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Ichthyofaunal diversity in tributaries of river Kosi, North Bihar

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Abstract
Ichthyofaunal diversity of five tributaries, viz., Mithai dhar, Bhirkhi dhar, Gomati dhar, Budhma dhar and river Sursar of river Kosi, a largest tributary of river Ganga was recorded from January, 2019 to December, 2019. During the study period, total 45 species under 33 genera, 18 families and 8 orders were recorded from tributaries. The order Cypriniformes was the dominant group comprising 42.2% followed by Siluriformes 24.4%, Perciformes 15.6%, Osteoglossiformes 4.4% and Symbranchiformes 4.4%, Clupeiformes 2.2% and Tetradontiformes 2.2%. Cyprinidae family represented maximum number of fish species (15 species) followed by the family Bagridae (4 species). The study revealed that tributary has a rich ichthyofaunal diversity which was exploited for human consumption. Fishes like, *Labeo rohita*, *Mystus vittatus*, *Mystus tengra*, *Wallago attu*, *Xenentodon cancila*, *Mastacembelus armatus*, *Channa punctatus* and *Channa marulius* were the common species. Sorensen's similarity index ranged from 43.9 to 65.0% shows more number of common species in all tributaries. The study revealed that as per IUCN criteria, 2 species were Vulnerable, 7 species Near Threatened, 33 species Least Concern, 1 species Data Deficient and 2 species Not Evaluated. While, according to CAMP status, 6 species were Endangered, 11 species Vulnerable, 16 species Lower Risk near threatened, 3 species Lower Risk least concern and rest 9 species Not Evaluated.

Keywords: Ichthyofauna, similarity, threats, tributaries, River Kosi

1. Introduction
Fish fauna is an integral part of the aquatic environment exhibiting enormous diversity in their morphology, habitat where live in and biology. Ichthyofaunal diversity refers to variety of fish species and their abundance. Altogether 28,500 fish species have been so far recorded worldwide [1], out of these, 22 hundred fish species are known to occur in different aquatic habitats of India. Over the past few decades, riverine ecosystems have been subjected to intense anthropogenic pressure resulting in its degradation and habitat loss for the fishes. As a result, many fish species have become highly endangered [2]. Fish species diversity in river and tributary is dependent on the combined interaction of different ecological variables like temperature, size and surface area, annual discharge, depth, flow velocity, topography, substrates nature and climate [3]. In addition to being an important edible food item for human consumption, fishes are part of aquatic food chain, energy flow, nutrient cycling and ecosystem services.

Kosi River is one of the major perennial rivers of Kosi basin (24º55' N to 27º31' N latitude and 83º21'E to 88º17' E longitude) of North Bihar (Fig. 1), which originates at an altitude of 7000 m above MSL in Tibet covers an area of about 724 kilometers of rich sandy alluvial plains, before meeting river Ganga near Kursela in the state of Bihar. On its way to plains, river Kosi is joined by many tributaries which are not only providing water for drinking, irrigation, waste disposal, but also supports substantial fisheries. Once, these tributaries conserve a rich variety of fish fauna which support to commercial fisheries. Since the last few decades, fish biodiversity of state is declining rapidly due to many factors including habitat loss and overfishing. There have been a number of studies conducted on fish diversity and threat status in various riverine ecosystems, but no work has been conducted so far in this region. The fishing in tributaries is the main source of incomes and livelihood for rural people and fishermen community. Therefore, in the present study, an attempt has been made to evaluate current status of fish diversity and conservation status in five tributaries of river Kosi at Madhepura district of North Bihar, India.

2. Materials and Methods

The present study was conducted in five tributaries, namely Mithai dhar, Bhirkhi dhar, Gomati dhar, Budhma dhar and river Sursar of river Kosi at Madhepura district, North Bihar to survey and sampling fish fauna. Samples of fish were collected from each tributary from January, 2019 and December 2019. During the present study, cast net, dragnet, scoop net and others indigenous fishing gears were used for capturing fish. Fishes were preserved in 10% formaldehyde solution. Fish specimens were brought to the laboratory and preserved in fresh formaldehyde in separate jars for study. Small fish were directly preserved in formalin solution while large fish were given an incision on abdomen. The fishes were identified using taxonomic keys and standard literatures [4, 5, 6]. Nomenclature was based on Fish Base (http//www.fishbase.org). Sorensen's similarity index [7] was use to assessed similarity in species composition within tributaries. For ascertaining conservation status, IUCN [8] Red List of Threatened Species and CAMP report [9] on freshwater fishes of India was referred.

3. Results and Discussion

The study revealed that tributaries of river Kosi at Madhepura district have a rich ichthyofaunal diversity. In total 45 species belonging to 33 genera, 18 families and 8 orders were recorded from tributaries. Fish species sampled is listed in Table 1. Out of the recorded 45 species, 11 species sampled from Mithai dhar, 17 from Bhirkhi dhar, 23 from Gumati dhar, 21 from Budhma dhar and 27 from river Sursar (Fig. 2). Despite rich biodiversity, the report on ichthyofaunal diversity of tributaries of the river Kosi is still lacking. Many studies have been carried out on diversity of fish in numerous river systems of India. Previously, Lakra *et al.* reported 63 species belonging to 45 genera and 20 families from river Betwa, a tributary of river Yamuna [10]. Das and Bordoloi recorded 62 species under 42 genera, 22 families and 9 orders from Majuli river island, Assam [11]. Kalita and Sarma enlisted 114 species belongs to 73 genera, 31 families and 11 orders from Beki River, Assam [12]. Bano and Serajuddin reported 56 species under 41 genera, 21 families and 9 orders from river Gomti, at Lucknow [13]. Kumar *et al*. enlisted 58 species belonging to 9 families and 7 orders from Ramganga River at Bareilly, Uttar Pradesh [14]. Bose *et al*. reported 56 species belonging to 39 genera, 18 families and 9 orders from river Chambal and its tributaries, Madhya Pradesh [15]. Chandran *et al*. enlisted 55 species belongs to 42 genera, 21 families and 9 orders from river Ib, a tributary of river Mahanadi [16]. However, Mohite and Samant reported 42 species belonging to 30 genera, 10 families and 4 orders from Warna river system [17] and Shelke enlisted 35 species under 27 genera, 17 families and 8 orders from river Girna [18], which is fewer than the present findings.

Based on the species composition, Cypriniformes was the dominant order group comprising of 42.2% followed by the Siluriformes (24.4%), Perciformes (15.6%), Osteoglossiformes (4.4%), Symbranchiformes (4.4%) and the rest orders Clupeiformes, Beloniformes and Tetradontiformes contributed 2.2% each (Fig. 3). Similar distribution was reported in various river systems [19, 12, 13, 16]. Maximum number of species belonging to family Cyprinidae (15 species) followed by the family Bagridae (4 species). Family Cobitidae and Channidae represented with 3 species each. Similar dominance was also reported in river Ramganga [14], river Ib [16], river Budhabalanga [20] and river Dudhi [21]. *Labeo rohita*, *Mystus vittatus*, *Mystus tengra*, *Wallago attu*, *Mastacembelus armatus*, *Xenentodon cancila*, *Channa punctatus* and *Channa marulius* were dominant species in these tributaries.

Sorensen's similarity index (S) shows a wide range of variation, 43.9% to 65.0% in five different tributaries (Table 2). Lowest percentage reveals less number of common species in the tributaries might be due to heterogeneity in habitats and ecological condition. Highest percentage indicates more number of common species in tributaries could be due to same environmental conditions. While analyzing the similarity percentage, highest similarity 65.0% was found between Bhirkhi dhar and Gumati dhar, 63.0% between Budhma dhar and river Sursar, 59.09% between Gumati dhar and Budhma dhar, 58.06% between Mithai dhar and Bhirkhi dhar and 57.89% between Bhirkhi dhar and Budhma dhar. Data revealed that percentage similarity was generally high and quite similar which shows more numbers of common species found in tributaries could be due to homogeneity in hydrological characteristics, located on same topographical area (Kosi basin) and linked with same river. Percentage of dissimilarity ranging from 35.0% to 56.1% could be due to differences in water quality, current, depth, food availability and substrate nature that produced impact on fish assemblages. Highest dissimilarity percentage, 56.10% was recorded between Mithai dhar and river Sursar could be attributed to environmental heterogeneity that brings about total disappearance of certain species [22].

In recent years, an extensive survey work has been carried out regarding the conservation status of fish species in the different river systems. Out of the 259 species, 19 species were categorized under threatened (5 endangered and 14 vulnerable), 22 species under near threatened, 141 species under least concern, 52 species under not evaluated and remaining 25 species under data deficient from river and rivulet of Arunachal Pradesh [23]. Among the 49 species, 35 species were as least concerned, 1 species as endangered, 1 species as vulnerable, 7 species as not evaluated, 3 species as near threatened and 2 species as data deficient from river Tezu, at Lohit district of same state [24]. Of the recorded 61 species, 2 species were enlisted under endangered category, 2 species under vulnerable, 4 species under near threatened, 36 species under least concern, 8 species under lower risks near threatened, 1 species under data deficient and remaining species under not evaluated category from Jia Bhorelli river of Assam [25]. Of the reported 35 species, 2 species considered as vulnerable, 1 species as near threatened, 29 species as least concern and 2 species as not evaluated and 1 species as data deficient from river Girna, Maharashtra [18]. out of the recorded 58 species, 5 species were categorized under endangered, 15 species as vulnerable, 16 species as low risk, 6 species as least concern and remaining 10 species as not evaluated category with 6 exotic species from middle stretch of river Ramganga, Uttar Pradesh [14]. Report on conservation status of fish species from tributaries of this region is not earlier documented. Fishes found in tributaries are under threat of increasing anthropogenic activities, habitat destruction, agricultural runoff and overfishing. As per IUCN [8], out of the recorded 45 species, 2 species categorized under Vulnerable (VU), 7 species Near Threatened (NT), 33 species Least Concern (LC), 1 species Data Deficient (DD) and 2 species Not Evaluated (NE). According to CAMP report [9], of the recorded species, 6 species categorized as Endangered (EN), 11 species as Vulnerable (VU), 16 species as Lower Risk near threatened (LRnt), 3 species as Lower Risk least concern (LRlc) and rest 9 species as Not Evaluated (NE) category.

Table 1: Ichthyofaunal diversity in tributaries of the Kosi river, North Bihar (order, family, local name and status).

Order	Family	Species	Local name	CAMP status [8]	IUCN Status [7]
Osteoglossiformes	Notopteridae	*Chitala chitala* (Hamilton,1822)	Chital/Moya	EN	NT
		Notopterus notopterus ((Pallas,1769)	Bhuna/Patra	LRnt	LC
Clupeiformes	Clupeidae	*Gudusia chapra (*Hamilton, 1822)	Suhia	LRlc	LC
Cypriniformes	Cyprinidae	*Amblypharyngodon mola* (Hamilton,1822)	Dhawahi/Madwa	LRlc	LC
		Aspidoparia morar (Hamilton,1822)	Chilwa	LRnt	LC
		Barilius barila (Hamilton,1822)	Baril	VU	LC
		Catla catla (Hamilton,1822)	Catla	VU	VU
		Cirrihinus mrigala (Hamilton,1822)	Nain	LRnt	LC
		Cirrihinus reba (Hamilton,1822)	Rewa	VU	VU
		Danio (danio) dangila (Hamilton,1822)	Bashpata	NE	LC
		Labeo bata (Hamilton, 1822)	Bata	LRnt	LC
		*Labeo calbasu (*Hamilton,1822)	Basrahi	LRnt	NT
		*Labeo rohita (*Hamilton,1822)	Rohu	LRnt	LC
		Puntius conchonius (Hamilton,1822)	Pothia	VU	LC
		Puntius sophore (Hamilton,1822)	Pothi	LRnt	LC
		Puntius chola (Hamilton,1822)	Sidhari	VU	LC
		Puntius terio (Hamilton,1822)	Sehra pothia	LRnt	LC
		Puntius phutunio (Hamilton,1822)	Pothia	LRnt	LC
	Balitoridae	*Nemacheilus botia* (Hamilton,1822)	Natwa	EN	NT
	Cobitidae	*Botia lohachata* Chaudhuri, 1912	Lohachata	EN	NE
		Lepidocephalus guntea (Hamilton,1822)	Nakati	NE	LC
		Lepidocephalus thermalis (Valenciennes,1846)	Baluari	LRnt	LC
Siluriformes	Bagridae	*Aorichthys seenghala* (Sykes, 1839)	Gagri	LRlc	NE
		Mystus tengara (Hamilton,1822)	Tengra	NE	LC
		Mystus vittatus (Bloch,1794)	Palwa tengra	VU	LC
		Rita rita (Hamilton,1822)	Rita	LRnt	LC
	Siluridae	*Ompok pabda* (Bloch,1794)	Jalkapoor/Pava	EN	NT
		Wallago attu (Bloch & Schneider,1801)	Boyari	NE	NT
	Schilbeidae	*Ailia coila* (Hamilton, 1822)	Patasi	VU	NT
		Eutropiichthys vacha (Hamilton,1822)	Bachawa	EN	LC
	Sisoridae	*Bagarius bagarius* (Hamilton,1822)	Gojta/Baghari	VU	NT
	Heteropneustidae	*Heteropneustes fossilis* (Bloch,1794)	Singhi	VU	LC
	Chacidae	*Chaca chaca* (Hamilton,1822)	Chakwa macchali	EN	LC
Beloniformes	Belonidae	*Xenentodon cancila* (Hamilton,1822)	Kauwa macchali	LRnt	LC
Symbranchifores	Mastacembelidae	*Macrognathus pancalus* (Hamilton,1822)	Gaichi	LRnt	LC
		Mastacembelus armatus (Lacepede,1800)	Baami	NE	LC
Perciformes	Chandidae	*Chanda nama* (Hamilton, 1822)	Chamwa	NE	LC
		Pseudambassis ranga (Hamilton, 1822)	Chanari	NE	LC
	Anabantidae	*Anabas testudineus* (Bloch,1792)	Kabai	VU	DD
	Belontidae	*Colisa chuna* (Hamilton,1822)	Kholisa	NE	LC
		Colisa lalius (Hamilton,1822)	Khosti	NE	LC
	Channidae	*Channa punctatus* (Bloch,1793)	Latta	LRnt	LC
		Channa marulius (Hamilton,1822)	Saurathi	LRnt	LC
		Channa gachua (Hamilton,1822)	Chanaga	VU	LC
Tetradontiformes	Tetradontidae	*Tetradon cutcutia* (Hamilton,1822)	Beng macchali	LRnt	LC

VU- Vulnerable, NT- Near Threatened, LC- Least Concern, NE- Not Evaluated, DD- Data Deficient, EN- Endangered, LRnt- Lower Risk near threatened and LRlc- Lower Risk least concern.

Table 2: Co-efficient value of Sorenson's Similarity index in percent (%).

Sites	Mithai dhar	Bhirkhi dhar	Gumati dhar	Budhma dhar	Sursar river
Mithai dhar	-	58.06	48.65	45.71	43.90
Bhirkhi dhar		-	65.00	57.89	50.00
Gumati dhar			-	59.09	52.00
Budhma dhar				-	63.00
Sursar river					-

Table 3: Co-efficient value of dissimilarity index in percent (%).

Sites	Mithai dhar	Bhirkhi dhar	Gumati dhar	Budhma dhar	Sursar river
Mithai dhar	-	41.94	51.35	54.29	56.10
Bhirkhi dhar		-	35.00	42.11	50.00
Gumati dhar			-	40.91	48.00
Budhma dhar				-	37.00
Sursar river					-

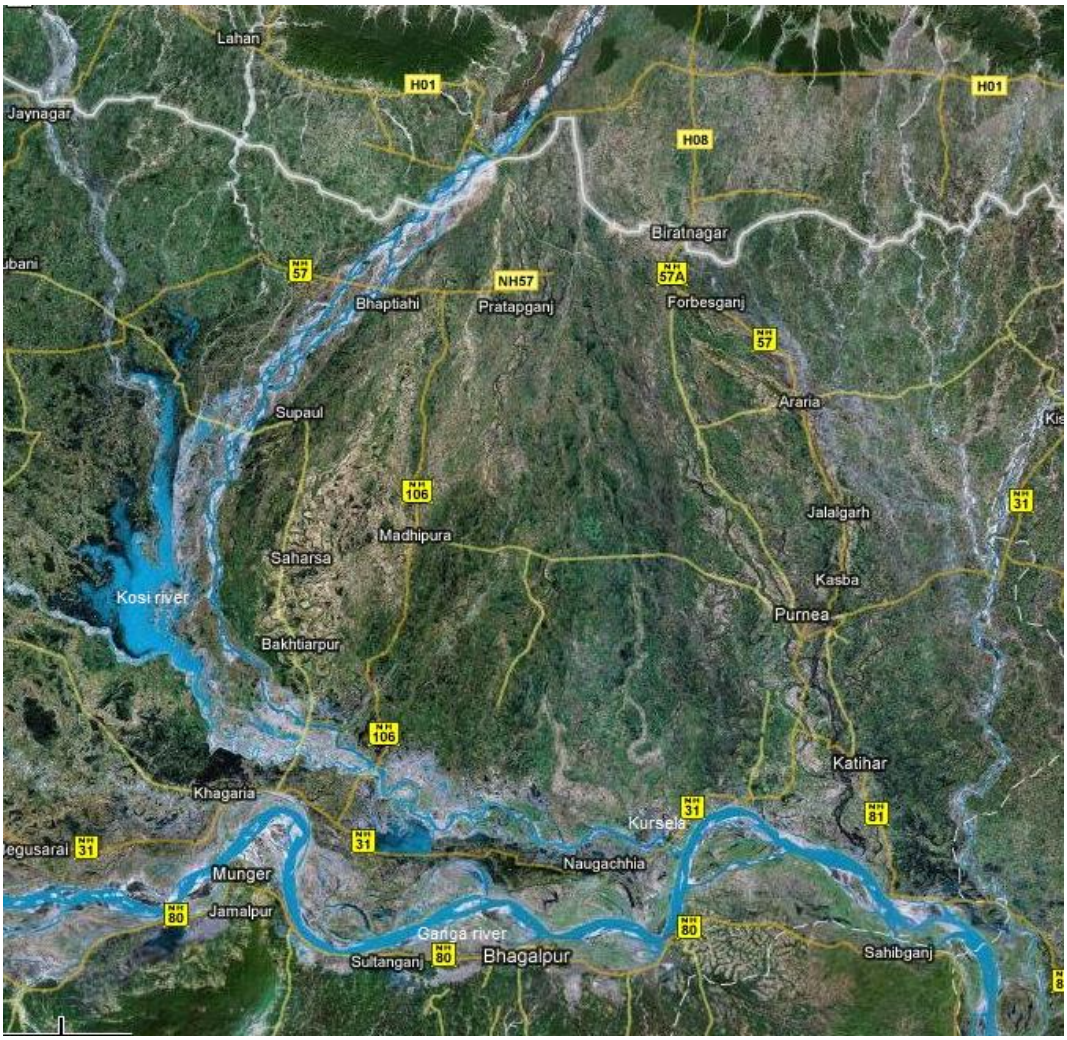

Fig 1: Satellite map showing Kosi River merging with river Ganga.

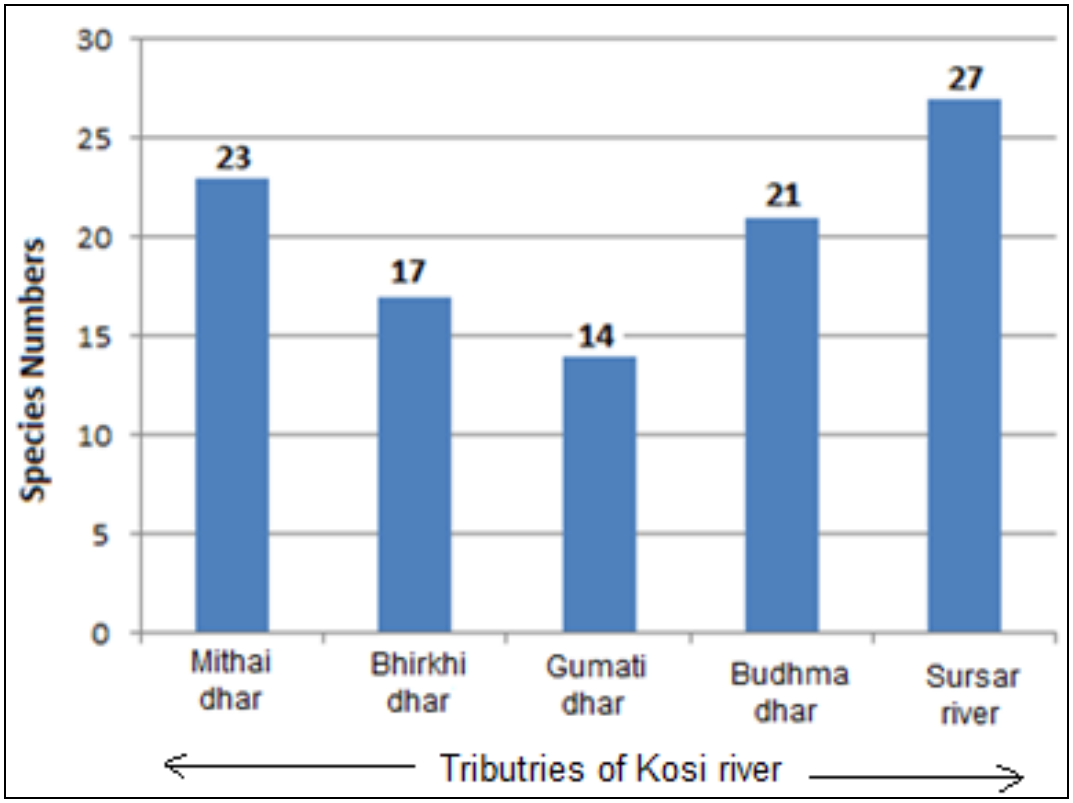

Fig 2: Numbers of fish species

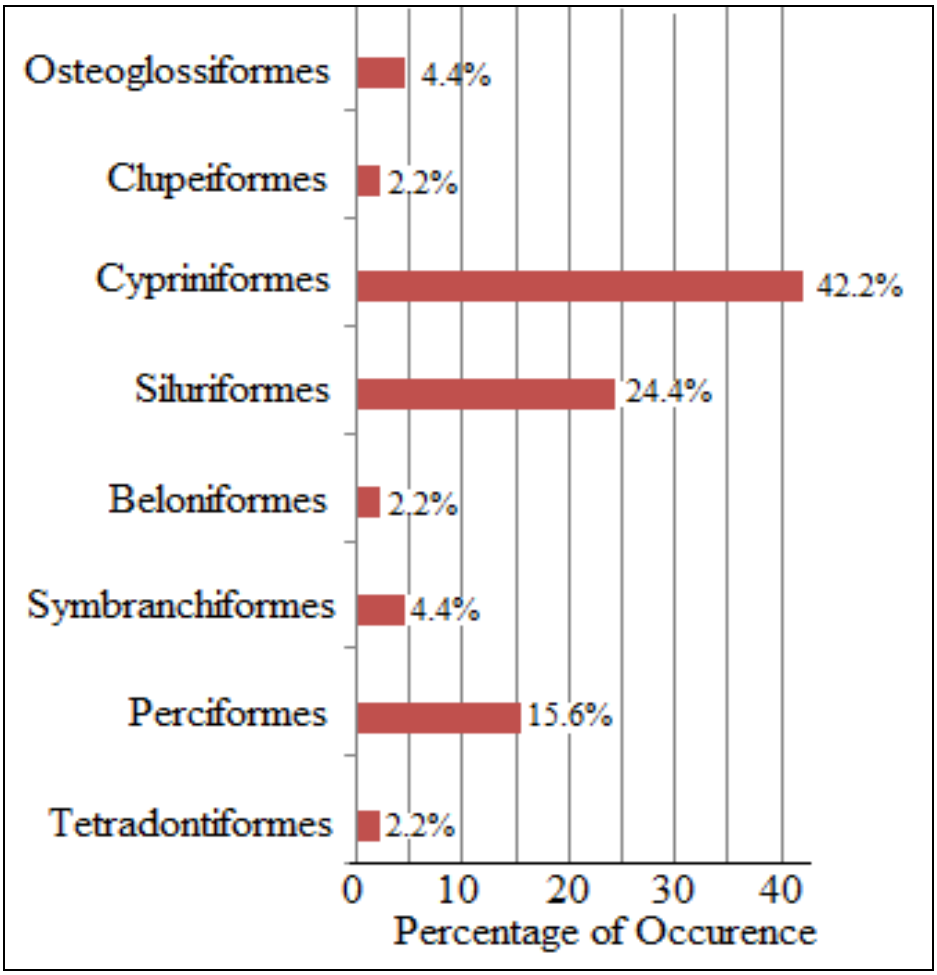

Fig 3: Percent of order representation

4. Conclusion

The findings of the present study revealed that the tributaries of river Kosi at Mahepura district of North Bihar have wide varieties of indigenous fishes which support commercial fisheries of this region. Cypriniformes was the dominant order which include family Cyprinidae, Balitoridae and Cobitidae. Order Siluriformes and Perciformes were also good contributors to fish diversity. Fishermen and rural people generally rely on the fishery of tributaries of the river Kosi as source of income and livelihood, but, tributaries become worsts victim of environmental degradation. Fish abundance and diversity has declined faster since last few decades, therefore, local fishery need to be organized to obtain high production.

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