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Threatened species of IUCN red list: *Labeo calbasu* (Hamilton, 1822) with requirement of imperative conservational management from Lower Anicut, Tamil Nadu, India

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Abstract
The river of Cauvery has a large network of mighty rivers, tributaries and several crossing channels, offering immense scope for expanding fishery in Tamil Nadu, India. One of the branch river namely Kollidam, Lower Anicut, were considered for focusing this study. Moreover, 110 species were live and breed in this river. Habitat alterations continue to have major impact on the distribution and abundance. Fishes of major rivers and feeder streams are perhaps least studied with poorest known natural resources. Family Cyprinidae was represented by the maximum number of species, richness and vast diversity. Requirement of the power dams have drastically altered fish habitat, communities and blocked seasonal movement of pristine migratory fishes. On the other hand, catching the juvenile using the types of net with small mesh size and improper fishing management is going to depletion of the resources. Furthermore, information on the conservation status and distribution of freshwater fish *Labeo calbasu* in The IUCN Red List of Threatened Species™ has been extremely until recently. As a result the dynamiting, poisoning and diverting water flows to collect fish are the major threats. To creating awareness, controlling illegal fishing, juvenile catching and protecting the breeding grounds of fishes are some of the measures were recommended to counter these threats.

Keywords: Morphological identification, Biometric analysis, *Labeo calbasu*, Threatened species, Conservational management.

1. Introduction

Fisheries are one of the most important sources of revenue and socio-economic industry of our country and serves as an important food sector in human nutrition [1]. However, the fish assemblage structure and function are also primarily associated with geographic variation and understanding the pattern is crucial effective assessment, monitoring of streams and rivers [2]. In India one of the richest riverine fish gene pools and network on hundreds of rivers, floodplains, contribution of riverine and capture fisheries is declining sharply and several have collapsed, despite having a great potential to grow. As a result, the current riverine fishing industry is below subsistence level with an average yield 0.3 tonne/km which is about 15% of their actual potential [3]. Besides, the riverine fishery is one of the mirrors in riverine health. Resembling, the rivers in India are facing multiple problems designed for severe water pollution, over extraction, encroachment, dams and barrages which cut off the connectivity of the river with its associated ecosystems, climate change, deforestation in catchment areas, etc. Though the increasing hydrological modification, absence of water in rivers, obstacle to migration, changes in salinity, sediment alteration, loss of riparian areas and floodplains brought about by dams perhaps the most important reason behind the dismal scenario of riverine fisheries. Severe and drastic changes of the entire hydrological cycle, particularly the river and dam water abstraction has affected by recruitment of more species, especially large carps, which like flowing water [3]. In India, natural flow of major rivers have been regulated for fulfilling water demand of agriculture and power sector, without giving any attention to fisheries sector. As a result, rivers have lost their character and fisheries have suffered huge losses [4].

Hitherto, most of the wild fish stocks in Indian rivers have been over exploited or get in touch with their maximum sustainable yield (MSY) due to in excess of fishing level, dreadful conditions of ecosystem and toxic waste [5]. Fish populations are natural control processes that continually modify with adjust structure, abundance and wide range of factors. Besides some factors as overfishing, species composition, population outbreak, behavior, species switching from small size to large, ecosystem degradation, incessant seasonal fluctuations, pesticide and aquatic pollution, diseases, introduction of exotic species, destruction of breeding grounds and unlawful fishing practices [6]. During the early 1980's, *L.calbasu* was a great commercial important species resembling three other Indian Major Carps such as Catla (*Gibelion catla*), Rohu (*Labeo rohita*) and Mrigal (*Cirrhinus mrigala*), although fish farmers lost interest due to the unavailability of seeds either natural or artificial sources. It is one of the most important causes for this species is going to attained threatened level in Indian freshwater ecosystem. Not only that the above said reasons for threatened state, are also wide variations in water flow during diverse seasons for basic turn down to determine the status of this species [6]. Furthermore, soil erosion and rising the bottom causing damage to fish food organisms, spoiling of fish feeding and breeding grounds, owing collection of stones and sands for construction purposes, deforestation in catchment area, collapsing the widely scattered pools once existing and entire river have disappeared along with the river has become quite shallow. Moreover, use of small mesh size fishing method, fishing during breeding season, increased weight and sluggish movements for the reason that the matured fishes are easily caught by fishermen, intensive fishing during this season as a results in loss of future fish stock, illegal fishing methods *viz.* poisoning, grenadine and dynamiting. Hitherto, these fishing methods are not only causing to damage for fish population, but even fish eggs, larvae and fish food organisms are collapsed. Therefore, it is the time, to take emergent steps to conserve the species of our riverine fish biomass and to restore their habitat [2]. So far, the objectives of this study explore better scientific information on the threatened status of *L.calbasu* resource and their impacts. Following that, proper flow and volume may facilitate to elimination of exotics as well as help in augmenting, breeding and recruitment of dwindling this species.

2. Materials and Methods

2.1 Study site

A branch of Cauvery, specifically Kollidam (Coleroon) river, Lower Anicut was selected for the present study (Figure 1) which is located 11º 08' 03'' N latitude and 79º 27' 05" E longitude. Kollidam River flows from west to east forming with northern boundary of this block whereas Cauvery River flows at the central part of this block flanking at Kumbakonam (Tamil Nadu). This river concerning about 500 peoples are actively engaged in fishing activities throughout the year. They are operating cast net and gill net through catamaran, thermocol craft teppam and four wheeler rubber tubes (floating devices) are also used as a craft for catching of fishes. The Cyprinidae family fishery occupies a prominent place in the landing centre at Lower Anicut.

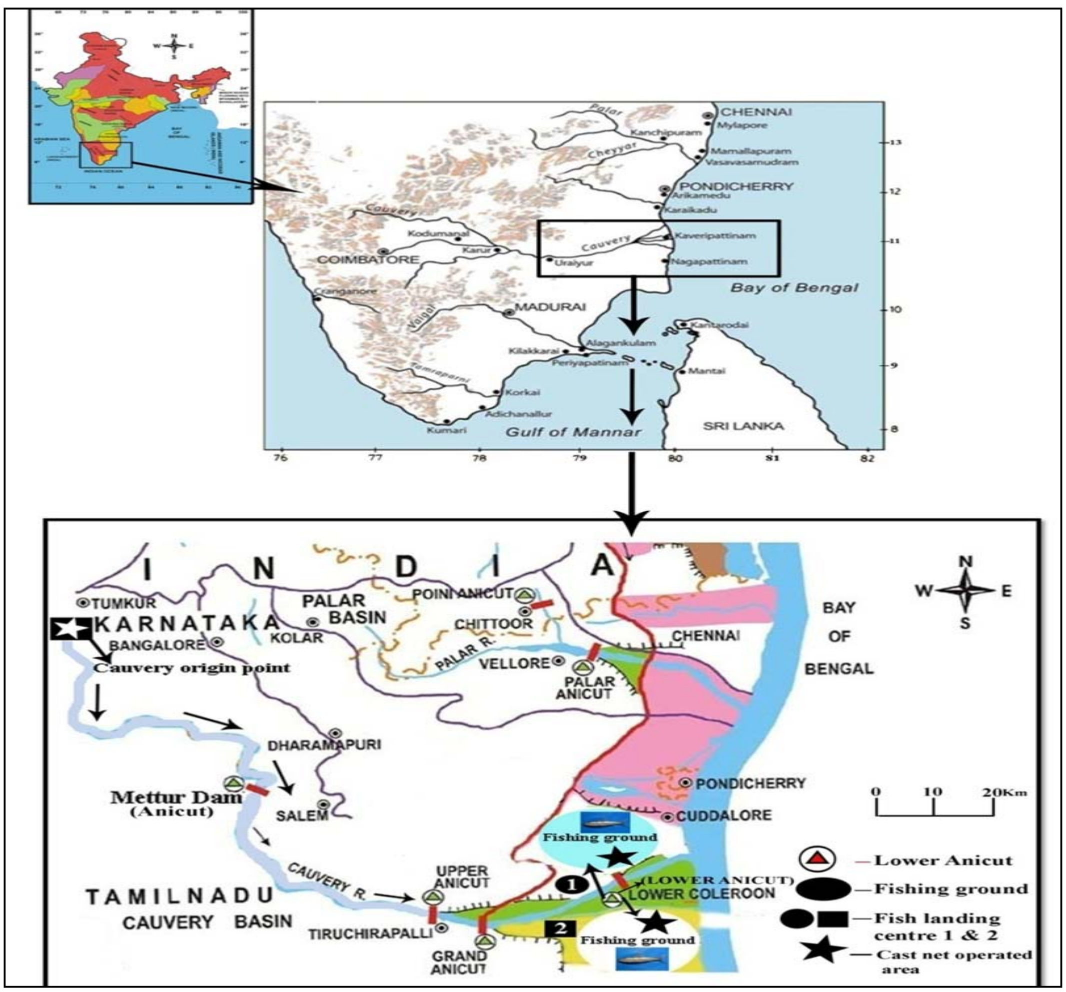


Fig 1: Map showing the geographical location of the sampling area in Lower Anicut, Tamil Nadu.

2.2 Biometrics sampling
Sampling focused of the species *L.calbasu* were collected from the landing centre at Lower Anicut (natural water bodies), Tamil Nadu during January 2014 - March 2014. Thirty individuals of fresh specimens were used for morpho-taxonomy study. After collection, specimens were washed, cleaned and mopped on filter paper to remove excess water. From their body surfaces by way of total length (mm), standard length (mm), fork length (mm) was measured with the help of a measuring board. Total weight (g) were measured with an electronic balance (DIGI' Arts maximum =1000 g to d=0.5 g). Specimens were identified morphologically using scientific literature relevant to the group with original descriptions [7]. However, the present approach of sampling has been made to gather complete information on threatened status and taxonomical aspects.

2.3 Photographical Image Identification
The wild population of *Labeo calbasu* was employed to invasive photographic techniques on the dorsal surface, head structure, maxillary and mandibular barbels, fins and lateral line scales. Colour patterns of the body and fins which are clearly focused for identification of images. In order to obtain more precise image of the selected individual using digital camera (SAMSUNG-PL 20 with 5x level; Lens focal length: 4.9-24.5; mega pixel 14.2 using Adobe Photoshop CS3). Photographs were taken perpendicular to the subject were only used when the fish with all types of fins were fully expanded. Additionally, the results of high-resolution image were used to extrapolate by morphological identification.

2.4 Morphometrics, Meristics and Statistical analysis
Descriptions are based on only fresh specimens. 44 morphometrics were measured to an accuracy of 0.1 mm respectively with all the measurements were made is illustrated in Figure 2. Measurements and counts were made using point to point dial calipers [8]. Head measurements are represented as a proportion of head length (%HL). Head length and body parts are given as proportions of standard length (%SL). Statistical analyses were fitted on morphometrics and meristics, since morphometrics are more susceptible and environmentally induced variable, while meristics are discrete and fixed in early development [9] and also the characters were independent of fish size and did not any change during growth [10]. Morphometrics and meristics were managed and analyzed by SPSS ver.19.0 and FAST STATISTICA computed software. Linear regression was made with log-transformed measurement and Pearson's correlations co-efficient were used between morphometrics at $P<0.05$ and $P<0.01$ level significant. Univariate statistical analysis (ANOVA) with multiple comparison test using between morphometrics at $P<0{\cdot}05$ and $P<0.01$ level. 16 meristics counts were using (Figure 2) in the present species *L.calbasu*. Fin rays and gill rakers were counted under binocular microscope using transmitted light. Lateral line scales were counted from the anterior most (operculum) contact to centre of the body of last scale on the caudal fin. They were counted from dorsal-fin origin to lateral line oblique (above lateral line) and below lateral line scales were counted from lateral line oblique to anal-fin origin. Counts of caudal-fin rays include marginal unbranched and branched rays in both lobes by separately. Kruskal–Wallis non-parametric test were employed by ANOVA for significant differences in meristics [11]. Numbers in parenthesis following, the meristics indicated that the number of specimens with that count and not adjusted for size differences.

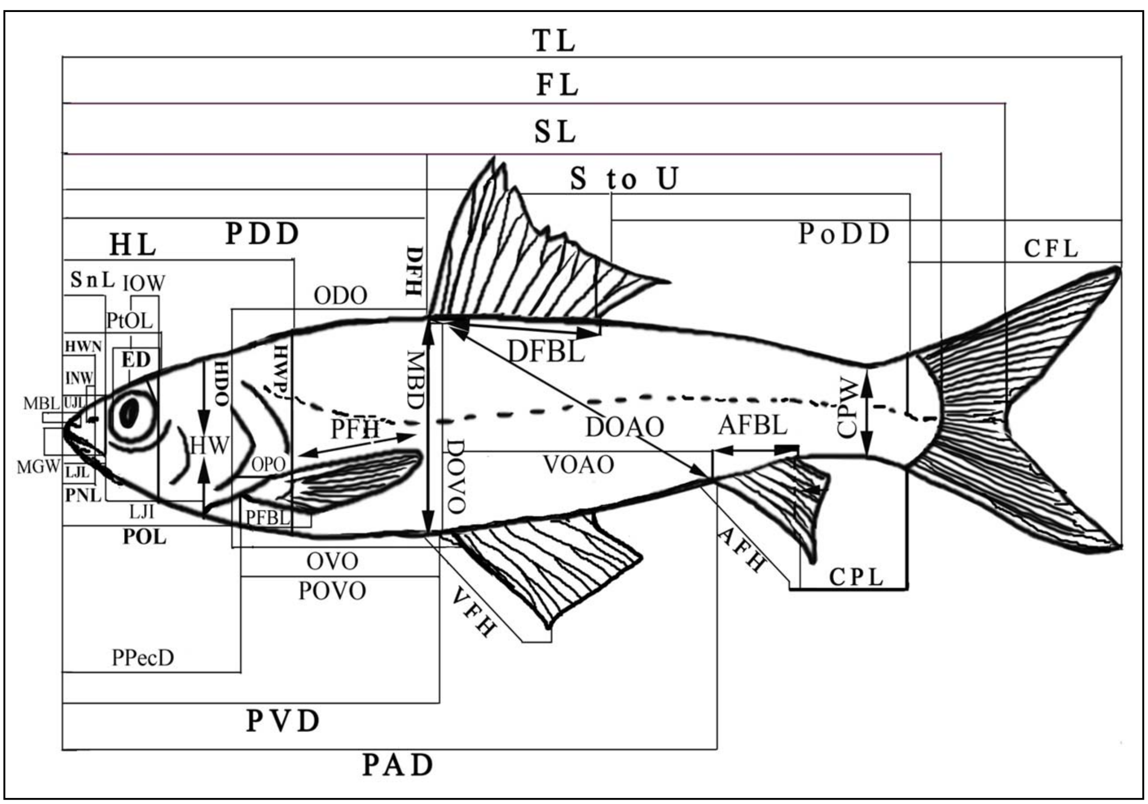


Fig 2: A schematic diagram for morphometric measurements of *Labeo calbasu*.

3. Results
Identification

Kingdom	Animalia
Phylum	Chordata
Sub phylum	Vertebrata
Super class	Gnathostomata
Class	Actinopterygii
Sub class	Neopterygii
Division	Teleostei
Order	Cypriniformes
Family	Cyprinidae
Genus	*Labeo* (Cuvier, 1817)
Species	*L.calbasu* (*Labeo calbasu* –Hamilton, 1822)

3.1 Type species
Cyprinus calbasu [12], Fishes of Ganges: 297 and 387, Pl. 2 and Figure -33 (type locality: rivers and ponds of Bengal and in the western provinces). *Labeo calbasu* [13], Fishes of India: 536, Pl. 126 and Figure – 4 [14], Fauna Br. India, Fishes, I: 259, Figure – 93 [15], *Rec. Indian Mus.*, 22(3): 182 [16], *J. Bombay Nat. Hist. Soc.* 44: 529.

3.2 Key to species
Dorsal fin rays 16-18. Barbels two pairs and fins are black; pectoral fins as long as head length; body deep, mouth distinctively inferior inside. [7].

3.3 Distinguishing characters
Body stout and rather than deep. Head fairly large with conical and its length less than the body depth. Snout depressed and fairly pointed, devoid of lateral lobe. No pores on snout. Eyes are moderate, not visible from underside of head and diameter about 3.3 times in head. Mouth inferior, lips thick and conspicuously fringed, both lips with a distinct inner fold. Barbels are two pairs, (rostral and maxillary) rostral pair longer than maxillary pair. Dorsal fin with a fairly long base, inserted midway between snout tip and base of caudal fin. Caudal fin deeply forked. Scales are moderate; lateral line with 40-44 scales; lateral transverse scale-rows 5-6 between lateral line and pelvic fin base; there are 20 rows of scales before dorsal fin and 22 rows round the caudal peduncle. Pre dorsal scales were arranged 150-180 mm. [7].

3.4 Fin formula
D. iii-iv 13-16; A. ii-iii 5; P. i 16-18; V. i 8 [7].

3.5 Colour
In life, blackish-green, lighter below; flanks buff pink or with scarlet spots with dark edges which may form stripes. Fins black; upper lobe of caudal fin usually tipped with white [7].

3.6 Valid scientific name
Worldwide accepted scientific and valid name *Labeo calbasu* (Hamilton, 1822).

3.7 Common / Local names
Kakkameen, Karuppusel (Lower Anicut in Tamil), Karunchel, Selkendai in Tamil Nadu; Kalbasu, Black rohu, Orange fin *Labeo* in English; Nallagandumenu, Kaki bonda, Nallchitraya in Andhra Pradesh; Kartamin, Karuthameen, Kalanchi in Kerala; Macchilu, Kurrimenu, Karae-kolasa in Karnataka; Kanas, Kanoshi, in Maharastra; Kalabeines in Orissa; Kalbasu, Kalbose, Kundu in West Bengal; Dini, Kalbans in Punjab; Kalabenise or Karaucha in Uttar Pradesh; Karauchar in Bihar and Bhopal; Mahlee, Kalisasu, Koliajora, Mali in Assam and Karnaunehar, Calbashu in Tripura; Kalbose, Kalbons and Dhai in Himachal Pradesh, India. Kalbaush or Kaliara in Bangladesh. Basarhil, Bashari, Gerdi, Kalbasu, Kalonch in Nepal. Nga-nan, Nga-net-pya in Myanmar [7, 17].

3.8 Synonyms
Cyprinus calbasu (Hamilton, 1822); *Catla calbasu* (Hamilton, 1822); *Morulius calbasu* (Hamilton, 1822); *Cirrhine micropogon* (Valenciennes, 1832); *Cyprinus micropogon* (Valenciennes, 1832); *Labeo velatus* (Valenciennes, 1841); *Rohita belangeri* (Valenciennes, 1842); *Cirrhinus belangeri* (Valenciennes, 1842); *Rohita reynauldi* (Valenciennes, 1842); *Labeo nigrescens* (Day, 1870).

3.9 Geographical distribution
Labeo calbasu [12] is distributed throughout India except in Kerala [18], Bangladesh, Pakistan, Nepal, Myanmar, Burma, Thailand, Yunnan and also South China [13]. Moreover, it is a commercially important species often cultured in South Western China [19]. In India geographically distributed in Cauvery, Yamuna [20]; Ganga [21]; Sylhet basin [22]; Ghaghra [23] and middle stretch of Ken [24]. Moreover, *L.calbasu* is widely called as Ganjetic carp species throughout in India [25]. Further it also occurs in Adma River, Buxa River, Cauvery, Chalakudy River, Godavari, Jayanti River, Krishna River, Salween Bhimtal Lake, Naukuchiatal Lake, Chilika Lake/Lagoon [26].

4. Habitat and ecology
Labeo calbasu attain the medium size to slow-moving in rivers and ponds. It inhabits in all natural water bodies such as rivers (relatively large water bodies), beels (static water in Ganga and Brahmaputra floodplains), haors (wetlands in which physically are bowl-or saucer-shaped shallow depression), baors (oxbow lakes, found mostly in the moribund delta) and lakes [18, 7, 25].

4.1 Length frequency, Length-weight relationship and growth
In past years, several authors have recorded the length frequency data analysis of *L.calbasu*. The LFD were ranging from 154 to 574 mm in length and 50 to 2800 g in total weight including males and females were collected [26]. Moreover, the collection included 90 males (160 to 545 mm in length and 55 to 2800 g in weight) and 98 females (163 to 574 mm in length and 50 to 2700 g in weight). The LFD of 149 specimens of *L.calbasu* ranging in size between 160-460 mm in total length and weight in 75-1170 g were measured [25]. *L.calbasu* generally attained the length and weight concerning 900 mm and weight of 5.5 kg respectively [7, 25]. The medium sized carp which is generally reaching the length of 710 mm with weight of 5.5 kg [27]. So far, the present research recorded that the length and weight relationship of this species attained the maximum length nearly 578 mm in length and 1520 gm in weight [28]. However, the growth parameters of this species were studied [29]. The age of 0.5^+ to 7.5^+ years was determined from the analysis. Herein, the largest specimen of this species was measured in 574 mm with the calculated age of 7.5^+ years whereas, the small individual were measured in 174 mm in total length with the age 0.5^+ years. Following this the maximum lifespan was recorded in 5^+ years for males and 6^+ years for females [28].

4.2 Feeding and reproductive biology
This species is an omnivore bottom feeder [30]. *Labeo calbasu* feeds on algae 10%, higher plants 48%, protozoa 12%, crustacean 10%, mollusc 5%, mud and sand 15%. It feeds on

plants, filamentous algae and diatoms [2]. The gut analysis of *L.calbasu* concluded to be an omnivore and occasionally bottom feeder [28]. Diatoms, blue green algae and green algae are the most preferable food item of *L.calbasu*. Studied the length at first maturity was nearly 328 mm in Kali River [29]. Further, the recent studies on proportion of 50% maturity (Lm_{50}) attained in 251-300 mm in males and 301-350 mm for females. Fecundity ranged between 1,93,000-2,38,000 (Rahman, 1989) matured eggs of this species ranged from 388 to 405 in diameter [29]. The fecundity of *L.calbasu* were ranged from 3,12,100 to 6,57,600 eggs [25]. The gonado-somatic index (GSI) was increased gradually from May to August with peak in July. However, the above result agreed with the present report with the spawning occurs once in a year; with peak during November in both sexes [28]. Fecundity of *L.calbasu* was ranged from 30,681 to 4,25,118 and the total length range between 237 and 405. The external sex differentiation could not be made on easily between males and females. Finally, the overall sex ratio was recorded 1:0.15 it indicating that highly skewed distribution between sexes.

4.3 Ecological role and economical importance
L.calbasu reaching the maximum size at 536 g and 650 mm and also the fish oil were found its liver contains Vitamin-A. It is a great demand in market value [31].

4.4 Fishery information
Labeo calbasu were distributed widely in India and it is one of the major Indian carps. It is an important food fish and at several places is referred to as the 'Black rohu'. Further, it is an important game-fish in the tanks where it is stocked and is cultivated along with other species. It thrives better in tanks and lakes than in running waters; can tolerate slightly brackish water also. *L.calbasu* breeds normally in rivers and ponds and also induced bred by hypophysation [7].

4.5 Population and Conservation status
It is a very common fish throughout India and in adjacent countries. Until now, this species population trends are exactly not known. Yet, the wild population of this species could be declining due to heavily harvested. However, no quantitative data are available turn over now. Presently, *L.calbasu* is regarded as in danger of extinction in India [11] and Bangladesh [32] one to need for and therefore there is an immediate need to protect and conserve it. One of the major actions to setup the Barnai River in Bangladesh this species *L.calbasu* was announced as the endangered one. So far, the major reason to create the public awareness and stopped destructive fishing method for protection of species. Not only this, are also to notify the inland fisherfolk were following the awareness.

4.6 Morphological identification
Following the taxonomical imperative information of the present species can be distinguished by photographical image identification. The present morphological characters suggest that there are three unbranched and fourteen branched rays were covered in dorsal fin, one unbranched and eight branched rays in ventral fin. Whereas, one unbranched and sixteen branched rays in pectoral fin and two unbranched and six branched rays in anal fin. Mouth structure of *Labeo calbasu* was clearly photographed as a bottom feeder. Barbels are covered both of maxillary and mandibular region while maxillary barbel longer than mandibular in Figure 4a. Pair of external nostrils is clearly visible. Five pairs of branchiostegal rays and four pairs of gill arches in each side of the operculum with opercular notch (Figure 4b). Lateral lines are straight with forty one scales are arranged in the middle region of the body starting from operculum to caudal peduncle with dark pinkish cycloid scales (Figure 3). Furthermore, forked caudal fin with the upper lobe have two unbranched and nine branched rays whereas the same in lower lobe. In the present result suggest that the morpho-taxonomical observation, no more spines are covered all the fins of *L.calbasu*.

Colour in live specimen *Labeo calbasu* 12.9 mm SL. Black colour marks (LLS) mentioned the straight line of lateral line scales

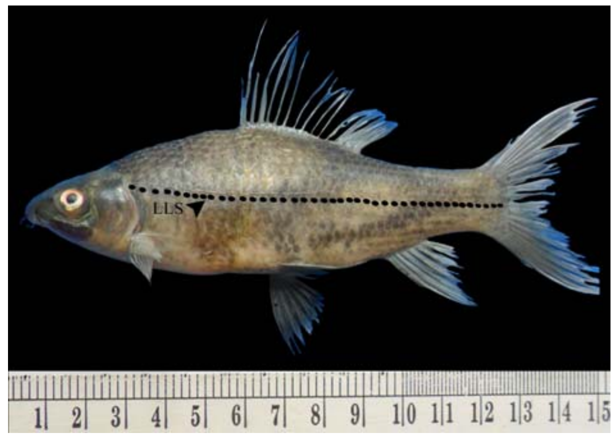
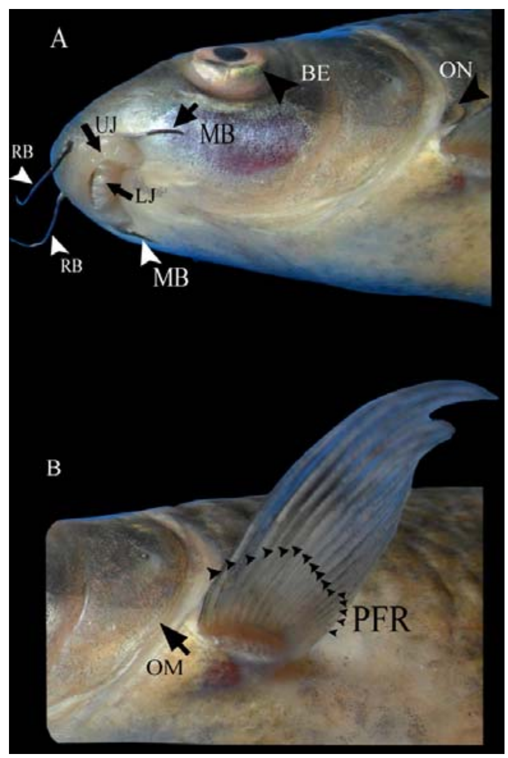


Fig 3: Photographical (morphological) image identification in whole specimen of *Labeo calbasu*.



4a. Head region: RB-Rostral Barbel; MB-Mandibular Barbel; UJ-Upper Jaw; LJ-Lower Jaw.

4b. BE-Bulging Eye; ON-Opercular Notch. B. PFR-Pectoral Fin Rays; OM-Opercular Membrane.

Fig 4a, 4b: Photographical images for head and pectoral fin rays of *Labeo calbasu*.

4.7 Morphometrics and Meristics

Statistical analyses of each morphometric characters were noticed as proportions of Standard Length. Among morphometrics concerning holotype values, %SL, Mean±SD, regression analysis, Pearson correlation co-efficient and univariate analysis were represented in Table-1. Herein, the Regression analysis were ranging from (r^2 =0.641-0.972) maxillary barbel length and standard length, whereas, the Pearson's correlation co-efficient (r) between 0.695^{**} - 1.000^{**} (head depth at occiput and occiput to ventral origin) at $^{*}P<0.05$ and $^{**}P<0.01$ level significant. Univariate statistical analysis (ANOVA) showed that all the morphometric measurements were significantly different between the variables at $^{***}P<0.001$ excluding standard length and pre ventral distance. In addition, as the proportions of Head Length based statistical analyses were represented in Table 2. Similarly, the head length based morphometrics about holotype values, %SL, Mean±SD, regression analysis, Pearson correlation co-efficient and univariate analysis (ANOVA) were also represented. In this, the Regression analysis were ranging from (r^2 =0.365-0.954) lower jaw length and pre nasal length, whereas, the Pearson's correlation co-efficient (r) between 0.445^{**}- 0.973^{**} (lower jaw length and lower jaw to isthmus) at $^{*}P<0.05$ and $^{**}P<0.01$ level significant. Univariate statistical analysis (ANOVA) showed that all the morphometric measurements were significantly different between the variables at $^{***}P<0.001$ excluding head width and head depth at occiput. Furthermore, the range values for meristic characters and Kruskall–Wallis test showed significant differences for all the meristic (countable) characters, in this the caudal fin rays at $^{*}P>0·05$ whereas, Dorsal fin rays, Upper transverse rows, Lower transverse rows (anus) and Circumpeduncular scales shows significant at **$P<0·01$** and other characters shows are highly significant at $^{***}P<0·001$ were noticed in Table 3.

Table 1: Percentage of standard length with proportional measurements of *Labeo calbasu.*

Characters	Acronym	Holotype (mm)	% SL (mm)	Mean	SD	a	b	r^2	r	F	*P*
Standard Length	SL	7.7-15.8	91.2	11.43	2.62	-0.412	1.021	0.972	0.989^{**}	0.057	0.815^{*}
Snout to Urocentrum	SU	7.0-14.9	93.1	11.14	2.60	-0.575	0.997	0.965	0.991^{**}	96.39	0.000^{***}
Head Length	HL	1.9-3.4	22.8	2.64	0.51	-0.699	1.101	0.698	0.781^{**}	114.3	0.000^{***}
Head Width	HW	1.0-2.4	13.4	1.81	0.52	-0.699	0.970	0.752	0.791^{**}	131.8	0.000^{***}
Head Depth at Nostril	HDN	0.9-1.5	11.3	1.25	0.18	-0.538	0.894	0.872	0.906^{**}	140.6	0.000^{***}
Head Depth at Pupil	HDP	0.7-1.0	8.86	0.94	0.13	-0.518	1.107	0.955	0.980^{**}	118.4	0.000^{***}
Head Depth at Occiput	HDO	1.1-2.2	16.9	1.71	0.36	-0.494	0.963	0.950	1.000^{**}	112.6	0.000^{***}
Occiput to Dorsal Origin	ODO	1.4-2.3	22.5	1.99	0.27	-0.534	0.841	0.882	0.934^{**}	128.8	0.000^{***}
Occiput to Pectoral origin	OPO	0.1-1.8	13.8	1.37	0.19	0.498	1.078	0.952	0.969^{**}	92.69	0.000^{***}
Occiput to Ventral Origin	OVO	1.9-3.3	27.2	2.74	0.51	-0.537	0.937	0.636	0.695^{**}	138.4	0.000^{***}
Pre Orbital Length or Snout Length	POL (or) SL	0.9-1.2	8.87	1.03	0.09	-0.698	1.115	0.732	0.791^{*}	129.1	0.000^{***}
Post Orbital Length	PtOL	0.8-.1.1	8.98	0.98	0.09	-0.695	0.997	0.717	0.863^{*}	146.7	0.000^{***}
Eye Diameter	ED	0.6-0.9	5.99	0.72	0.13	-0.662	1.217	0.711	0.854^{*}	127.8	0.000^{***}
Inter Orbital Width	IOW	0.9-1.8	8.73	1.35	0.40	-0.689	1.042	0.919	0.969^{*}	143.4	0.000^{***}
Pre Nasal Length	PNL	0.7-1.1	4.61	0.84	0.12	-0.571	0.998	0.790	0.839^{**}	138.6	0.000^{***}
Inter Nostril Width	INW	0.9-1.3	4.99	1.01	0.14	-0.613	0.978	0.689	0.803^{**}	107.6	0.000^{***}
Pre Occipital Length	POcL	2.0-2.6	19.7	2.22	0.19	-0.734	1.010	0.837	0.896^{**}	153.1	0.000^{***}
Upper Jaw Length	UJL	0.4-0.6	9.11	0.50	0.07	0.592	0.908	0.659	0.697^{*}	156.2	0.000^{***}
Lower Jaw Length	LJL	0.3-0.5	5.86	0.39	0.03	-0.422	0.982	0.764	0.879^{*}	142.6	0.000^{***}
Mouth Gape Width	MGW	0.7-1.0	10.4	0.87	0.09	-0.514	1.011	0.952	0.978^{**}	139.1	0.000^{***}
Lower Jaw to Isthmus	LJI	0.7-1.2	8.61	0.99	0.18	-0.499	0.969	0.843	0.976^{**}	143.8	0.000^{***}
Maxillary Barbel Length	MxBL	0.7-0.9	1.87	0.82	0.09	-0.589	0.879	0.641	0.681^{**}	151.1	0.000^{***}
Mandible Barbel Length	MnBL	0.5-0.6	1.12	0.79	0.05	-0.523	0.890	0.815	0.970^{**}	71.64	0.000^{***}
Maximum Body Depth	MBD	3.1-4.5	30.6	3.84	0.44	-0.597	1.123	0.825	0.873^{**}	91.18	0.000^{***}
Dorsal Fin Height	DFH	2.3-4.2	25.1	2.95	0.59	0.578	0.992	0.719	0.738^{**}	97.96	0.000^{***}
Pectoral Fin Height	PFH	2.1-3.2	20.2	2.61	0.38	-0.478	1.001	0.897	0.909^{**}	99.36	0.000^{***}
Ventral Fin Height	VFH	2.2-2.8	18.9	2.55	0.24	0.545	1.051	0.841	0.863^{**}	96.12	0.000^{***}
Anal Fin Height	AFH	2.2-3.1	18.4	2.68	0.34	-0.431	1.033	0.891	0.941^{**}	41.31	0.000^{***}
Pre Dorsal Distance	PDD	4.7-6.9	41.1	5.63	0.66	0.464	0.998	0.891	0.976^{**}	55.98	0.000^{***}
Post Dorsal Distance	PoDD	3.1-5.7	46.7	4.53	0.85	-0.423	1.150	0.898	0.890^{**}	90.97	0.000^{***}
Pre Pectoral Distance	PPecD	2.1-3.4	22.7	2.89	0.66	-0.571	1.134	0.968	0.847^{**}	46.35	0.000^{***}
Pre Ventral Distance	PVD	4.1-6.0	48.8	5.19	0.66	-0.579	1.023	0.809	0.858^{**}	7.80	0.013^{**}
Pre Anal Distance	PAD	6.8-10.9	74.9	8.79	1.18	-0.411	1.190	0.903	0.917^{**}	79.82	0.000^{***}
Dorsal Fin Base Length	DFBL	1.9-2.7	15.6	2.75	0.22	-0.428	1.012	0.886	0.925^{**}	146.3	0.000^{***}
Pectoral Fin Base Length	PFBL	0.4-0.9	4.24	0.71	0.22	-0.450	0.986	0.771	0.792^{**}	143.1	0.000^{***}
Ventral Fin Base Length	VFBL	0.5-1.0	6.23	0.84	0.18	-0.378	0.966	0.745	0.765^{**}	138.4	0.000^{***}
Anal Fin Base Length	AFBL	0.6-1.1	7.24	0.99	0.24	-0.301	0.807	0.705	0.715^{**}	77.92	0.000^{***}
Dorsal Origin to Anal Origin	DOAO	2.2-4.1	31.1	3.44	0.63	-0.467	1.123	0.722	0.746^{**}	86.58	0.000^{***}
Dorsal Origin to Ventral Origin	DOVO	1.6-3.7	25.5	2.97	0.62	-0.411	1.153	0.858	0.883^{**}	91.61	0.000^{***}
Pectoral Origin to Ventral Origin	POVO	1.9-3.2	29.2	2.84	0.37	-0.478	1.267	0.954	0.969^{**}	85.25	0.000^{***}
Ventral Origin to Anal Origin	VOAO	2.0-3.7	29.7	3.09	0.57	-0.439	1.101	0.867	0.878^{**}	112.5	0.000^{***}
Caudal Peduncle Length	CPL	1.6-2.1	26.5	2.01	0.09	-0.399	1.034	0.845	0.892^{**}	127.3	0.000^{***}
Caudal Peduncle Width	CPW	0.8-1.8	11.1	1.34	0.41	-0.312	0.987	0.790	0.832^{**}	70.81	0.000^{***}
Caudal Fin Length (both lobe)	CFL	2.9-4.1	27.9	3.71	0.72	-0.373	0.960	0.701	0.798^{**}	93.35	0.000^{***}

SL-Standard Length, SD = standard deviation, a-intercept, b-slope, r^2-regression co-efficient, r-Pearson's correlation co-efficient with significant at $^{**}P<0.05$ and highly significant at $^{*}P<0.01$. Univariate statistics (ANOVA) for testing differences among variables such as F and *P*- value probability at $^{*}P<0.01$ and $^{***}P<0·001$.

Table 2: Percentage of head length with proportional measurements of *Labeo calbasu*

Characters	% HL (mm)	Mean	SD	a	b	r^2	r	F	*P*
Head Width	58.4	1.81	0.51	-0.468	1.274	0.710	0.809^{*}	12.11	0.003^{*}
Head depth at nostril	49.2	1.25	0.17	-0.267	0.615	0.698	0.802^{**}	65.48	0.000^{***}
Head depth at pupil	38.7	0.94	0.13	-0.371	0.677	0.883	0.927^{*}	108.1	0.000^{***}
Head depth at occiput	74.3	2.15	0.43	-0.434	1.106	0.922	0.948^{*}	20.26	0.004^{*}
Pre Orbital Length or Snout Length	38.7	1.80	0.72	-0.128	0.637	0.578	0.782^{*}	100.3	0.000^{***}
Post Orbital Length	39.3	1.79	0.29	-0.149	0.634	0.575	0.617^{*}	103.1	0.000^{***}
Eye Diameter	26.2	1.68	0.32	-0.487	0.787	0.741	0.887^{**}	139.1	0.000^{***}
Inter Orbital Width	38.2	1.99	0.45	-0.519	1.285	0.731	0.856^{*}	39.93	0.000^{***}
Pre Nasal Length	20.2	1.74	0.31	-0.367	0.691	0.954	0.980^{**}	123.1	0.000^{***}
Inter Nostril Width	21.8	1.83	0.36	-0.251	0.609	0.760	0.873^{**}	97.57	0.000^{***}
Pre Occipital Length	86.3	2.43	0.34	0.189	0.575	0.781	0.889^{*}	5.065	0.039^{***}
Upper Jaw Length	39.8	1.57	0.58	-0.541	0.671	0.706	0.856^{**}	181.8	0.000^{***}
Lower Jaw Length	25.7	1.52	0.41	-0.297	0.409	0.365	0.445^{**}	202.2	0.000^{***}
Mouth Gape Width	45.4	1.75	029	-0.268	0.505	0.789	0.907^{**}	120.6	0.000^{***}
Lower jaw to isthmus	37.7	1.81	0.34	-0.399	0.929	0.950	0.973^{**}	95.55	0.000^{***}
Maxillary Barbel Length	8.2	1.73	0.30	-0.309	0.549	0.904	0.937^{**}	126.5	0.000^{***}
Mandible Barbel Length	6.3	1.60	0.28	-0.367	0.365	0.413	0.578^{**}	170.9	0.000^{***}

SL-Standard Length, SD = standard deviation, a-intercept, b-slope, r^2-regression co-efficient, r-Pearson's correlation co-efficient with significant at $^{**}P<0.05$ and highly significant at $^{*}P<0.01$. Univariate statistics (ANOVA) for testing differences among variables such as F and *P*-probability at $^{*}P<0.01$ and $^{***}P<0{\cdot}001$.

Table 3: List of meristic counts and Kruskal–Wallis test (univariate statistics ANOVA) for testing differences among variables of *Labeo calbasu*.

Meristic counts		Acronym	Range		*H*-statistics	*P*
			Minimum	Maximum		
Branchiostegal Rays		BR	0	5	2.530	$P<0{\cdot}001^{***}$
Gill Rakers		GR	80	83	1.791	$P<0{\cdot}001^{***}$
Dorsal Fin Rays	Unbranched	DFR	0	2	35.091	$P<0{\cdot}01^{**}$
	Branched		0	14		
Ventral Fin Rays	Unbranched	VFR	0	1	31.123	$P<0{\cdot}001^{***}$
	Branched		0	8		
Pectoral Fin Rays	Unbranched	PFR	0	1	16.671	$P<0{\cdot}001^{***}$
	Branched		0	14		
Anal Fin Rays	Unbranched	AFR	0	2	26.682	$P<0{\cdot}001^{***}$
	Branched		0	6		
Pre Dorsal Scales		PDS	19	21	11.551	$P<0{\cdot}001^{***}$
Pre Anal Scales		PAS	21	25	16.925	$P<0{\cdot}001^{***}$
Lateral Line Scales		LLS	36	38	18.713	$P<0{\cdot}001^{***}$
Lateral Line to Ventra Scale Rows		LL to VSR	6	7	21.612	$P<0{\cdot}001^{***}$
Upper Transverse Rows		UTR	6	8	13.517	$P<0{\cdot}001^{***}$
Lower Transverse Rows		LTR	5	7	10.824	$P<0{\cdot}01^{**}$
Circumpeduncular Scales		CPS	16	18	8.701	$P<0{\cdot}01^{**}$
Circumferential scales		CFS	29	33	6.495	$P<0{\cdot}001^{***}$
Caudal Fin Upper Lobe	Unbranched	CFUL	0	1	40.991	$P>0{\cdot}05^{*}$
	Branched		0	9		
Caudal Fin Lower Lobe	Unbranched	CFLL	0	1		
	Branched		0	8		

H - Kruskal–Wallis statistical value, $*P>0{\cdot}05$ – insignificant, $^{**}P<0.01$ – significant and $^{***}P<0{\cdot}001$ - highly significant.

5. Discussion

The Orange fin Labeo (*Labeo calbasu*) is a serious threatened species, in India [11] and also the tributaries of Cauvery and most of the riverine structure in its populations. The present study is mainly focusing that the adult population of *L.calbasu* was declining very fast for the reason that, the juvenile's population was overexploited. It has revealed that the tributaries of Cauvery (Kollidam) were primarily used as a breeding ground for this species and unfortunately due to various anthropogenic pressures to adversely affect the adult populations. Besides, the indiscriminate fishing and habitat destruction (local sand mining and riverine pollution for agricultural chemicals) were the major damaging factor in this region [2]. Further, the inorganic toxic waste of the river due to some industrial activities is another important threat factor to fish fauna. In this study area, the Cyprinidae family fishes were the dominant members of the assemblage structure concerning nearly seventy five species (www.fishbase.org) in tributaries of Cauvery and Lower Anicut, Tamil Nadu. Besides, most of the Cyprinids spawn during April to August and September. Spawning season should be banned for fishing practices, because the large scale brooder stocks were domesticated, natural cultured stocks and produced fingerlings are degraded. Since, the fish fauna in this region are supports to livelihood of the several economic classes is an urgent need to understand the protection priorities and implement to the conservational actions [33]. In this mean time, development of artificial breeding and rearing of this species *L.calbasu* have also been conducted by several researchers is very essential one [34]. Moreover, most of the authors were recorded in diverse filed such as taxonomy, biology, landmark-based biometric study, population dynamics, stock assessment, socio-geographical and micro floral study about this species *L.calbasu*. However, the conservational and fisheries management studies of this species assemblage structure are still rudimentary in Cauvery waters and Lower Anicut, Tamil Nadu. In this context, the most important conservation and recommendations aspect, the long-term strategy on sustainability stock structure is a parallel way to that the developmental strategy for fisheries and aquaculture is a paramount importance, as these complementary and interlinked. During this study, the fish sanctuary should establish to preserve fish stock, indigenous juveniles and brooder. Moreover, the fishery regulation should strictly apply for protection of this species and enhanced the fishery production especially in Indian major carps [33]. Resembling, the Indian major carps are highly priced fishes on the other hand, their stocks are going to turn down in recent years. So far, the conservational plan should be strictly following in this riverine region. Furthermore, the sampling areas are no past research information regarding fisheries management and morpho-taxonomical identification. Since the effective study was only concentrated on part of the distributional region of Orange fin *Labeo* at Lower Anicut, Tamil Nadu. As a result, the traditional morphometrics are more effective to manage the resource in rationally and effectively is very necessary to know the stock structure because no quantitative data in this region of an explored species. Now, it is must be conservational managed with separately and most optimized their yield [33]. Subsequently, the present study is imperative and mainly focusing that the morphometric and meristic studies have been proved insight information to discriminate and more effective for identification of the stocks.

Following this, the present results were obtained from the biometric work to indicate that the existence of morphological differentiated groups of variables. Among morphometrics, head and maximum body depth have been regarded as the most important characters to discriminate the fish populations within and between stocks [35]. Besides, the mechanism of phenotypic plasticity is very high. It may become easily habituated by modifying their physiology and behavior to change the environmental limitation. So far, these modifications are ultimately changing their morphology and quickly adapt themselves by altering the necessary morphometrics of fishes [36]. Further, the phenotypic differences among stocks are most expected one, because they are geographically separated and it may have originated from different ancestors. However, the obvious morphological differences were relatively low variability when compared to other nature of stocks [37]. In addition, one of the most desirable inferences to explore the methods of meristic characters among populations was equal or close to each other, indicating that there were only tiny intra-species variations. Also, as the results of this study were clearly suggested that there was low variability occurs in meristic characters. Following, the Kruskal-Wallis test showed significant differences among fish populations by way of the meristic statistics were most important part at the inter-species level. The meristic characters may follow a predetermined narrow range of variability, because the divergence from that range could be fatal for the individual [38]. It is a well-known fact, that morphological characters can show high plasticity in response to differences in environmental conditions. Hitherto, the reason that fishes are foremost susceptible to environmentally-induced phenotypic differentiations such as temperature, salinity, prolonged swimming, abundance of food, different feeding environment, food types and availability of food or other features [39]. In addition, for the most important part of the body characters to affect predominantly in wild fish populations were well separated from indicating that the environmental factors did influence to the morphological variation. Thus, morphometric variation may reflect genetic differences between stocks and/or environmental differences among localities. The stock identification based morphometric characters must be confirmed the genetic evidences to verify that the morphological variations to reflect some degree of reproductive isolation rather than simply environmental differences [40]. Besides, those are similar factor were highly influenced to the phenotypic differentiation between them and it must have reflected to genetic divergences of fish stocks in an exacting region. Further, as the morphological characters is especially dependent upon ecological conditions during early life-stages for the reason that the phenotypic differentiation may explore to indicate the majority of fishes to spend their separate regions in entire lives [41]. Therefore, the findings of this study can be used to identify morphology based information to differentiate these stocks more precisely. Besides, there could a possible linking between the observed low morphological variability with some differences in this habitat for prey-predator relationship to meet in single geographical location for it may be considered [41]. Until now, the factual reasons for the observed morphological variations should be studied. Further, to gathering appropriate sampling design in future, that it includes two different localities as well as to find out prey-predator behavior of this species. Moreover, application of molecular genetic markers such as microsatellite and mtDNA study would be a most effective tool for examining the phenotypic discreteness for this geographic region and facilitate to the development of management recommendations.

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7. Conclusion

Conservational measures, including stopping the illegal fishing, dynamiting, poisoning, identifying crucial breeding habitats and creating mass awareness are need to save the threatened fish fauna in this region. Without these efforts many freshwater-fish species would become extinct. Collecting the juveniles and maintaining aquariums are pivotal to raising awareness and actively conserving species through conservational programmes as informed by the information made available through the species assessments published on the Red List.

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