



LOCAL EXTINCTION OF VALENCIENNES CLARIID *CLARIAS DUSSUMIERI* VALENCIENNES, 1840 FROM TWO PANCHAYATHS OF THRISSUR DISTRICT, KERALA

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Abstract: *Clarias dussumieri* one of the common cat fish in the low land freshwaters of Kerala. The decline of the species has been noticed since 2002 onwards. A study has been conducted in water bodies of Kuzhur and Annamanada of Thrissur district during the period from 2010-2016 by monitoring the catch during monsoon and summer fishing, interview with fisher folk and regular sampling. This paper declare the local extinction of the *Clarias dussumieri*.

Key words: Monsoon Floodplain fishery, *Clarias*, Extinct, ootha

INTRODUCTION

Anthropocene is characterized by increasing interventions on natural ecosystems and the biological diversity is therefore threatened due to habitat destruction and fragmentation, climate change, over exploitation, invasive alien species, and pollution (WWF, 2016). One of the critical requirements for conservation is to find out the species that are vulnerable to extinction. According to IUCN (2012), a taxon is said to be 'Extinct' (EX) when there is no reasonable doubt that the last individual has died or when exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual. Local extinction, or extirpation, is the condition of a species (or other taxon) that ceases to exist in the chosen geographic area of study, though it still exists elsewhere.

The Family Clariidae is at present known from the East Indian Archipelago, Southeast Asia, Syria and Africa and enjoys a discontinuous distribution (absent in Persia, Baluchistan). The genus *Clarias* Scopoli, 1777 possess a long history of evolution and its fossil remains were reported from the lower Pliocene deposits of Siwalik Hills of India. The other fossil records of the Clariidae were also reported from the Middle Pliocene de-

posits of Natron Valley in Egypt (Menon, 1951). Based on the fossil records Menon (1951) concluded that the Family Clariidae must have originated in the Siwalik hills of India during the Pliocene periods and dispersed to West Africa and East China during the Pliocene period. Moreover the climatic conditions and habitat, as Menon (1951) suggests, prevailed during the Pliocene periods were quite similar to that of Sundrban areas which also intellectualize the evolution of accessory respiratory organs. The co-evolved fishes like *Channa*, *Heteropneustes* and *Anabas* possess the similar adaptations for aerial respiration. Hora (1937) and Menon (1951) concluded that the ancestral home of the Clariidae is South China.

The members of the genus *Clarias* enjoys a wider distribution in Asia, with 12 species. Hora (1936) identified three species *Clarias* from India viz, *Clarias batrachus* (Linnaeus), *C. dussumieiri* (Cuvier and Valenciennes) and *C. dayi* Hora. The family Clariidae, as reported by various workers, is represented by three species under the genus *Clarias* and three species under *Horaglanis* Menon in Kerala. *Clarias batrachus*, *C. dussumieiri*, *C. dayi* and *Horaglanis krishnai* and *H. alikunhi* (Babu and Nair, 2004) and *H. abdulkalami* (Babu,

2012). *Horaglanis* is an independently evolved blind clariid from tip of the Indian peninsula (Menon, 1950, 1955). Binoy (2010) reported that *Clarias dussumieri*, *C. batrachus* from the low lands and *Clarias dayi* from Wayanad Hills (Hora, 1941). Ng and Kottelat (2008) resolved the nomenclatural crisis of the *Clarias batrachus* and designated a neotype (NRM 54718, 174.1 mm SL; Java: vicinity of Bandung; C. L. Hubbs, 22.v.1929). *Clarias batrachus* is distinguished from all Asian congeners in having a narrow snout, in dorsal view with straight lateral outline and convex anteriorly and differs from *C. dussumieri* having long and thin frontal fontanelle.

Currently *C. dussumieri* is classified as Nearly Threatened in the IUCN redlist (Abraham, 2011, Biju Kumar and Rajeev, 2015). This paper aims to report on the local extinction of the Valenciennes clariid *Clarias dussumieri* (Siluriformes: Clariidae) from the water bodies extended two panchayats, Annamanada and Kuzhur panchayats of Thrissur district, Kerala, India.

MATERIALS AND METHODS

Study area: Annamanada Grama Panchayat is located in Thrissur district of Kerala which has an extent of 25.08KM². The Panchayat is divided in 18 wards. The total population of the Panchayat is 26448 (<http://lsgkerala.in/annamanada-panchayat/general-information>). Kuzhur Grama Panchayat is also located in the Thrissur district having an extent of 19.11KM². The total population of the panchayat is 18569 (<http://lsgkerala.in/kuzhurpanchayat/general-information>).

Annamanadapuzha, Chiryam chaal of 3 ha area spread over in Annamanada GP and Karikkattu chaal of 22 ha spread in Annamanada and Kuzhur GP and network of natural irrigation canals and ponds (Figure 1-4) are the wetland resources of the panchayat.

Fisher folk including Licensed Regular fishermen (LRF), Occasional Fishermen (OF), unlicensed fishermen (ULF), Fish vendors were interviewed for a period from 2010-2016 periods. In addition

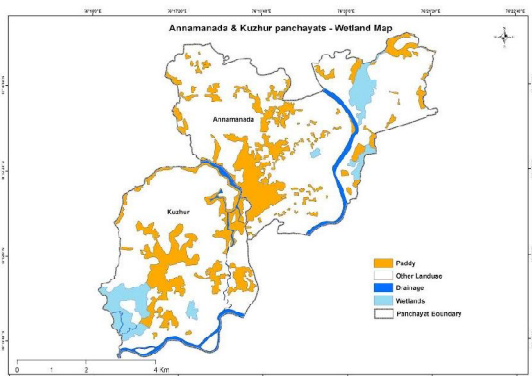


Fig. 1. Annamanada and Kuzhur Panchayat, Thrissur Dt., Kerala



Fig. 2. Karikkattu Chaal



Fig. 3. Natural irrigation canal in the midst of paddy fields of Annamanada Panchayat



Fig. 4. Chiryam Chaal

to these, the *all fish available season*, the ootha period (Monsoon Floodplain Fishery - Shaji, 2012; Shaji and Laladhas, 2013) the fishing grounds were visited regularly by the author. Visits were also made to the places where the summer fishing is taking place by dewatering of the ponds, irrigation (natural) canals, natural water tanks, where the possibility to encounter the species is high. The local fish markets were also visited and interviewed the fish vendors to gather the information on the availability of the *Clarias dussumieri* in the markets.

RESULTS

Annamanada and Kuzhur grama Panchayats are bestowed with freshwater bodies consisting of river (Annamanada river), Kole wetlands (not true kole wetland), paddy field associated irrigation canals, ponds (religious, irrigation). The two chaals and the associated paddy lands support 36 species of freshwater fish species (Table 1).

All the species enlisted in the Table 1 are uniformly distributed in aquatic ecosystems of these two Panchayats and play a pivotal role in the local inland fishery. *Channa striata*, *C. marulius*, *Systemus subnasutus*, *Wallago attu*, *Horabagrus brachysoma* fetch an exorbitant prize in the inland fish market. The small carps, *Puntius mahecola*, *P. parrah*, *Dawkinsia filamentosa*, contribute substantially to the local fishery. The fishery market would be active during the onset of monsoon which coincides with the *ootha* fishery (MFF) (Shaji, 2012).

After the monsoon fishery, the two chaals mentioned above would be auctioned to fishermen through an open tender system for summer fishing by the Panchayat. The fishing is mainly concentrated in the chaals and fishing right gained through tender is limited to the summer season only (March to April). *Systemus subnasutus*, *Channa striata*, *C. marulius*, *Heteropneustes fossilis*, *Anabas testudineus*, *Ompok bimaculatus* are the species that sustains this summer fishery. The fisherfolk interviewed belonged to the age group ranging from 21 to 80. There are no special fish market/fish vendors exclusively for the freshwater fishes. The freshwater fish marketing is limited the monsoon season and summer season (March-April). Of the total fisher folk inter-

viewed, 52.94% of them were occasional fishermen (OF), 17.64% were Regular Licensed fishermen (RL) and 29.42% were Regular Unlicensed fishermen (RUF) (Table 2). Regular Licensed fishermen belongs to the age group of 62-82.

The decline of the *Clarias dussumieri* has been came to the notice of fisherfolk since 1980. Apparently, this coincides with the outbreak of *Epi-zootic Ulcerative Syndrome* (EUS) which was prevalent during the period from 1980 to 2002 in the study area. *Clarias dussumieri* was one of the most affected species in the area. The other species affected due to the EUS are *C. striata*, *Systemus subnasutus*, *H. fossilis*, *Anabas*, *Dawkinsia filamentosa*, however, they could regain their population.

The occasional fishermen noticed the decline of the species during the period from 1985. According to the Occasional Fishermen, the last collected *C. dussumieri* was during 2010. However, Unlicensed Fishermen noticed the decline during the period from 2000 and the last occasion of their encounter was during 2009 (Table 3).

During the period from 2010-2016, the author collected data on the monsoon floodplain fishery, which is known as *ootha* in local parlance. During this period, almost all the fishes known from the area migrate to the paddy field for breeding/feeding. The fishermen (including, OF, RUL, RL) do active fishing employing different gears such as cast net, gill net, *adichil*, *chaattom*, electroshocker, *koodu*, etc. Since fishing is intensive employing all types of gears during MFF, the probability to encounter of even rarest species of fishes is rather high. The *Clarias dussumieri* was last collected during ootha or MFF of 2011 June. No *Clarias dussumieri* was reported from the wetlands of Annamanada-Kuzhur GP after June 2011 (Table 4). Though the ootha has been banned during the 2014 by the panchayat authorities, the unauthorized fishing has been taken place. The interview with the fishers during 2014 revealed that none of them got the *Clarias dussumieri*. During the 2016, the ootha was irregular and no regular fishing has taken place.

During 2016 the monsoon was irregular the fishing was irregular and unlike earlier ootha. The delayed monsoon disrupted the migration pro-

Table 1. List of freshwater fishes in Annamanada-Kuzhur Grama Panchayat, Thrissur, Kerala

Family: Anguillidae	21. <i>Ophisternon bengalense</i> McClelland
1. <i>Anguilla bengalensis</i> (Gray)	Family: Mastacembelidae
2. <i>Anguilla bicolor</i> McClelland	22. <i>Macrogathus guentheri</i> (Day)
Family: Cyprinidae	23. <i>Mastacembelus armatus</i> (Lacepede)
3. <i>Amblypharyngodon melettinus</i> (Val)	Family: Ambassidae
4. <i>Devario malabaricus</i> (Jerdon)	24. <i>Parambassis ranga</i> (Hamilton)
5. <i>Rasbora dandia</i> (Valenciennes)	Family: Nandidae
6. <i>Systemus subnasutus</i> (Valenciennes)	25. <i>Nandus nandus</i> (Hamilton)
7. <i>Dawkinsia filamentosa</i> (Valenciennes)	Family: Cichlidae
8. <i>Puntius dorsalis</i> (Jerdon)	26. <i>Etroplus maculatus</i> (Bloch)
9. <i>Puntius mahecola</i> (Valenciennes)	27. <i>Etroplus suratensis</i> (Bloch)
1. <i>Puntius parrah</i> Day	Family: Godiidae
11. <i>Pethia punctatua</i> (Day)	28. <i>Glossogobius giuris</i> (Hamilton)
12. <i>Pethia vittatus</i> (Day)	29. <i>Awaous gutum</i> (Hamilton)
Family: Cobitidae	Family: Anabantidae
13. <i>Lepidocephalichthys thermalis</i> (Val)	30. <i>Anabas testudineus</i> (Bloch)
Family: Bagridae	Family: Belontiidae
14. <i>Horabagrus brachysoma</i> (Guenther)	31. <i>Pseudosphromenus cupanus</i> (Cuvier)
15. <i>Mystus ocutatus</i> (Valenciennes)	Family: Channidae
Family: Siluridae	32. <i>Channa gachua</i> Hamilton
16. <i>Ompok bimaculatus</i> (Bloch)	33. <i>Channa marulius</i> (Hamilton)
17. <i>Wallago attu</i> (Bloch & Schneider)	34. <i>Channa striata</i> (Bloch)
Family: Heteropneustidae	Family: Tetraodontidae
18. <i>Heteropneustes fossilis</i> (Bloch)	35. <i>Carinotetraodon travancoricus</i> (Hora & Nair)
Family: Belonidae	Family: Megalopidae
19. <i>Xenentodon cancila</i> (Hamilton)	36. <i>Megalops cyprinoides</i> (Broussonet)
Family: Aplocheilidae	
20. <i>Aplocheilus lineatus</i> (Valenciennes)	
Family: Synbranchidae	

Table 2. Spectrum of fisherfolk in Annamanada-Kuhur Gramapanchayat, Thrissur, Kerala.

Category	%	Age
Occasional Fishermen	52.94118	28-54
Regular but Unlicensed	29.41176	21-72
Regular Licensed	17.64706	62-80

Table 3. *Clarias dussumieri* -trend in the population status reported by the fisher folk

Category	Last collected year	Noticed the decline from
OF	2010	1985
RL	2011	1985
RUL	2009	2000

Table 4. Quantity of fish species collected during the Floodplains of Annamanada-Kuzhur Panchayats during 2011-2016

Fish species	% in the collection					
	2011	2012	2013	2014	2015	2016
1 <i>Anabas testudineus</i>	08.02	09.98	08.76		20.16	
2 <i>Anguilla bicolor</i>	02.70	04.30	03.12		01.98	
3 <i>Amblypharyngodon melettinus</i>	03.48	02.67	05.02		00.00	
4 <i>Channa marulius</i>	02.87	01.45	01.45		03.60	
5 <i>Channa gachua</i>	00.01	01.25	00.80		00.00	
6 <i>Channa striata</i>	17.93	17.93	19.31		21.65	
7 <i>Clarias dussumieri</i>	00.15	00.00	00.00		00.00	
8 <i>Heteropneustes fossilis</i>	02.30	01.80	03.68		12.01	
9 <i>Horabagrus brachysoma</i>	13.38	10.09	12.16		15.46	
10 <i>Mystus oculatus</i>	00.14	00.85	01.32		00.00	
11 <i>Macrogathus guentheri</i>	00.24	00.00	00.08		00.00	
12 <i>Nandus nandus</i>	00.29	00.15	01.64		00.00	
13 <i>Ompok bimaculatus</i>	01.31	00.84	01.12		00.00	
14 <i>Puntius filamentosus</i>	01.70	01.90	02.80		04.65	
15 <i>Puntius parrah</i>	04.52	02.86	03.98		00.00	
16 <i>Barbodes subnasutus</i>	07.79	04.35	05.27		11.23	
17 <i>Puntius mahecola</i>	06.30	06.30	05.46		02.40	
18 <i>Rasbora dandia</i>	00.16	01.02	01.05		04.30	
19 <i>Wallago attu</i>	26.38	32.10	22.86		02.56	
20 <i>Xenentodon cancila</i>	00.32	00.18	00.15		00.00	
Total	99.99	100.02	100.03		100.00	

**Fig. 5.** *Clarias dussumieri* Valenciennes.

cess of the fishes and consequently the fishing. The fishery was limited to *Channa striata*, *Channa marulius*, *Wallago attu* and *Systomus subnasutus*.

The flooded plains remains as the fishing ground till the end of SW monsoon. The main gears is the gill nets. The interview with the fishere who employ the gill nets regularly (28 person in these two panchayats), revealed the entire absence of

C.dussumieri in their regular fish collection.

Summer Fishing

Summer fishing by either by dewatering or by group fishing is a common practice in these two panchaytats. Ponds, natural irrigation canals, small water logged areas are the fishing centers by dewatering. Here also the possibilities to encounter the rare fishes are maximum.

There are 36 privately ponds in Annamanada Panchayat and 50 privately owned ponds in Kuzhur Panchayat. In addition to these, there are 4 panchayat owned ponds (355 cents total area) in Kuhur GP and 3 panchayat owned ponds (718 cents) in Annamanada GP (Anon, 2011).

The Species collected during the summer fishing consists of *Channa striata*, *C. marulius*, *H. fossilis*, *Ompok bimaculatus*, *Systemus subnasutus*, *Puntius mahecola*, *D. filamentosus*, *P. dorsalis*, *P. parrah*, *Pethia punctata*, *Pethia vittatus*, *Rasbora dandia*, *Mystus oculatus*, *Nandus nandus*, *Etroplus maculatus* and *Anabas testudineus*. These ponds were once the abode of *Clarias dussumieri*. No specimen of *Clarias dussumieri* was recorded from the samples fished from the ponds during the period from 2010 to 2015. A decline of *Nandus nandus*, *Etroplus maculatus*, *Macroganthus guentheri* and *Mastacembelus armatus* is also obvious.

DISCUSSION

The taxonomic history of *Clarias dussumieri* can be traced back to Valenciennes (1840) with naming of the species. On the description of *Clarias dussumieri* Valenciennes noted "Une troisième espèce, rapportée de la côte de Malabar par MM. Bélanger et Dussumier, et de Pondichéry par M. Leschenault" (A third species, brought from the coast Of Malabar by MM. Bélanger and Dussumier, and of Pondicherry by M. Leschenault). Gunther (1864) recognized *Clarias brachysoma* from Ceylon. The single specimen recognized by Day as *Clarias dussumieri* in 1878 from Wayanad Hills, later formed as the type of *Clarias dayi* of Hora (1941). Though the type localities include Pondicherry, Krishnan and Mishra (2004) reported the occurrence of *Clarias dussumieri* is doubtful.

There is certain level of ambiguity on the identity of the *Clarias* species occurring in peninsular India. Hora (1941) included all the peninsular and Ceylonese species of *Clarias* under *dussumieri* group and recognized three distinct sub species viz, *C. dussumieri dussumieri* Valenciennes, *C. dussumieri dayi* (Hora) and *Clarias dussumieri brachysoma* Guenther. Among these, *Clarias dussumieri dayi* is known only from Wayanad hills. However, later workers elevated these sub-

species to the level of species.

The alarming decline of the *Clarias* has been brought to the conservation discourse for the first time was Babu *et al.* (2002). Babu *et al.* (2002) affirmed that their survey of 1215ha of Muriyad Kole wetland, one of the important wetland in Thrissur, could not yield even a single specimen of *Clarias*. Ensuing that, Biony (2010) reported that the population of *C. batrachus* and *C. dussumieri*, which were once common the shallow waters and in the paddy fields of Kerala respectively has dwindled drastically. Padmakumar *et al.* (2010) as well recorded the sharp decline of *C. dussumieri*. IUCN, during the assessment in 2004 included *C. dussumieri* in 'Vulnerable' category (Kurup *et al.*, 2004). However, in the subsequent assessment, IUCN (2010) included this species under the *Near Threatened* category. While assessing the status of the species, IUCN (2010) observed "*Clarias dussumieri* has undergone a sharp decline (more than 80%) in Kerala over the last 20 years generally caused by loss of habitat, pollution and overfishing. Although over its entire range the species is facing similar threats, it has not undergone such rapid declines over the last 10 years. It is therefore inferred that the overall rate of decline may be less than 30%, hence it is assessed as *Near Threatened*". Nambudiri (2010) quoting the studies of Cochin University of Science and Technology reported the vanishing *C. dussumieri* from Pamba river. Renjithkumar (2011) reported the *C. dussumieri* from Pamba river without commenting on the status of the species in the Pamba river.

The vulnerability of *Clarias dussumieri* to extinction had been noticed by Salin (2013) who conducted extensive surveys in Kerala during 2011 (he could collect only 208 individuals). Though Easa and Shaji (1997) had remarked *C. dussumieri* as abundant in the rivers of Kerala during 1993-1995 period, decline of the species have been noticed later in many parts of Kerala (Shaji *et al.*, 2000; Dahanukar *et al.*, 2004; Devi *et al.*, 2005; Raghavan *et al.*, 2008). Thomas *et al.* (2002) reported the extirpation of the native *Clarias* sp. from the Muriyad kole wetland. The statistical data of catch provided by Salin (2013) is enough to conclude the vulnerability of the species towards extinction which says that the he could collect only 6 specimens from Thrissur district

during the period from June 2010 to May 2011. Salin (2013) has even recommended to revise the IUCN red list category of *C. dussumieri* from 'Near-Threatened' to 'Critically Endangered'. Ramachandra *et al.* (2012) reported the extinction of *C. dussumieri* from the west-flowing rivers of Karnataka (Kali, Bedthi, Aghnashini, Sharavathi and Netravathi, etc). Plamoottil (2015) while enlisting the catfishes of Travancore, included the *C. dussumieri* in the list nevertheless mentioned nothing on the availability or abundance of the species in the region.

Multitudes of reasons have been indicated by the authors on the decline *Clarias dussumieri* from its natural habitat. Padmakumar *et al.* (2010) finds the deterioration of its natural habitats and breeding grounds, excessive use of chemical fertilizers and pesticides in the wetland systems Aneesh *et al.* (2013) reported that the EUS that which was prevalent in Kerala since 1991 which had rapidly spread to all parts of Kerala (Anon, 1992) affected particularly on *C. dussumieri*. Similar observations are also available from Thailand (Tonguthai, 1985). The African catfish *C. gariepinus* is being farmed in Kerala since 1993 (Krishnakumar *et al.*, 2011) is a potential threat to the species. This observation by Aneesh *et al.* (2013) is comparable to the Vidthayanon (2002), who commented that *C. gariepinus* are potential enough to replace the native population of *C. dussumieri*.

The indiscriminate use of pesticides and excessive use of chemical fertilizers became a common practice since 1975 in Annamanada-Kuzhur Grama Panchayat. A sizable portion of paddy lands, which served as the breeding grounds have been reclaimed within the recent past. The natural irrigation canals, which served as the migratory paths of the species have been reclaimed in many parts of the panchayat. The areas of Chirayam chaal and karikkattu chaal, where the species was abundant once have been compromised considerably. Paddy fields associated with these chaals became fallow lands. As a part of Peoples Planning Programme during 1996, the exotic cat fish, *Clarias gariepinus* have been stocked in Chirayam chaal. The migratory routes connecting the Annamanadapuzha, Chiryam chaal, Karikkattu chaal were reduced to 1 or 2 canals. These canals served as a single window system for the mon-

soon fishers. This helped the fishers to heavily exploit the berried fishes at their breeding ground. The introduction of monofilamentous gill net, rampant use of electroshocker for fishing wiped out even the most common species. The complete absence of *Etroplus maculatus* and poor representation of *Macrognaathus guentheri*, *Nandus nandus* in the last two ootha (MFF) is also worth to mention (Table 1).

The interview among the senior fisherfolk, revealed that the species was common erstwhile in the wetlands (especially in Chirayam chaal and Karikkattu chaal) of Annamanada and Kuzhur Gramapanchayats. It was fished by rod and line, Vettu (hook and line), fish basket, and summer fishing by dewatering. This species was a common in all season collections from these two panchayats.

This paper aims to initiate similar surveys in different parts of the state to generate the data on the status of the population of *Clarias dussumieri* which may help to develop suitable strategies to preserve the species. Further, there is also need to study the population genetics of this species using modern molecular tools so as to assess the genetic variation as a starting point towards planning much more effective conservation programmes for this threatened catfish.

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REFERENCES

- Abraham, R. 2011. *Clarias dussumieri*. The IUCN Red List of Threatened Species 2011: e.T172332A6870008. Downloaded on 24 December 2016.
- Aneesh, B, Salin, K.R. and Nair, C.M. (2013) Breeding for Conservation: Case of an Endangered Catfish, *Clarias dussumieri* (Valenciennes, 1840). *Fishery Technology* 50: 101-109.
- Anon (1992) Enigma of EUS. In: Summary of Proceedings, Consultation on epizootic ulcerative syndrome vis-à-vis the environment and the people. 40 p, 25-26 May 1992, Trivandrum, Kerala, India. International collective in support of fish workers, Madras, India.

- Anon, 2011. Panchayat Level Statistics 2011. Thrissur district. Department of Economics & Statistics, Thiruvananthapuram, Kerala
- Babu, S.K.K., Thomas, K.J. and Sreekumar, S. 2002. In Proceedings of the National Seminar on Current Environmental Problems and Management, Irinjalakuda. 1-3, August, 59-63pp.
- Babu, K.K.S. and Nayar, C.K.G. 2004. A new species of the blind fish *Horaglanis* Menon (Siluroidea: Clariidae) from Parappukara (Trichur District) and a new report of *Horaglanis krishnai* Menon from Ettumanur (Kottayam District) Kerala. *J. Bombay Nat. Hist. Soc.* 101(2): 296-298.
- Babu, K.K.S., 2012. *Horaglanis abdulkalami*, a new hypogean blind catfish (Siluriformes: Clariidae) from Kerala, India. *Samagra* 8(5):51-56.
- Binoy, V.V. 2010. Catfish *Clarias* is vanishing from the waters of Kerala. *Curr Sci.*, 99 (6): 714.
- Cuvier, M. LE B and Valenciennes, M.A. 1840. Histoire Naturelle des Poissons . Paris
- Dahanukar, N., Raut, R. and Bhat, A. 2004. Distribution, endemism and threat status of freshwater fishes in the Western Ghats of India. *J. Biogeogr.* 31: 123-136. DOI: 10.1046/j.0305-0270.2003.01016.
- Devi, K.R., Indra, T.J., Reghunathan, M.B. and Ravichandran, M.S. 2005. Fish fauna of the Anamalai Hill ranges, Western Ghats, India. *Zoos' Print Journal* 20(3), 1809-1811.
- Easa, P.S. and Shaji, C.P. 1997. Freshwater fish diversity in Kerala part of the Nilgiri Biosphere Reserve. *Curr. Sci.*, 73(2): 180-182.
- Günther, A., 1864. Catalogue of the fishes in the British Museum. Volume fifth. Catalogue of the Physostomi, containing the families Siluridae, Characiniidae, Haplochitonidae, Sternoptychidae, Scopelidae, Stomiidae, in the collection of the British Museum. Trustees of the British Museum, London. 455 p.
- Heywood, V.H. (1995) Global Biodiversity Assessment. Cambridge University Press, Cambridge
- Hora, S.L. 1936. Siluroid fishes of India and Burma and Ceylon. IV. Fishes of the genus *Clarias* Gronovius. *Rec. Ind. Mus.*, 38: 347-351.
- Hora, S.L. 1937. Geographical distribution of Indian freshwater fishes and its bearing on the probable land connections between India and the adjacent countries. *Curr. Sci.*, 5 (7): 351-356.
- Hora, S.L. 1941. Siluroid fishes of India and Burma and Ceylon. XII. A further note on the genus *Clarias* Gronovius *Rec. Ind. Mus.* 43: 112-115.
- IUCN, 2012. IUCN Red list categories and criteria. Version 3.1. Prepared by the IUCN Species Survival Commission As approved by the 51st meeting of the IUCN Council Gland, Switzerland.
- Krishnakumar, K., Ali, A., Pereira, B. and Raghavan, R. (2011) Unregulated aquaculture and invasive alien species: a case study of the African Catfish *Clarias gariepinus* in Vembanad Lake (Ramsar Wetland), Kerala, India. *J. Threat. Taxa.*, 3(5): 1737-1744.
- Krishnan S. And Mishra, S.S. 2004. An inventory of fish species discarded fish species described originally from fresh and coastal marine waters of Pondicherry. *Rec. zool. Surv. India*, 102 (Part 3-4): 65-87.
- Kurup, B.M., Radhakrishnan, K.V. and Manojkumar T.G. 2004. Biodiversity status of fishes inhabiting rivers of Kerala (S. India) with special reference to endemism, threats and conservation measures. Proc second int. symp.on the management of large rivers for fisheries (Volume II). Sustaining - Livelihoods and Biodiversity in the New Millennium 11th-14th February 2003 in Phnom Penh, Kingdom of Cambodia. Edited by Robin L. Welcomme and T.Peter.
- Menon, A.G.K. 1950. On a remarkable blind siluroid fish of the family Clariidae from Kerala (India). *Rec. Ind. Mus.* 48: 59-66.
- Menon, AGK. 1951. Further studies regarding Hora's Satpura Hypothesis. (1) The role of the Eastern Ghats in the distribution of the Malayan Fauna and Flora to Peninsular India. *Proc.Nat.Inst. Sci. India.* 17: 475-497.
- Nambudiri, S. 2010. Fish wealth in Pampa river declines: Study. Indian Express. Published on 25.10.2010.
- Ng, H.H. and Kottelat, M. 2008. The identity of *Clarias batrachus* (Linnaeus, 1758), with the designation of a neotype (Teleostei: Clariidae). *Zool. J. Linn. Soc.*, 153, 725-732
- Padmakumar, K.G., Bindu, L., Basheer, V.S. and Gopalakrishnan, A. 2010. Threatened fishes of the world: *Clarias dussumieri dussumieri* (Valenciennes, 1840) (Clariidae). *Environ. Biol. Fish.*, 87: 297-298. doi:10.1007/s10641-010-9598-9.
- Plamoottil, M. 2015. Taxonomic notes on the catfishes of central Travancore of Kerala, India. *Journal of Zoological and Bioscience Research*, 2(3):6-17.
- Raghavan, R., Prasad, G., Ali, A.P.H. and Pereira, B. (2008). Fish fauna of Chalakudy River, part of Western Ghats biodiversity hotspot, Kerala, India, patterns of distribution, threats and conservation needs. *Biodivers. Conserv.* 17: 3119-3131.
- Ramachandra, T.V., Chandran, MDS, Joshi, NV, Sreekantha, Kumar, R., Rajinikanth, R., Desai, S.R. and Babu, S. 2012. Ecological profile of Saravathi river basin. ENVIS Technical Report. 22.
- Renjithkumar C.R., Hari Krishnan, M and Kurup, B.M. 2011. Exploited fisheries resources of the Pampa

- River, Kerala, India. *Indian J. Fish.*, 58(3): 13-22.
- Salin, K.R. 2013 Breeding for Conservation: Case of an Endangered Catfish, *Clarias dussumieri* (Valenciennes, 1840). *Fishery Technology* 50: 101 – 109.
- Shaji C.P. 2012. Oothayilakkon- padana report. Kerala State Biodiversity Board, Thiruvananthapuram.
- Shaji, C.P. and Laladhas, K.P. 2013. Monsoon Floodplain Fishery and traditional fishing methods in Thrissur district, Kerala. *Ind. J. Trad. Knowledge*. 12(1): 102-18.
- Shaji, C.P., Easa, P.S. and Gopalakrishnan, A. (2000) Freshwater fish diversity of Western Ghats. In: Endemic Fish Diversity of Western Ghats. (Ponniiah, A.G. and Gopalakrishnan A., Eds), pp 33-35, NBFGRNATP Publication. National Bureau of Fish Genetic Resources, Lucknow, U.P., India.
- Thomas, K.J., Sreekumar, S. and Babu, S.K.K. 2002. Impacts of Developmental Interventions on the Ecology and Fish Diversity of Muriyad Wetland (Trissur, Kerala) In: Proceedings of the National Seminar on Current Environmental Problems and Management. pp. 59-63, 1-3 August 2002. Irinjalakuda, Trissur, Kerala, India, http://wgbis.ces.iisc.ernet.in/energy/lake2002/proceedings/3_2.html.
- Tonguthai, K. 1985. A preliminary account of ulcerative fish diseases in the Indo-Pacific region. 39 p. Department of Fisheries, Ministry of Agriculture and Cooperatives, Bangkok
- Tonguthai, K. 1985. A preliminary account of ulcerative fish diseases in the Indo-Pacific region. 39 p. Department of Fisheries, Ministry of Agriculture and Cooperatives, Bangkok.
- Vidhayanon, C. 2002. Peat Swamp Fishes of Thailand, Office of Environmental Policy and Planning, 136 p, Bangkok, Thailand.
- WWF. 2016. Living Planet Report 2016. Risk and resilience in a new era. WWF International, Gland, Switzerland.

