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NEW SPECIES OF *LABEO* CUVIER (CYPRINIFORMES: CYPRINIDAE) FROM BHADRA RIVER, KARNATAKA REGION OF WESTERN GHATS, PENINSULAR INDIA.

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ABSTRACT
A new cyprinid fish *Labeo shivamogaensis*is is described from Bhadra Reservoir Karnataka, India. *Labeo shivamogaensis* is distinguished from its closest congener *Labeo dussumieri*, by having more upper transverse scale rows, more circumferential scale rows, more pre-dorsal scales, more circumpeduncular scale rows and from *Labeo fimbriatus* by having fewer lateral line scales, pre-dorsal scales, more circumferential and circumpeduncular scale rows.

KEYWORDS: Cyprinidae, *Labeo*, taxonomy, Western Ghats.

INTRODUCTION

The Bhadra River originates from a place called Gangamoola in the Western Ghat mountain ranges and flows towards east and confluences with Thunga River at Koodli. A Reservoir is built on the river near Lakkavalki which is called as Bhadra Dam. In downstream it flows through the city, Bhadravathi, Karnataka. *Labeo shivamogaensis* sp. nov. prefers riverine habitats with deep pools. After the confluence with Thunga River, the river is called Thungabhadra and it confluences with Krishna River near a village called Sakthi Nagar.

Genus *Labeo* Cuvier (1816) comprised of medium sized food fishes and most importantly as the species with high aquaculture potential. The successful invasion through aquaculture by the gangetic carp, *Labeo rohita* is the most striking example with potential for aquaculture in several South East Asian Countries (Das *et al.*, 2005). Nearly 28 species of *Labeo* were reported from India (Jayaram, 2010), out of which few species have been moved to other genera like *Bangana* (*L. dero* Hamilton), *Cirrhinus* (*L. ariza* Hamilton) and *Crossochilus* (*L. macmahoni* Zugmayer), while *Labeo rajasthanicus* (Datta and Majumdar, 1970) has been resurrected from the synonymy of *Labeo boggut* and designated as a valid species (Lal *et al.*, 2015). Also *Labeo fisheri has* been recorded from Tamirparani River, Southern India (Anusha *et al.*, 2017) recently. In the genus *Labeo*, currently there are two groups recognized (Jayaram, 2010) one, with lateral line scale counts more than 50 and the other, with lateral line counts below 50 and this species with the lateral line counts of 45-51 and comes under intermediate group.

As a part of the inventory of the freshwater fishes of Western Ghats streams and rivers, several collections have been made in the Thunga and Bhadra Rivers in Shimoga District, Karnataka by the senior author and his team and amongst the collections, a new species of *Labeo* has been discovered and herein we describe it as new.

MATERIALS AND METHODS

Measurements were made point to point using digital calipers. Methods used for the meristic and morphometric characters are based on Hubbs and Lagler (1964). Morphometric characters from landmarks 9, 18 - 26, 29 - 31 and 34 - 35 (Table 1) were the additional truss measurements (Strauss and Bookstein, 1982). Pre-anal scales (Jayaram, 1991) are the scales from the anus to isthmus, pre-pelvic scale rows and scale rows from anal fin to lateral line (Jayaram, 2010). Upper transverse scale rows are counted diagonally forward from the lateral line and include the last scale of the pre-dorsal midline. Circumpeduncular scales are taken at the region of the least depth of the caudal peduncle. Transverse breast rows are counted from the posterio medial edge of the base of the pectoral fin to the same position on the opposite side (Rainboth, 1991).The meristic character of lateral transverse scale (L.tr.) rows described by Day (1889) is “number of longitudinal rows of scales between the back and abdomen, usually counted, unless some other

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part of the side is specified, from the anterior end of the dorsal fin to the ventral". Body measurements are expressed as percentage of Standard Length (%SL); head measurements are expressed as percentage of Head Length (%HL). The following abbreviations were used for museum: CUKMNH (Central University of Kerala Museum of Natural History), ZSI/SRC (Zoological Survey of India, Southern Regional Centre, Chennai), MNHN (The French National Museum of Natural History) and CMA (collections of M. Arunachalam).

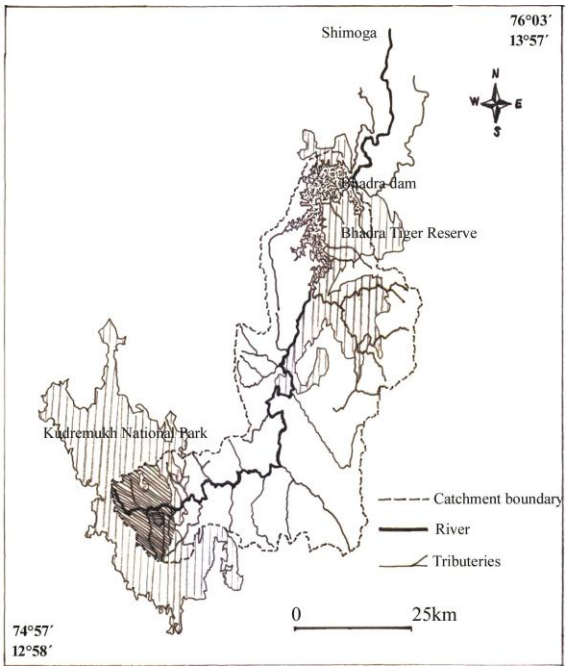

Figure 1. Map of the Bhadra Reservoir, Shimoga, Karnataka, India

RESULTS

Labeo shivamogaensis sp. nov.

Figure 2.*Labeo shivamogaensis* sp.nov**., Holotype**: CUKMNH F 1, 138.7 mm SL; India: Bhadra Reservoir, Shimoga, Karnataka, M. Arunachalam and team, 29 May, 2003.

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Figure 3. *Labeo shivamogaensis* sp.nov**, Paratype:** CUKMNH F.1, 4, 108.2mm SL; India: Bhadra Reservoir, Shimoga, Karnataka, M. Arunachalam and team, 29 May, 2003.

Figure 4. Ventral view of *Labeo shivamogaensis* sp.nov. A-Holotype; B-Paratype

Figure 5. Lateral view of *Labeo fimbriatus* from MNHN

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Holotype: CUKMNH F 1, 138.7 mm SL; India: Bhadra Reservoir, Shimoga, Karnataka, (13° 42' 15.1632" N75° 38' 34.1988" E) M. Arunachalam and team, 29 May, 2003. (Figures 2 and 4A)

Paratypes: CUKMNH, 4, 108.2-131.74 mm SL; data same as holotype. (Figures 3 and 4B)

Diagnosis: *Labeo shivamogaensis* sp.nov. is distinguished from all other species with 45 - 51 lateral line scales of its close congeners, *Labeo fimbriatus* and *Labeo dussumieri* based on the lateral line scale counts (45, 52 - 57), dorsal fin commences vertically opposite about 13th scale of the lateral line (vs. 12, 14). It is distinguished from *L. fimbriatus* by having more upper transverse scale rows (14.5 - 16.5 vs. 10.5), more pre-dorsal scales (22 - 24 vs. 19), more lower transverse scale rows (9.5 - 10.5 vs. 7.5), more circumpeduncular scale rows (26 - 29 vs.22), more circumferential scale rows (56 - 63 vs. 43) and pre-anal scale rows (48 - 55 vs. 39) and the morphometric characters of lesser distance between dorsal-fin origin and pelvic-fin insertion (27.59 - 29.85 vs. 34.50 % SL), lesser pre-dorsal length (43.20 – 45.48 vs. 48.96 % SL), shorter anal fin height (18.34 – 19.74 vs. 23.04 % SL), less body depth (26.55 – 30.26 vs. 35.41 % SL), larger eyes (23.83 - 26.53 vs. 20.48 %HL), lesser distance between lower jaw and isthmus (43.06 – 48.90 vs. 54 % HL) and very long rostral barbel (9.87 – 13.56 vs. 5.93 % HL). It is distinguished from *Labeo dussumieri* by having more pre-dorsal scales (22 - 24 vs. 18 - 20), upper transverse scale rows (14.5 – 16.5 vs. 8.5 - 9.5) lower transverse scale rows (9.5 - 10.5 vs. 6.5 - 7.5), more circumpeduncular scale rows (26 - 29 vs. 22 - 23), more circumferential scale rows (56 - 63 vs. 39 - 44) and pre-anal scale rows (48 - 55 vs. 43 - 53) and the morphometric characters of short pre-pectoral length (21.37 – 22.86 vs. 23.8 – 28.47 % SL), broader dorsal-fin base length (25.16 – 26.84 vs. 21.52 – 23.98 % SL), smaller head (23.48 – 24.57 vs. 25.27 – 27.90 % SL), greater length of snout to opercle (72.64 – 74.75 vs. 64.65 - 68.87 % HL) greater snout length (40.77 - 42.45 vs. 30.84 – 34.60 % HL), lesser distance between lower jaw and isthmus (43.06 – 48.90 vs. 55.62 – 64.02 % HL) and greater head depth at pupil (60.30 – 65.72 vs. 52.19 - 55.95 % HL).

Description: Morphometric and meristic data are given in Table 1. General appearance of the body is fusiform, slightly compressed, the abdominal profile rather more convex than the dorsal with maximum depth (26.55 – 30.26 %SL) greater than that of head length.

Head relatively short 23.48 - 24.57 %SL, with moderately long cranium 77.46 - 80.65 %HL. Head depth at nostril 42.51 - 46.06 %HL, at pupil 60.30 - 65.72 %HL and at occiput 76.43 - 80.28 %HL respectively. Mouth sub terminal, its lower jaw to isthmus 43.06 - 48.90 %HL, snout moderate in length 40.77 - 42.45 %HL and gape width 24.36 - 30.13 %HL. Gill pectinate (shaped like comb).

Mouth broad, transverse, lips rather broad, lower lip fringed studded with large bi or tri lobated (Figure 4A) tubercles are different in the middle, upper lip fringed and covered with rostral fold, inner side of the lower and upper lips having series of ridges. Post labial groove/fold continuous and well developed. Snout obtuse, covered with smooth tubercles, barbels two pairs, moderately long maxillary pair, 11.69 - 15.89 %HL, and rostral pair 9.87 - 13.56 %HL.

Eyes are large, less or more than one fourth of the head (23.83 – 26.53 %HL) situated in the middle of the length of the head, inter orbital space (43.69 - 47.63 %HL) convex, broad, width being more to the distance of the hind margin of the eye from the end of the snout (40.77 – 42.45 %HL), nape slightly convex behind a concavity after the occiput. Dorsal-fin rays iii-14 (3), 13 (2), anal-fin rays iii-5 (5), pelvic-fin rays i-8 (5), pectoral-fin rays i-15 (4), 16 (1). Dorsal-fin moderately high 22.30 - 23.36 %SL, with a slightly concave or straight distal margin. Last unbranched ray smooth and weak, its dorsal spinous length 10.30 - 11.88 %SL. Dorsal-fin origin is vertically two scale rows before pelvic-fin origin with pre-dorsal length 43.20 - 45.48 %SL which is less when compared to pre-pelvic length of 49.20 - 51.14 %SL. Anal fin long with 18.34 – 19.74 %SL with distance between pelvic-fin insertion and anal-fin origin (18.76 - 21.05 %SL) is less than the distance between the pectoral-fin insertion and pelvic-fin insertion (29.08 - 30.51 %SL). Anal-fin short and pointed exceeding to 3 body scales anterior to the base of the caudal-fin rays. Last unbranched ray longest, distal margin concave when fin is erect, and anal-fin height 18.34 - 19.74 %SL, terminating well ahead of caudal-fin exactly 3 scales anterior to caudal-fin base of the lower lobe. Pelvic-fin extending to 5 scales rows before anal-fin origin and pelvic-fin length 17.90 - 19.55 %SL. Pectoral-fin extending to 6.5 scales before pelvic-fin origin and its length 18.56 - 20.29 %SL. Distance between pectoral-fin and vent is 49.31 - 51.84 %SL and pelvic-fin insertion and anal-fin origin 20.24 - 22.38 %SL.

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Table 1. Morphometric characters of *Labeo shivamogaensis* sp. nov, *Labeo dussumieri* and *Labeo fimbriatus.* Body character measurements are represented as % standard length and head character measurements are represented as % head length.

Sl.No.	Measurements from point to point (identified by numbers and name)	*Labeo shivamogaensis* sp.nov.			*Labeo dussumieri* topotypes (n=12)		*Labeo fimbriatus* ZSI/SRC F.941 (n=3)	
		Holotype	Paratype (n=4)					
			Min.	Max.	Min.	Max.	Min.	Max.
1	Standard length (mm)	138.7	108.2	131.74	84.61	97.98	82.8	101.6
2	Total length (mm)	173.6	130.84	169.18	107.46	125.25	105.17	122.09
	% of Standard length							
3	Snout to urocentrum	93.81	93.65	95.10	93.70	97.43	90.20	92.20
4	Pre-anal length	74.19	73.55	75.50	74.57	78.66	74.41	75.33
5	Pre-dorsal length	45.00	43.20	45.48	44.13	47.48	46.94	48.42
6	Pre-pelvic length	50.96	49.20	51.14	50.83	54.75	51.23	53.21
7	Pre-pectoral length	22.14	21.37	22.86	23.08	28.47	24.55	24.59
8	Caudal peduncle length	13.50	12.22	15.73	10.21	13.14	12.13	13.08
9	Dorsal-fin origin to pelvic-fin insertion insertion	27.87	27.59	29.85	25.59	27.72	33.10	34.28
10	Dorsal spinous height	10.30	11.01	11.88	9.45	13.37	11.44	12.08
11	Anal fin height	19.74	18.34	19.03	16.14	18.15	22.29	22.75
12	Depth of caudal peduncle	11.01	10.63	11.96	10.49	11.65	36.84	37.84
13	Caudal fin length	31.48	29.63	32.78	27.39	33.94	28.97	34.65
14	Dorsal fin height	22.86	22.30	23.36	21.21	23.33	24.87	26.31
15	Pectoral fin length	20.16	18.56	20.29	16.04	18.99	20.67	21.01
16	Pelvic fin length	19.55	17.90	19.19	16.03	17.82	21.23	21.61
17	Pelvic axillary scale length	9.60	8.12	8.45	4.31	5.96	6.57	7.47
18	Occiput to dorsal-fin origin	26.34	25.03	27.24	24.78	26.80	28.95	30.53
19	Occiput to pectoral-fin insertion	20.46	18.77	20.30	19.07	21.37	22.13	22.71
20	Occiput to pelvic-fin insertion	43.19	41.69	43.60	40.45	42.91	43.85	45.60
21	Dorsal-fin insertion to pelvic-fin insertion	25.96	24.07	26.62	22.51	25.42	29.21	30.24
22	Dorsal-fin origin to pectoral-fin insertion	29.50	29.26	30.45	27.17	28.98	31.62	33.10
23	Dorsal-fin origin to anal-fin origin	38.00	39.05	39.84	38.61	41.80	38.93	41.77
24	Dorsal- fin insertion to caudal-fin	24.29	25.18	26.95	26.84	33.91	18.97	22.27
25	Dorsal-fin insertion to anal-fin origin	18.64	18.62	20.12	20.22	22.28	19.68	21.19
26	Dorsal-fin insertion to anal-fin insertion	19.91	20.55	21.67	22.09	25.02	18.67	19.68
27	Dorsal-fin base length	26.40	25.16	26.84	21.52	23.98	27.40	29.13
28	Anal- fin base length	8.33	8.13	9.05	6.57	9.09	7.33	8.69
29	Pectoral-fin insertion to pelvic-fin insertion	29.08	29.68	30.51	26.81	31.65	26.77	29.67
30	Pectoral-fin insertion to anal-fin origin	48.79	47.89	50.30	46.96	52.76	45.74	48.44
31	Pelvic-fin insertion to anal-fin origin	18.76	19.54	21.05	19.13	22.76	19.73	20.31
32	Post-dorsal length	51.25	51.21	53.28	50.14	56.87	48.92	52.29
33	Body depth	27.88	26.55	30.26	24.22	27.70	34.32	36.25
34	Distance between pectoral-fin and vent	49.73	49.31	51.84	47.25	52.07	47.84	48.64
35	Distance between pelvic-fin and vent	20.86	20.24	22.38	19.86	22.61	19.64	21.98
	% of Head length							
36	Head length (mm)	32.56	26.12	31.47	22.89	25.4	20.27	25.16
37	Pre-occipital length	77.46	77.79	80.65	73.01	81.17	75.83	81.15
38	Snout to opercle	74.20	72.64	74.75	64.65	68.87	67.57	74.54
39	Upper jaw length	34.58	31.94	39.85	27.87	31.47	30.74	31.68
40	Snout length	41.71	40.77	42.45	30.84	34.60	38.87	39.74
41	Pre-nasal length	29.21	26.99	28.97	20.06	24.13	25.00	29.21
42	Orbit width	25.37	23.83	26.53	24.86	27.27	24.10	24.91
43	Inter-orbital width	45.30	43.69	47.63	39.17	45.65	49.09	50.04
44	Inter- nasal width	31.17	30.60	34.41	28.83	33.36	32.26	33.62
45	Head width	59.37	58.13	63.29	55.60	58.16	59.26	60.13
46	Gape width	24.36	26.00	30.13	19.65	26.66	19.48	24.17
47	Lower jaw to isthmus	43.61	43.06	48.90	55.62	64.02	55.09	57.42
48	Head depth at nostril	43.89	42.51	46.06	31.38	37.13	36.84	37.84
49	Head depth at pupil	61.58	60.30	65.72	52.19	55.95	60.04	62.05
50	Head depth at occiput	78.19	76.43	80.28	67.80	74.69	72.85	79.88
51	Maxillary barbel length	12.50	11.69	15.89	6.55	10.31	4.13	10.16
52	Rostral barbel length	11.27	9.87	13.56	2.78	5.98	5.06	7.67

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Peduncle moderately deep 10.63 - 11.96 %SL and its length, 10.50 - 11.88 %SL. Caudal-fin deeply forked its length 29.63 – 32.78 %SL, with marginal rays of upper lobe longest and more than 4.6 times the length of median rays. Marginal rays of both lobes slightly produced with fin margin becoming concave at 3rd and 4th branched rays of both lobes, and remainder of margin nearly straight.

Coloration in preservative: In 10% formalin, the basic color of the preserved specimens is light brown in posterior, but anterior side dark brown and more concentrated. The scales are darkly bordered down to first scale row, below the dorsal-fin. Dorsal-fin with blackened margin and slightly darkened apex.Caudal-fin gray distally along the margin of both forks.Anal-fin clear, as are pelvic and pectoral-fin. Top head is dark brown, as are suborbital operculum and lacrimal region. Cheeks without pigmentation but a dark pigmented blotch on the middle of the operculum.

Etymology: Named after the location of Shivamoga, the old name of Shimoga town, noun in opposition.
The name of the city is derived from the term Shivmoga. History behind the city name due to story that the Lord Shiva drunk Thunga River water using Mogge at the city, hence the name Shiva-Mogga (Government of Karnataka announced the renaming of Shimoga to Shivamoga on 1st November, 2014).

Distribution: This species is currently known from Bhadra Reservoir of Bhadra River, Shimoga, Karnataka.

Habitat: *Labeo shivamogaensis* sp. nov .is associated with riverine habitats where they prefer deep pools. The Bhadra River originates in place called Gangamoola in the Western Ghats mountain ranges, and flows towards east and confluences with Thunga River at Koodli. A Reservoir is built on the river near Lakkavalki which is called as Bhadra Dam. Downstream it goes through Bhadravathi city, Karnataka.

Conservation: Large sized fishes of the genera, *Labeo*, *Tor*, *Hypselobarbus*, and *Sperata* are common in the reservoirs of Karnataka in Thunga, Bhadra, Supa and Bottom dam of Kali River (Arunachalam*et al.*, 2005). Also fishing practices are heavy after monsoonal months in these dams lead to the destruction of brooders.

Table 2. Meristic characters of *Labeo shivamogaensis* sp.nov.,*Labeo dussumieri* and *Labeo fimbriatus.*

Sl.No.	Meristic counts	*Labeo shivamogaensis* sp.nov.		*Labeo dussumieri* topotypes (n=12)	*Labeo fimbriatus* ZSI/SRC F.941 (n=3)
		Holotype	Paratype (n=4)		
1	Dorsal fin rays	iii 14	iii 13-14	iii 13	iii 16-17
2	Anal fin rays	iii 5	iii 5	iii 5	iii 5
3	Pelvic fin rays	i 8	i 8	i 8	i 8
4	Pectoral fin rays	i 15	i 15 -16	i 15 - 16	i 15 – 17
5	Caudal fin upper lobe	6+9	(5-6)+9	(7-8)+(9-10)	6+9
6	Caudal fin lower lobe	5+8	5+8	(4-7)+8	(4-5)+8
7	Lateral-line scales	50	45-51	52-57	44-46
8	Pre-dorsal scales	24	22-24	18-20	19-20
9	Upper transverse scale rows	15.5	14.5-16.5	8.5-9.5	10.5-11.5
10	Lateral line to pelvic scale rows	9.5	9.5-10.5	6.5-7.5	7.5
11	Circumpeduncular scale rows	29	26-29	22-23	22
12	Circumferential scale rows	58	56-63	39-44	43-44
13	Transverse breast scale rows	15	15-16	11-13	12
14	Anal scales	5	3-5	3	3
15	Pre-anal scales	50	48-55	43-53	38
16	Pre-pelvic scales	36	32-36	25-30	23-24
17	Anal fin to lateral line scale rows	9.5	8.5-9.5	7.5	7.5
18	Lateral transverse rows (L.tr)	16/9	15-17/8-9	10/7-8	(11-12)/7

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DISCUSSION

Labeo shivamogaensis. sp.nov. was compared with the closely related species *Labeo fimbriatus* (Bloch, 1797) and *Labeo dussimieri* (Valenciennes, 1842).The new species differs from congeners of *Labeo* in having more pre-dorsal scales, more upper transverse scale rows, Smore circumpeduncular and circumferential scale rows. It differs from both the species in morphometric characters (Table 1) of greater in snout length, head depth at nostril, gape width and long barbels). This new species is in between group of the lowest and highest lateral line scale rows groups (Jayaram, 2010).

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