia*				
%SL	Average	Std.	Min	Max	N
BD	28.07	1.74	26.56	30.53	5
HL	26.86	5.67	17.02	31.25	5
PDL	52.00	0.90	51.22	53.16	5
CPL	16.67	3.41	13.62	21.95	5

CPD	16.33	3.85	11.91	21.95	5
PCFL	20.51	0.92	19.51	53.16	5
DFL	23.58	1.99	21.70	25.79	5
PFL	18.10	0.99	17.07	19.47	5
AFL	19.48	0.87	18.05	20.31	5
DBL	14.05	0.93	13.16	15.38	5
PBL	4.24	0.58	3.68	5.13	5
ABL	7.36	0.77	6.32	8.21	5
%HL					
HW	58.65	7.65	50.00	70.18	5
SNL	34.75	1.38	33.33	36.36	5
OD	15.76	2.17	13.00	18.18	5
IOL	35.79	11.11	27.27	55.00	5
Meristic characters					
Dorsal spine number	IV 9,(8)				5
Anal fin number	III,5				5
Dorsal spine shape	Concave				5
Head shape	Straight				5
Caudal fin type	Forked				5
Dorsal fin insertion	Little in advance of ventral fin				5
Lateral line scales	30--32				5
Lateral line scales spine_ LLS	5.5--6				5
Lateral line scales _belly	3.5-4.5				5
Lateral line scales-pelvic fin	3.5-4.5				5
Lateral line scales - pectoral fin	2.5				5
Lateral line scales -anal fin	4.5--5.5				5

Morphometric parameters	*Barbus paludinosus*				
%SL	Average	SD	Min	Max	N
BD	0.254	0.017	0.235	0.276	5
HL	0.257	0.010	0.248	0.275	5
SNL	0.065	0.007	0.058	0.078	5
IOL	0.075	0.009	0.062	0.088	5
OD	0.075	0.009	0.062	0.088	5

LFB	0.057	0.006	0.047	0.065	5
LSB	0.086	0.007	0.078	0.097	5
BD	0.254	0.017	0.235	0.276	5
CPD	0.129	0.005	0.125	0.139	5
CPL	0.183	0.011	0.172	0.199	5
PREDL	0.495	0.024	0.468	0.533	5
DFL	0.232	0.012	0.215	0.250	5
Vent-anal Length	0.210	0.005	0.201	0.215	5
Thickness of dorsal spine length	0.222	0.001	0.015	0.016	5
Dorsal ossified fin length	0.172	0.026	0.138	0.209	5
% HL					
SNL	25.369	1.853	23.484	28.304	5
IOL	73.677	12.357	60.954	91.721	5
OD	21.982	3.203	16.958	25.546	5
HW	67.425	1.782	65.178	69.055	5
FBL	81.001	15.699	62.470	100.712	5
SBL	152.633	16.731	125.416	171.390	5
Meristic characters					5
Dorsal fin	III,7				5
Pectoral fin	13-16				5
Pelvic (ventral) fin	9(13 rarely)				5
No of scales on lateral line	27,31,34				5
No of scales on lateral line	27,31,34				5
Predorsal row	14-15				5
b/n dorsal fin origin & LL	5.5-6.5				5
B /n pelvic fin origin & LL	4.5-6.5				5
Caudal peduncle scale	14,16				5

Morphometric parameters	*Barbus humilis*				
%SL	Ave.	Std.	Min	Max	N
BD	23.2097	2.3945	18.92	26.57	10
HL	24.6223	2.1235	20.87	27.21	10
PDL	49.9062	3.3415	43.17	53.23	10
PCFL	15.8263	2.1856	12.53	18.69	10
CPL	17.2582	1.7561	14.41	20.73	10

CPD	12.2345	0.8802	10.88	13.54	10
DFL	17.5331	2.429	12.82	21.08	10
THDSP	0.97317	0.1064	0.799	1.104	10
PORL	40.9076	2.1559	38.19	44.42	10
%HL					
HW	67.4774	3.4853	63.77	74.94	10
SNL	25.004	4.7024	21.56	36.12	10
ED	19.3814	2.8159	15.65	23.45	10
IOL	29.5575	3.7778	19.72	33.55	10
%ED					
FBL	92.2952	18.528	67.4	125	10
SBL	148.371	29.27	116.4	220.3	10
Meristic characteristics					
Dorsal fin number	III, 7 (8)				10
Pectoral fin number	15-18				10
Pelvic (ventral) fin	8				10
Anal fin	III, 5				10
No of scales on lateral line	30-36				10
Predorsal row	14-16				10
b/n dorsal fin origin & LL	5.5-7.5				10
b /n pelvic fin origin & LL	5-5.5				10

Morphometric parameters	*Labeobarbus intermedius*				
% SL	Average	Standard deviation	Minimum	Maximum	N
BD	29.01	3.38	23.20	33.14	7
PREDL	28.80	3.38	23.20	33.14	7
PECFL	20.61	1.53	19.09	22.86	7
CPL	22.75	9.18	15.00	38.29	7

CPD	12.88	1.05	11.20	14.29	7
DFL	22.66	2.92	18.13	27.22	7
AFL	18.81	1.95	15.79	21.07	7
PFL	20.61	1.53	19.09	22.86	7
DBL	13.77	1.79	11.11	22.86	7
PSBL	4.90	0.52	4.00	5.45	7
ABL	7.20	1.17	5.45	8.00	7
PLBL	5.04	0.85	3.64	6.13	7
HL	26.19	1.21	25.00	28.27	7
% HL					
SNL	30.38	4.77	24.00	37.50	7
OD	18.03	2.56	14.15	20.83	7
IOL	42.27	4.65	37.74	50.91	7
ABL	16.98	5.64	10.64	24.00	7
PBL	24.10	6.52	15.87	31.25	7
%OD					
OL	82.78	4.43	80.00	90.00	7
PBL	133.33	41.31	90.00	200.00	7
ABL	94.44	35.19	50.00	146.67	7
Meristic features					
Dorsal spine number	IV,9(8,10)				7
Anal fin number	III,5				7
Dorsal spine shape	Concave				7
Head shape	Straight				7
Caudal fin type	Forked	Forked			7
Mouth type	Inferior	Inferior			7
Lip1	Continuous	Discontinuous			7
Lip2	Median lobe	No median lobe			7

Morphometric features	*Garra dembeensis*					
% Standard length	Average	Median	Std	Min.	Max.	N
BD	17.23	17.24	0.01	16.62	17.94	8
HL	17.23	17.49	0.45	16.94	18.26	8
PREDL	50.10	48.00	2.82	46.00	52.00	8
PECFL	15.70	15.88	0.62	14.52	16.34	8

CPDL	14.99	12.97	1.41	11.40	14.99	8
CPD	9.33	9.46	0.36	8.61	9.66	8
DFL	16.41	16.24	0.78	15.26	17.69	8
PELFL	13.38	13.42	0.69	12.58	14.25	8
ANFL	12.05	12.11	0.57	11.21	12.87	8
% Head length						
HW	62.06	61.85	2.59	57.57	66.27	8
SNL	39.69	40.88	4.26	34.63	46.39	8
OD	17.61	17.09	2.26	14.93	21.39	8
IOL	43.81	44.47	1.94	40.13	45.77	8
% Orbital diameter						8
RBL	83.85	85.21	9.25	67.17	97.87	8
MBL	51.57	49.80	9.50	37.69	64.59	8
Meristic features						
DFL	IV (10)					
AFL	IV (18)					
PECRFL						
PELVFL						
LLS	36 - 38					
CPSR						
Dorsal fin - LLS						
Pelvic -LLS						
Anal - LLS						
Disc C type						

Morphometric features *Garra dembecha*

% Standard length	Average	Std.	Min	Max	N
Body depth	19.55	2.61	13.88	24.53	10
Head length	23.32	0.95	21.99	24.88	10
Predorsal length	50.02	2.19	48.09	55.64	10
Pectoral fin length	18.68	1.35	16.39	21.47	10
Length of caudal peduncle	15.91	1.23	13.55	18.07	10

Depth of caudal peduncle	18.01	23.00	9.36	83.42	10
Dorsal fin length	19.01	0.85	17.86	20.38	10
Anal fin length	15.39	0.48	14.74	16.08	10
Pelvic fin length	15.73	1.01	14.60	17.54	10
% Head length					
Head width	55.47	1.79	52.38	58.34	10
Snout length	43.67	4.15	37.27	63.00	10
Orbital diameter	15.05	2.09	12.38	18.53	10
Interorbital distance	40.01	2.16	36.72	42.72	10
% Orbital diameter					
Rostral barbel length	83.97	16.85	58.61	116.96	10
Maxillary barbel length	62.25	14.56	41.39	88.84	10
Dorsal fin rays	IV+7				10
Anal fin rays	IV+5				10
Pectoral fin rays	IV+3(9-12)				10
Pelvic fin rays	III+2(6)				10
Caudal peduncle scale	14-16				10
Lateral line scale	37 - 39				
Dorsal fin origin - LLS	5 -6.5				10
Pelvic fin origin - LLS	4.5-6.5				10
Anal - LLS	3.5-4.5				10
Predorsal scale rows	12---16				10
Chest scales	No scale				10
Disc type	A				10
Post dorsal scales	full				10

Morphometric parameters		*Oreochromis niloticus*			
% SL	Average	SD	Min	Max	N
HW	29.09	2.01	26.32	30.95	5
HL	31.90	0.65	30.95	32.56	5
PREDL	36.96	1.84	34.62	39.05	5
PREOL	12.48	1.82	10.53	15.35	5
CPL	13.05	1.41	11.63	15.04	5
CPD	12.66	3.36	6.77	14.88	5

DSL	58.03	22.87	30.95	77.86	5
PECFL	34.46	2.83	31.43	39.07	5
PEFL	30.01	1.36	27.82	31.54	5
%HL					
HW	91.24	7.14	81.40	100.00	5
OD	17.04	0.54	16.28	17.78	5
OL	19.03	0.69	18.46	20.00	5
SNL	24.21	3.16	20.93	29.23	5
%OL					5
OD	89.57	2.29	87.50	92.31	5
SNL	142.16	18.80	125.00	172.73	5
Meristic features					
LLS	31-34				5
DSP_LLS	4.5-5.5				5
SECLL_belly	4.5--5.5				5
LLS_PECT	4.5-6.5				5
LLL_Anal	6.5-9.5				5
DSNo	16,11-17,12				5
Asno	III,8-10				5

Morphometric parameters	*Bagrus bajad*					
%SL	Average	Median	Std	Min.	Max.	N
HL	29.06	29.27	0.94	27.78	30.24	5
BD	85.79	84.42	5.86	78.74	94.44	5
PRDL	45.49	42.62	8.03	38.89	59.26	5
CPL	17.27	17.04	1.41	15.56	19.05	5
CPD	12.34	12.22	0.19	12.20	12.62	5
POSDL	46.11	46.30	2.97	41.67	50.00	5

PCFL	4.32	4.15	0.51	3.70	4.92	5
PELFL	14.84	14.75	1.69	13.33	17.62	5
AFL	16.09	15.56	1.91	13.66	18.33	5
DFL	22.42	22.96	1.98	20.00	24.59	5
DSBL	16.23	16.39	0.91	15.12	17.41	5
PCFBL	4.32	4.15	0.51	3.70	4.92	5
PELFBL	14.84	14.75	1.69	13.33	17.62	5
Adipose fin	25.34	29.63	9.12	9.26	31.15	5
Pectoral serrated	14.54	14.44	1.44	12.68	16.67	5
%HL						5
ED	9.05	8.66	1.28	7.79	11.11	5
HW	67.91	66.67	4.87	62.50	74.80	5
SNL	15.25	15.75	1.38	13.33	16.88	5
MW	54.62	55.56	4.25	48.00	59.06	5
NBL	21.04	25.56	12.39	0.00	31.17	5
MXBL	52.33	52.33	6.57	45.29	61.35	5
OMNBL	71.71	70.67	3.75	67.50	76.62	5
IMNBL	36.21	36.67	3.92	30.83	41.56	5
IOL	35.10	35.56	1.52	33.33	37.01	5
Meristic features						
Gill raker numbers	13,10					5
Caudal fin type	Forked					5
Dorsal fin insertion	Before vent, upper longer and pointed					5
Dorsal spine number	I, 9(10)					5
Anal spine number	II, (12) rarely 8					5

Morphometric parameters	*Bagrus docmac*					
%SL	Average	Median	Std	Min.	Max.	N
HL	27.56	27.56	2.61	25.71	29.41	2
BD	25.66	25.66	1.14	24.86	26.47	2
PREDL	42.75	42.75	0.15	42.65	42.86	2
CPL	15.92	15.92	1.72	14.71	17.14	2
CPD	9.42	9.42	0.40	9.14	9.71	2
POSDL	47.23	47.23	1.90	45.88	48.57	2

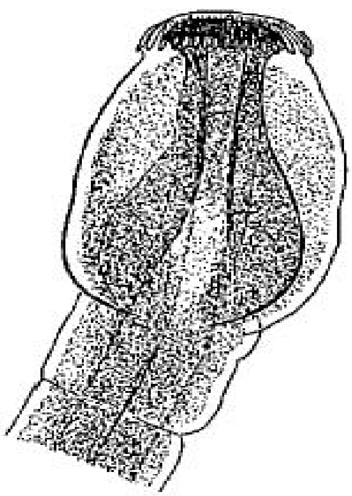
PECFL	15.66	15.66	1.14	14.86	16.47	2
PELFL	14.66	14.66	2.15	13.14	16.18	2
AFL	16.67	16.67	0.14	16.57	16.76	2
DFL	21.03	21.03	1.46	20.00	22.06	2
DSBL	15.65	15.65	0.09	15.59	15.71	2
PCFBL	4.79	4.79	0.30	4.57	5.00	2
PELFBL	4.93	4.93	0.10	4.86	5.00	2
Adipose fin length	4.93	4.93	0.10	4.86	5.00	2
Pectoral serrated length	30.42	30.42	1.43	29.41	31.43	2
%HL						
ED	10.06	10.06	1.49	9.00	11.11	2
NABL	27.89	27.89	0.16	27.78	28.00	2
HW	57.33	57.33	13.20	48.00	66.67	2
SNL	18.50	18.50	2.12	17.00	20.00	2
MXBL	51.19	51.19	0.89	50.56	51.81	2
OMNBL	79.67	79.67	5.19	76.00	83.33	2
IOL	37.50	37.50	3.54	35.00	40.00	2
VTL	53.17	53.17	14.38	43.00	63.33	2
IMDL	38.56	38.56	3.61	36.00	41.11	2
PMXBL	40.00	40.00	0.00	40.00	40.00	2
PMXTW	18.56	18.56	3.61	16.00	21.11	2
Meristic characters						
Gill raker numbers	9					
Caudal fin type	Forked					
Dorsal fin insertion	Advance of ventral					
Teeth band	Small sand paper type					
Dorsal spine number	I,(9,11)					
Anal spine number	IV(7,9)					

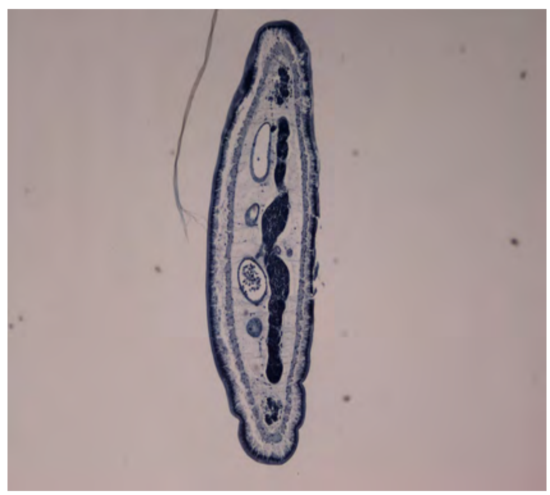
Morphometric parameters		*Raiamas loati*				
% SL	Average	Median	Std	Min.	Max.	N
BD	25.38	24.86	1.40	23.87	27.27	5
PREDL	61.25	61.29	1.02	60.00	62.58	5
CDPL	16.34	16.13	2.93	13.62	21.21	5
CPD	9.14	9.19	0.48	8.39	9.68	5
DSL	15.87	16.13	0.71	15.14	16.77	5
DFL	16.97	17.42	0.63	16.22	17.45	5

PECFL	4.45	4.52	0.38	3.87	4.85	5
PELFL	3.52	3.24	0.45	3.23	4.26	5
AFL	19.58	19.35	0.64	18.79	20.43	5
DSBL	11.03	10.81	1.01	10.32	12.77	5
PECFBL	4.45	4.52	0.38	3.87	4.85	5
PELFBL	3.52	3.24	0.45	3.23	4.26	5
AFBL	19.58	19.35	0.64	18.79	20.43	5
CDP-_DL	38.70	38.71	0.89	37.58	40.00	5
% HL						
ED	12.58	13.21	1.45	10.00	13.33	5
HW	56.06	55.56	4.62	49.06	61.43	5
OL	14.86	15.22	1.14	12.86	15.56	5
SNL	26.94	26.67	1.61	24.53	28.57	5
IOL	34.10	33.33	2.63	31.11	37.74	5
OCC_DL	74.63	74.19	1.97	72.58	77.78	5
Meristic features						
Dorsal spine number	III,9					5
Anal fin number	III, 14-15					5
Dorsal spine shape	Straight, convex					5
Head shape	Straight					5
Band number	10-12					5
Lateral line scales _belly	4--4.5					5
Lateral line scales-pelvic fin	2--2.5					5
Lateral line scales -pectoral fin	2--3					5
Lateral line scales -anal fin	2.5--3					5

II. Some pictures of the identified Cestode species

A **B**





C **D**

A. Proteocephalidea new.genus (Lake Tana), B. Proteocephalus glanduliger (Lake Tana), C. Polyonchobotherium clarias , D. Section of the new genus (Lake Tana)