Eco. Env. & Cons. 29 (2) : 2023; pp. (867-876)
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ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i02.055

Endemic Larvivorous Fish Fauna in Vicinities of Selected Water Bodies of Doon Valley (Uttarakhand)

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(Received 12 October, 2022; Accepted 7 January, 2023)

ABSTRACT

Fish that are predators of immature stages of mosquitoes are referred to as larvivorous fish. Both exotic and indigenous fishes are used as biocontrol agent of pre adult mosquitoes. This study was conducted with a purpose to estimate diversity, habit-habitats and abundance of endemic larvivorous fish. Present study was conducted during 2018-20, in the vicinity of three selected rivers *i.e.*, Asan, Song and Suswa of Doon valley. Collected fish were sorted and identified following standard keys and catalogues. Habit-habitat, species abundance, diversity indices and similarity index were estimated using standard formulae. A total of 35 species of larvivorous fish under 5 orders, 8 families and 17 genera have revealed and listed based on habit and habitat found. Different study areas showed variation in abundance of fish diversity. Suswa's sites contribute highest number of species (32) followed by Asan (28) and Song (27). Water bodies like pond, river, stream, tank, water canal, swamp and rice field are the main habitats in the study sites. Highest number of fish species is shared by river (35) followed by stream (26), pond (25), water canal (23), rice field (19), tank (18) and swamp (16) in succeeding order. *Channa punctata* is recovered from all the considered habitats. Some fish are found to restrict in particular habitats in all sites. While estimating relative abundance (RA), *Pethia ticto* species shows highest in Asan's sites and Song's sites but in Suswa's sites *Channa punctata* showed highest abundance. None of the fish species shows dominant and eudominant status in abundance. Species richness, diversity, evenness, effective number of species are also estimated. Similarity index of species diversity among the selected riverine sites are also calculated. Prior the adoption of fish as biocontrol agents of mosquito, extensive knowledge on larvivorous fish, its features, diversity, distribution, habit and habitat are required.

Key words: *Habit-habitats, Species abundance, Biocontrol agents, Larvivorous fish.*

Introduction

Mosquito borne diseases are well known public health problems for tropical and subtropical regions. For abatement of mosquito population to suppress the recurrence of mosquito borne diseases, various control strategies - chemical, physical and biological methods are being adopted. Among biocontrol agents fish has shown to be promising under the bioenvironmental control strategies adopted for disease control (Menon, 1991). Over 255 species of fish having larvivorosity potential including excellent one in the control of mosquito immature have been reported throughout the globe (Sharma, 1994). It was added by Hass (1984) that indigenous fish have more advantages than exotic one as they are well adapted and suited under the native conditions. Larvivorous fish is extensively used all over the world since the early 1900s (Raghavendra and Subbarao, 2002; Floore, 2006; Walton, 2007; Walker and Lynch, 2007). In India, use of larvivorous fish in malaria control is not a new strategy and it is also a

major component of integrated vector borne disease control programmes (Gerberich and Laird, 1968; Ghosh and Dash, 2007; Chandra *et al.,* 2008 and Sharma, 1984). Most fish consumed immature of mosquito during their early part of life, but some fish are equipped with specialized features to render larvivorosity lifelong and considered as potent larvivorous fish. Job (1940) envisages feeding habits, habitats, specialized morphology and behaviours of potential larvivorous fish.

As far as faunal diversity of fish in studied area is concerned, extensive explorations have been made by several workers. Some considerable works are Husain (1995, 2003, 2015, 2018); Uniyal and Kumar (2006); Kumar (2017) and Rana *et al.,* (2017a, b). While considering species diversity and habit - habitat study of larvivorous fish, the investigations made by Sharma and Rajagopal (1987); Sharma *et al.* (1987); Yadav *et al.* (1992); Haq and Yadav (1997); Sumodan and Kumar (1998); Pemola and Jauhari (2009); Das and Dutta (2013); Rama Rao (2014); Krishna *et al.* (2016); Rao *et al.* (2017); Das *et al.,* (2018, 2021) and Ubarhande (2019) could be mentioned here. Also, investigation made by Jauhari *et al.* (1996) on distribution of indigenous larvivorous fish with special reference to their larvivorous potential from Sahaspur area Doon Valley could be one remarkable work. No work has been done on the habit-habitat and abundance of larvivorous fish in sub-montane region of Garhwal so, there is a need on such study so that bio-control measures could be designed in present scenario. Henceforth, present study has been planned to conduct thorough investigation on species abundance, diversity indices, habit and habitats of endemic larvivorous fish in some selected riverine sites of Doon Valley.

Materials and Methods

Present study was carried out in the vicinity of selected rivers - Asan, Song and Suswa of Doon Valley those located on the foothill of Himalayas nestled between river Ganges on the east and Yamuna on the west. Fish sampling sites, five from each riverine are as were fixed randomly and surveyed twice on each year. Fish catching was performed with the help of local fisherman using common nets and gears from any possible water lodging habitat like pond, river, stream, water canal, tank, swamp and rice field during the period of 2018-20. Fish were also collected from local fish markets and landing centers located near the rivers. Collected fish samples were sorted and identified following the Keys and catalogue of Jayaram (1999); Talwar and Jhingran (1991) and Nath and Dey (2000). Species abundance, dominance status, diversity indices and similarity index of collected larvivorous fish were estimated using the following standard formulas.

A) Abundance

Relative abundance is the percent composition of an organism of a particular kind relative to the total number of organisms in the area. Dominance status of various species was described on the basis of relative abundance following Engelmann (1973).

$$RA\ (\%) = Isi\ /\ \Sigma Nsi \times 100$$

where, Isi = Total number of individual species and ΣNsi = Total number of species population

B) Diversity indices

Species diversity of fishes was estimated using Shannon-weiner index 'H' (Shannon and Weiner, 1949) and Simpson's index 'D' (Simpson, 1949)

Shannon-weiner index 'H'

$$H= -\Sigma_{i=1}^{S}(p_i \ln p_i)$$

where, Σ = Sum or values from species 1 to species S

ln= Natural log

p_i = Proportion of individuals found in the i^{th} species.

S = the number of species in the community

Shannon Evenness 'E' (Pielou, 1966)

$$E= H/Hmax$$

where, H= the Shannon diversity index

Hmax= ln(S)= Maximum diversity possible

Effective number of species (Shannon index) 'ENS'

$ENS= e^H$ (exponential of Shannon entropy index)

Simpson's index 'D'

$$D = \Sigma n(n-1)/N(N-1)$$

where, n= the total number of individuals of each species

N= the total number of organisms of all species.

The value D ranges between 0 and 1. Bigger the value of D the lower the diversity.

Gini-Simpson index/Simpson's index of diversity = (1-D)

where, D= Simpson's index

Simpson Effective number of species 'ENS'= 1/D
where, D = Simpson's index
Simpson's Evenness= 1/D/S or Simpson's ENS/S
where, D = Simpson's index; S = observed no. of species

C) Similarity index (Jaccard) 'Cj'

Similarity of species of fish community was calculated by Jaccard's measures (Southwood, 1978)
Cj= j/(a+b-j)
where, Cj = Similarity between any two zones a and b; J = No. of species common to both zones a and b; a = No. of species at zone a; b = No. of species at zone b; if Cj = 1= complete similarity; 0 = Complete dissimilarity

Results and Discussion

A total of 35 species of larvivorous fish from 5 orders, 8 families and 17 genera were revealed and listed with common / local name, feeding habit and habitat on Table 1. Order Cypriniformes shared highest number of genera (9) and species (19), while only one genus and species was shared by Beloniformes. Order Siluriformes Suffix to contribute highest number of families (03), one each by Cypriniformes, Beloniformes and Synbranchiformes. Percentage composition of families, genera and species under 5 reported orders were depicted in Fig. 1. According to IUCN (2017) status, all the available fish are least concerned (LC) except *Channa harcourtbutleri* that is near threatened (NT). Water bodies like pond, river, stream, tank, water canal, swamp and rice field were habitats from where fish were collected from the chosen study sites. Fish species contributed by different habitats in percentile is presented in Fig. 2. *Channa*

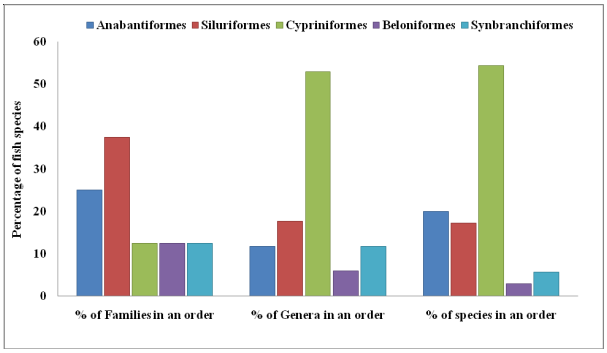


Fig. 1. Percentage composition of families, genera and species under various orders.

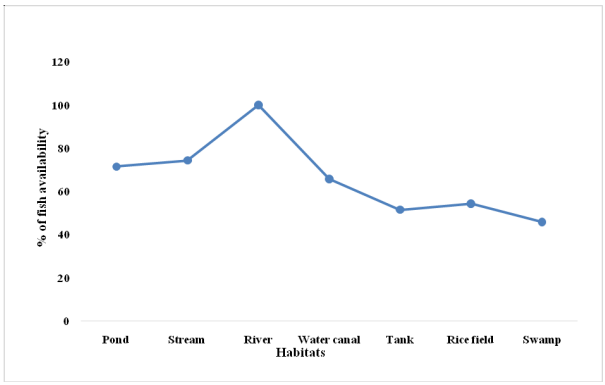


Fig. 2. Showing percentage wise availability of larvivorous fish in varying habitats.

punctata species was recovered from all the habitats and *Labeo dyocheilus* species was found to restrict in river and stream habitats. Based on trophic niches and food habit, fish species occurrence in percentile is represented in Fig. 3. Maximum fish species (31.43%) were surface feeder followed by bottom column feeder (25.71%), column feeder (22.86%), bottom feeder (14.29%), surface column feeder and sub surface column feeder (2.86%) in succeeding order. Based on types of food consumed, 48.57% species of fish were omnivorous, 40% species are carnivorous and 11.43% species are herbivorous.

Fig. 4 shows percentage composition of fish indi-

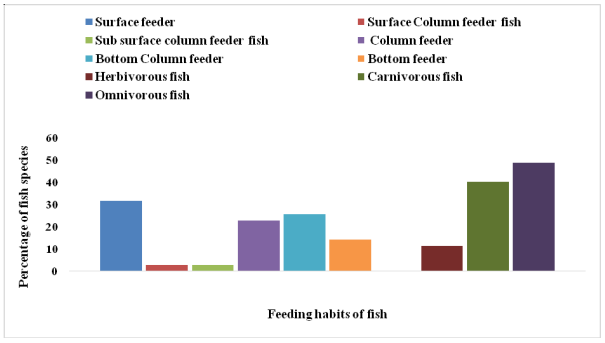


Fig. 3. Percent occurrence of fish species in accordance to their trophic niche and food habits.

viduals in each five sites (05) of the selected riverine areas – Asan, Song and Suswa. Species abundance, relative abundance and dominant status of fish diversity were estimated and listed on Table 2. Suswa's sites contribute highest number of fish species (32) followed by Asan (28) and Song (27). Fish like *Trichogaster/Colisa lalius*, *Channa marulius*, *Chana harcourtbutleri* and *Puntius terio* were only recovered from Suswa's sites. Fish like *Opsarius tileo/Barilius*

Table 1. Showing habit-habitat of some larvivorous fishes in vicinities of selected riverine areas in Doon Valley during the study period (2018-2020).

S. No.	Order/Family	Name of Species	Common / Local name	Feeding Habit (food type/ trophic niche)	Habitat	IUCN (2017) Status
1	Anabantiformes/ Osphronemidae	*Trichogaster fasciata* Bloch & Schneider, 1801	Banded gourami/ Sunera	OF/SFF	P, R, T, WC, RF	LC
2		*Trichogaster lalius* (F. Hamilton, 1822)	Dwarf Gourami	OF/SFF	P, R, S, T, WC, RF	LC
3	Anabantiformes/ Channidae	*Channa punctata* (Bloch, 1793)	Spotted snakehead/Sewal	CF/BCFF	P, R, S, T, WC, SW, RF	LC
4		*Channa gachua* (Hamilton, 1822)	Dwarf snakehead/ Sowan	CF/BCFF	P, R, S, T, SW	LC
5		*Channa striata* (Bloch, 1793)	Striped snakehead/ Shol chena	CF/BCFF	P, R, S, T, SW, RF	LC
6		*Channa marulius* (Hamilton, 1822)	Great snakehead/ Saur	CF/BCFF	P, R, WC, SW	LC
7		*Channa harcourtbutleri* (Annandale, 1918)	Burmese snakehead	CF/BCFF	P, R, WC, SW, RF	NT
8	Siluriformes/ Bagridae	*Mystus vittatus* (Bloch, 1794)	Striped dwarf catfish/Tengra	CF/BCFF	R, S, SW, RF	LC
9		*Mystus tengara* (Hamilton, 1822)	Golden catfish/ Kater	CF/CFF	R, S, SW	LC
10		*Mystus seengtee* (Sykes, 1839)	Giant River Catfish/Tengra, Singara	CF/CFF	R, S, SW	LC
11		*Mystus bleekeri* (Day, 1877)	Day's Mystus/ Kater	CF/CFF	R, S, T, WC, SW	LC
12	Siluriformes/ Heteropneustidae	*Heteropneustes fossilis* (Bloch, 1794)	Stinging catfish/ Singhi, Billi Macchi	CF/BFF	P, R, T, SW, RF	LC
13	Siluriformes/ Clariidae	*Clarias batrachus* (Linnaeus, 1758)	Walking catfish/ Manguri	CF/BFF	R, T, WC, SW, RF	LC
14	Cypriniformes/ Cyprinidae	*Esomus danrica* (Hamilton, 1822)	Indian flying barb/Chal	OF/SCFF	P, R, T, WC	LC
15		*Amblypharyngodon mola* Hamilton, 1822	Mola carplet	HF/CFF	P, R, S, T, WC	LC
16		*Rasbora daniconius* (Hamilton, 1822)	Slender rasbora/ Bhuri	OF/SSCFF	P, R, S, T, WC, SW	LC
17		*Devario devario* (Hamilton, 1822)	Bengal danio/ Dhono, Chand	OF/SFF	P, R, WC, RF	LC
18		*Danio rerio* (Hamilton, 1822)	Zebra fish/ Dharidar Salari	OF/SFF	P, R, S, WC, RF	LC
19		*Barilius bendelisis* (Hamilton, 1807)	Indian hill Trout/Chedra, Chilwa	OF/SFF	P, R, S, WC	LC
20		*Barilius vagra* (F. Hamilton, 1822)	Vagra baril/ Chalra	OF/ SFF	P, R, S, SW, RF	LC
21		*Barilius barna* (F. Hamilton, 1822)	Barna baril/ Childi	OF/SFF	P, R, S	LC
22		*Barilius tileo* (F. Hamilton, 1822)	Tileo barb	OF/SFF	R, S, WC, RF	LC

Table 1. *Continued ...*

S. No.	Order/Family	Name of Species	Common / Local name	Feeding Habit (food type/ trophic niche)	Habitat	IUCN (2017) Status
23		*Barilius shacra* (F. Hamilton, 1822)	Bola	OF/SFF	R, S, WC	LC
24		*Barilius barila* (Hamilton, 1822)	Barred baril/ Caedra, Gilland	OF/SFF	P, R, S, WC	LC
25		*Puntius sophore* (Hamilton, 1822)	Pool barb, Stigma barb/ Pothi, Phuti	OF/BCFF	P, R, T, WC, RF	LC
26		*Pethia ticto* (Hamilton, 1822)	Ticto barb, two spot barb/ Bhuri, Phuti	HF/BCFF	P, R, S, T, WC, RF	LC
27		*Puntius conchonius* (F. Hamilton, 1822)	Rosy barb/ Kharauli-pothi, Chidhu	OF/CFF	P, R, S, T, WC, RF	LC
28		*Puntius sarana* (F. Hamilton, 1822)	Olive barb/ Khami, Khangan, Phutia, Pothia	OF/CFF	P, R, S, T	LC
29		*Puntius chola* (Hamilton, 1822)	Swamp barb/ Phuti, Ticker, Chidhu	OF/CFF	P, R, S, T, WC, RF	LC
30		*Puntius terio* (Hamilton, 1822)	One spot barb/Putiyah	OF/CFF	P, R, S, T, WC, RF	LC
31		*Labeo dyocheilus* (McClelland, 1839)	Brahmaputra Labeo/Bolla, Kali, Doongri	HF/BFF	R, S	LC
32		*Labeo dero* (Hamilton, 1822)	Silgharia, Gorea/Dero, Kalabans, Moil	HF/BFF	R, S, WC	LC
33	Beloniformes/ Belonidae	*Xenentodon cancila* (F. Hamilton, 1822)	Needle fish, Gar fish/Sua, Cowa, Takla	CF/SFF	R, S, SW, RF	LC
34	Synbranchiformes/ Mastacembelidae	*Macrognathus pancalus* (F. Hamilton, 1822)	Barred spiny eel/ Bam	CF/BCFF	P, R, S, T, SW	LC
35		*Mastacembelus armatus* (Lacepede, 1800)	Zig- Zag eel/ Bam, Gaj	CF/BFF	P, R, WC, SW, RF	LC

HF: Herbivorous Fish, CF: Carnivorous Fish, OF: Omnivorous Fish
SFF: Surface Feeder Fish, CFF: Column Feeder Fish, SSCFF: Sub Surface Column Feeder Fish, BFF: Bottom Feeder Fish, BCFF: Bottom Column Feeder Fish
P: Pond, R: River, S: Stream, WC: Water Canal, T: Tank, SW: Swamp, RF: Rice Field
LC: Least Concern, NT: Near Threatened

tileo and *Barilius shacra* was collected only from Song and Asan's sites respectively. While estimating relative abundance (RA) of species, *Pethia ticto* showed highest dominant (RA-8.78%) and *Barilius shacra* (RA-0.88%) was lowest dominant species in Asan's sites. In Song's sites also, highest dominant species was *Pethia ticto* (RA-7.52%) but lowest was *Mystus bleekeri* (RA-0.89%). In Suswa's sites, *Channa gachua* showed highest dominant (RA-7%) and lowest dominant by *Channa harcourtbutleri* (RA-0.52). In all selected sites, none of the fish species was dominant and eudominant status of abundance. In Asan's sites, 57.14% of fish species showed subdominant (SD), 39.29% species were recedent (R) and 3.57% species showed subrecedent (SR) status of species abundance. In Song's, 55.56% fish species were sub-

dominant (SD), 37.04% species were recedent (R) and 7.41% species were subrecedent (SR) status. In Suswa's 56.25% fish species were subdominant, 34.38% were recedent and 9.38% were subrecedent.

Larvivorous fish species diversity indices were analysed and listed in Table 3. More or less similar species abundance and richness swere found in studied areas –Suswa (2444, 32) followed by Asan (2279, 28) and Song (2022, 27). Comparative fish species diversity profile by Shannon Weiner index and Simpson's index of selected study sites were plotted in Fig. 5. Similarity index of fish diversity were estimated by Jaccard's similarity index and revealed highest index between Asan and Song (0.774) followed by Asan and Suswa (0.764) and Song and Suswa (0.735) (Table 4).

A good diversity of fish fauna have been reported by the earlier workers from the same region. But the present observation accounted less diversity as mainly focus on fish having good larvivorosity po-

Table 2. Abundance and dominant status of fish species in selected riverine areas in Doon valley during the study period (2018-2020).

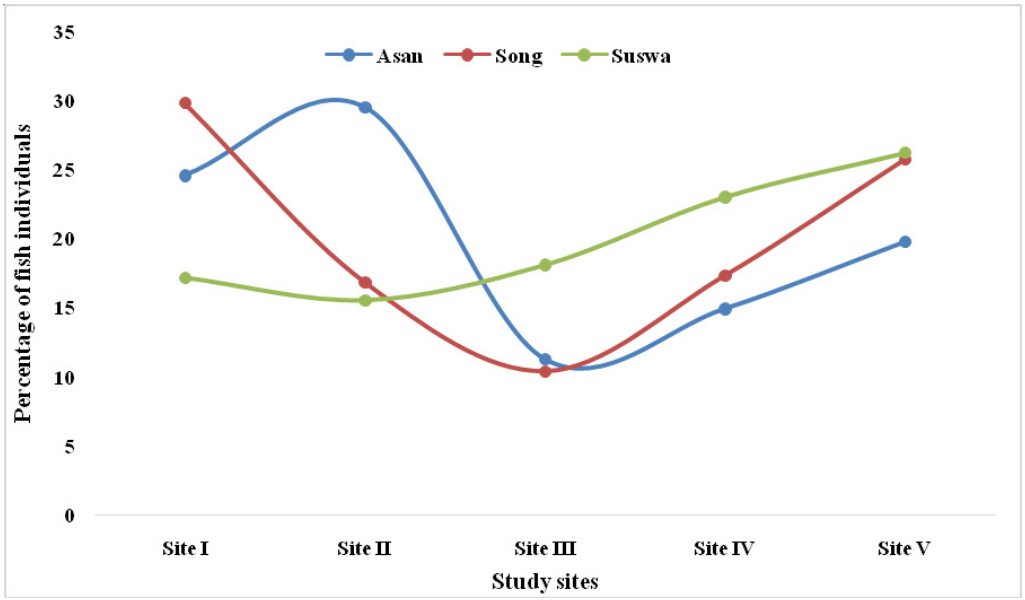
S. No.	Fish species	ASAN			SONG			SUSWA		
		N	RA %	DS	N	RA %	DS	N	RA %	DS
1	*Trichogaster fasciata*	33	1.45	R	-	-	-	117	5.02	SD
2	*Trichogaster lalius*	-	-	-	-	-	-	110	4.72	SD
3	*Channa punctata*	121	5.31	SD	41	2.03	R	132	5.67	SD
4	*Channa gachua*	69	3.03	R	76	3.76	SD	163	7	SD
5	*Channa striata*	71	3.12	SD	-	-	-	103	4.42	SD
6	*Channa marulius*	-	-	-	-	-	-	87	3.73	SD
7	*Channa harcourtbutleri*	-	-	-	-	-	-	12	0.52	SR
8	*Mystus vittatus*	90	3.95	SD	-	-	-	79	3.39	SD
9	*Mystus tengara*	-	-	-	32	1.58	R	82	3.52	SD
10	*Mystus seengtee*	81	3.55	SD	82	4.06	SD	55	2.25	R
11	*Mystus bleekeri*	29	1.27	R	18	0.89	SR	48	2.06	R
12	*Heteropneustes fossilis*	-	-	-	39	1.93	R	19	0.82	SR
13	*Clarias batrachus*	50	2.19	R	29	1.43	R	36	1.55	R
14	*Esomus danrica*	77	3.38	SD	128	6.33	SD	68	2.92	R
15	*Amblypharyngodon mola*	38	1.67	R	38	1.88	R	59	2.41	R
16	*Rasbora daniconius*	76	3.33	SD	112	5.54	SD	75	3.22	SD
17	*Devario devario*	69	3.03	R	43	2.13	R	130	5.58	SD
18	*Danio rerio*	38	1.67	R	48	2.37	R	88	3.78	SD
19	*Barilius bendelisis*	112	4.91	SD	132	6.53	SD	79	3.39	SD
20	*Barilius vagra*	90	3.95	SD	127	6.28	SD	80	3.43	SD
21	*Barilius barna*	101	4.43	SD	46	2.27	R	98	4.21	SD
22	*Barilius tileo*	-	-	-	39	1.93	SR	-	-	-
23	*Barilius shacra*	20	0.88	SR	-	-	-	-	-	-
24	*Barilius barila*	80	3.51	SD	88	4.35	SD	-	-	-
25	*Puntius sophore*	136	5.97	SD	134	6.63	SD	113	4.85	SD
26	*Pethia ticto*	200	8.78	SD	152	7.52	SD	125	5.36	SD
27	*Puntius conchonius*	176	7.72	SD	116	5.74	SD	79	3.39	SD
28	*Puntius sarana*	149	6.54	SD	106	5.24	SD	84	3.61	SD
29	*Puntius chola*	76	3.33	SD	85	4.20	SD	53	2.27	R
30	*Puntius terio*	-	-	-	-	-	-	23	0.99	SR
31	*Labeo dyocheilus*	80	3.51	SD	36	1.78	R	48	2.06	R
32	*Labeo dero*	59	2.59	R	51	2.52	R	42	1.80	R
33	*Xenentodon cancila*	59	2.59	R	85	4.20	SD	52	2.23	R
34	*Macrognathus pancalus*	55	2.41	R	72	3.56	SD	52	2.23	R
35	*Mastacembelus armatus*	44	1.93	R	67	3.31	SD	53	2.27	R

N: Number, RA: Relative Abundance, DS: Dominant Status

RA<1%= Subrecedent, 1.1-3.1%= Recedent, 3.2-10% = Subdominant (SD), 10.1-31.16% = Dominant, >31.7% = Eudominant (Engelmann, 1973)

tential. In all, Order Cypriniformes and Family Cyprinidae are found to be the most dominant group contributing 19 species of 9 genus. The dominance of Cypriniformes and Cyprinidae is supported by earlier works on fish diversity from same area Husain (1995, 2003, 2015, 2018); Uniyal and Kumar (2006); Rana *et al.* (2017 a, b) and Kumar (2017). The investigations like Sharma and Rajagopal (1987); Sharma *et al.* (1987); Ilango (1990); Yadav *et al.* (1992); Haq and Yadav (1997); Rao *et al.* (2017) and Das *et al.* (2018) from far regions also mentioned same reports of dominancy of Cypriniforms and Cyprinidae.

Almost all the reported fish species are already mentioned by the earlier worker from same region irrespective of sites. Fish like *Mystus seengtee, Amblypharyngodon mola, Barilius shacra, Barilius barila, Clarias batrachus* and *Channa striata* of present study were not reported from Asan's sites Hussain (2003, 2015). But fish like *Barilius bendelisis, Barilius vagra, Barilius barna, Danio rerio, Devario devario, Esomus danricus* and *Rasbora daniconius* are already reported by Husain, (2018). Among 32 species of larvivorous fish from Suswa's sites, 28 species are common with findings of Rana *et al.* (2017 a, b). Fish species recovered from Asan and Song's sites are almost common with the earlier reported species of Rana *et al.* (2017 b). Similar study on fish species and



Asan River's sites: I-Kunja grant, II-Dhalipur,III-Selakui, IV-Badowala, V-Chandrabani
Song River's sites: I-Maldevta, II-Raipur, III-Gularghati, IV-Lachhiwala, V-Nepali farm
Suswa River's sites: I-Asarori forest, II-Mothrowala, III-Doiwala, IV-Kansrao, V-Gauri ghat (Tehri farm)

Fig. 4. Percentage composition of larvivorous fish in different sampling sites of selected riverine areas in Doon Valley during the study period (2018-2020).

Table 3. Fish diversity indices of selected riverine areas in Doon Valley during the study period (2018-2020).

Parameters	Asan	Song	Suswa
No. of individual (N) (Species abundance)	2279	2022	2444
No. of species (Richness)	28	27	32
Species diversity Shannon Weiner index (H)	3.20	3.16	3.35
Shannon Evenness (E)	0.96	0.96	0.97
Shannon Effective number of species (ENS)	24.63	23.66	28.64
Simpson's index (D)	0.05	0.05	0.04
Simpson's index of diversity (1-D)	0.95	0.95	0.96
Simpson's evenness	0.79	0.80	0.83
Simpson's reciprocal index (1/D) (ENS)	22.18	21.61	26.71

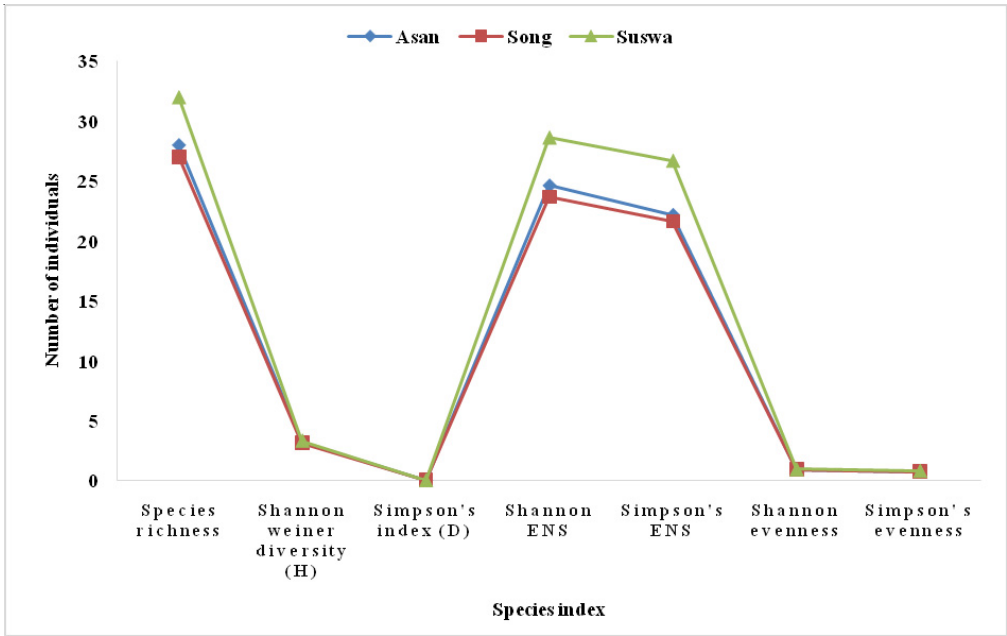


Fig. 5. Fish species diversity profile of selected riverine areas in Doon Valley during the study period (2018-2020).

Table 4. Similarity index (Jaccard's) of larvivorus fish diversity among the selected riverine areas during the study period (2018-2020).

	ASAN	SONG	SUSWA
ASAN	1		
SONG	0.774		
SUSWA	0.764	0.735	1

relative abundance from Asan River was conducted by Bhatt *et al.* (2016) and found 6 common fish with higher relative abundance than the present study. While discussing the habitat preference, *Channa punctata* was found positive in all chosen habitats but Das and Dutta (2013) observed another species of same genus, *Channa gachua* in varying habitats (pond, marshy wetland, deep irrigation canals, shallow irrigation canals, rivulets and crop fields).

Though fish diversity is somewhat different, maximum abundance of larvivorous fish species in river habitat is supported by Sharma and Rajagopal, (1987); Yadav *et al.* (1992); Haq and Yadav (1997) and Das *et al.* (2018). Ecological niches of feeding habitat of larvivorous fish were conducted by Rao *et al.*, (2014) and Das *et al.* (2018) and reported maximum number of fish species are bottom feeder, so, it is contradictory to our observation, *i.e*, maximum number of fish species are surface feeder. Also, the findings of Krishna *et al.* (2016) and Rao *et al.* (2017) as maximum bottom column feeder are not agree with present findings. But present observation-maximum fish are of surface feeder is similar with Das *et al.* (2021's) reports from Andaman and Nicobar Islands. Maximum number of omnivorosity of larvivorous fish is also similar with the reports of Krishna *et al.* (2016); Rao *et al.* (2017); Das *et al.* (2018, 2021).

Conclusion

A good diversity of fish fauna is supported by water bodies and surrounding environmental conditions of Doon Valley, consequently, larvivorous potential fish are also abundant with good number. While considering mosquito diversity and its borne disease in studied areas, it is quite concerning one. Main vectors of malaria, dengue, JE and Filariasis disease are abundant along with a good diversity of non vectors and available data supported annual recurrence of the said diseases. So, it is required to adopt appropriate strategies to abate mosquito population in present ongoing scenario. As biocontrol measures using larvivorous fish is safest and eco-friendly, available endemic fish might be engaged and conserved the fish diversity and its habitats in spite of anthropogenic threats like human interference, habitat loss, over exploitation, others, etc.

Acknowledgements

The authors would like to thank Principal D.B.S. (P.G.) College, Dehradun for providing laboratory facilities.

Author's contributions

Authors planned the research work, searched the literatures, performed the field work and built the database. All authors has reviewed the submitted draft.

Research content: The research content of manuscript is original and has not been published elsewhere.

Ethical approval: Not applicable.

Conflict of Interest

The authors declare no potential conflict of interest.

Data from other sources: Not applicable.

Consent to publish: All authors agree to publish the paper in *Ecology Environment and Conservation.*

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