E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 76.37
(GIF) Impact Factor: 0.549
IJFAS 2023; 11(6): 26-30

www.fisheriesjournal.com
Received: 02-09-2023
Accepted: 04-10-2023

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Aquatic fauna biodiversity in Dzuna River, Jotsoma, Nagaland, India

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DOI: https://doi.org/10.22271/fish.2023.v11.i6a.2809

Abstract
The present investigation was conducted in Dzuna river of Jotsoma village under Kohima district of Nagaland, India to study the aquatic fauna biodiversity in between 2020 to 2021. During the survey a total of 926 individuals representing 37 species belonging to 6 classes, 13 orders, 22 families were recorded. Maximum of 36 species of aquatic fauna were recorded in Lieho (upstream) and minimum of 33 species were recorded in Chiiriizhu (downstream). At family level, Heptageniidae dominated the composition by 7%, Cyprinidae by 3%, Aeshnidae, Libellulidae, Perlidae, Ranidae by 2% and others by 1% each in composition. Species belong to order Diptera showed the highest relative abundance by 0.777 while lowest relative abundance was showed by order Decapoda with 0.001. Maximum diversity (Hs=3.25) and minimum diversity (Hs=3.22) was recorded in Lieho and Chiiriizhu accordingly. Maximum dominance Ds=0.95 and the least Ds=0.98 was recorded in Dziimetou and Chiiriizhu respectively.

Keywords: Aquatic fauna, Biodiversity, Dzuna river, Freshwater, Species.

Introduction
The fauna of not only terrestrial habitats but also freshwater mega diversity exhibits a high degree of biodiversity richness (Mittermeier *et al*., 1997) [6]. India has gigantic freshwater resources encompassing both lentic and lotic habitats (Ayyappan 2007) [1]. Rivers are among the oldest waterbodies in the world. Many species entered stagnant waters after having developed in running waters. Therefore, of all freshwater entities on earth, river systems have the most complex and intricate biodiversity. Because of human civilization, nature has been altered to fulfil our requirements, and rivers are among the most successfully tamed habitats. It seems improbable that there are any substantial numbers of freshwater bodies left that have not undergone irreversible changes as a result of human activity from their initial state (O.E Sala *et al.*, 2000) [7]. This in turn has an impact on the abundance, diversity, and distribution of freshwater aquatic life.
Rivers are often home to wide varieties of species from insect to amphibians, reptiles, fish, crustaceans and even mammals which can either be vertebrates or invertebrates living in the water for most/all of their life time. Among various aquatic organisms, the benthic fauna of rivers has been regarded as the best biological instrument for assessing the water quality of an aquatic ecosystem. They are recognized as the most illuminating biological markers of water contamination as they are sensitive to pollution and can live only in streams with high dissolved oxygen levels. In aquatic habitats, these organism are essential for the circulation and recirculation of nutrients. Most benthic organisms are prey for a wide range of fishes (Arimoro *et al.*, 2007) [4]. Aquatic fauna, especially freshwater fauna is often of special concern to conservationists because of the vulnerability of the environment. Since streams and rivers are among the most vulnerable ecosystem worldwide, it is urgent that their rate of changes be monitored and their proper evaluation be conducted using all available methodological tools. Contrary to terrestrial life forms, the variety of freshwater organisms is probably underestimated.

The diversity and distribution of taxonomic group that have been extensively investigated, such as fish and amphibians, offer insight into the relevance and global patterns of freshwater biodiversity (Abell *et al.*, 2008) [2]. Therefore, this study seeks to characterize aquatic fauna biodiversity of Dzuna River with the aim of understanding in term of taxonomy and ecology.

Materials and Methods

Description of study site

The river Dzuna originates from the range of Mt. Japfü hill and flows through Jotsoma for about 18 km before joining Dzudza River, which eventually finds its way into Doyang River, Nagaland's largest river. The Dzuna River is comparatively narrow and shallow comprising of boulders, pebbles, sand, silt, stones, rocky stream accumulated with plants and rock debris. The entire river's length is encircled by a wide variety of towering trees, bushes, climbers, and ferns. The river is crystal clear in Lieho (upstream), while Chiiriizhu (downstream) appears to be brownish due to various anthropogenic activities.

Three experimental sites were selected in river Dzuna: Lieho, upstream (25°42'1.48"N and 94° 4'24.23"E), Dziimetou, mid-stream (25°43'38.78"N and 94° 3'6.98"E) and Chiiriizhu, downstream (25°49'11.24"N and 93°58'48.08"E).

Collection of Data

Fishes, aquatic insects and other fauna were collected with standard gill net, cast net and aquatic insects net. The river diversion method was also applied to ease the collection with handpicking.

Preservation of the specimen

The collected samples were preserved in 10% formaldehyde and stored in labelled bottles at the laboratory, Department of Zoology, Kohima Science College, Jotsoma. All specimens collected were sorted, enumerated, and identified to lowest taxonomic level with the help of available keys.

Identification

Specimens were identified following: (Sivaramakrishnan KG 2007, bugguide.net) [9] for aquatic insects; (Jayaram 1999, Talwar and Jhingran 1991) [5, 11] for fishes and other relevant literatures for amphibians and crustaceans.

Statistical Analysis

Aquatic fauna diversity was estimated after the Simpson index (1-D) and Shannon diversity index (H').

Results and Discussion

In the presence study, a total of 926 individuals representing 37 species belonging to 6 classes, 13 orders, 22 families were recorded. Maximum of 382 individuals with 36 species were recorded in Lieho (Upstream) while minimum of 252 individuals with 33 species were recorded in Chiiriizhu (downstream) (Table 3). At family level, Heptageniidae dominated the composition by 7%, Cyprinidae by 3%, Aeshnidae, Libellulidae, Perlidae, Ranidae by 2% each while Ampullariidae, Balitoridae, Blattidae Cancridae, Coleochaetaceae, Corydalidae, Coenagrionidae, Cordulegastridae, Ephemeridae, Gecarcinucidae, Palaemonidae, Pachychilidae, Phryganeidae, Potamidae, Sisoridae, Tipulidae by 1% each in composition. Among the fishes, highest diversity was observed in the family Cyprinidae with 3% where *Garra mcclellandi* retains the highest number followed by *Schizothorax richardsonii*. Presence of less tolerant orders such as Ephemeroptera, Pleoptera, Trichoptera and Odonata have been observed to reflect clean water condition (Miserendino and Pizzolon, 2003) [8] in the study site.

Species belonging to order Diptera showed the highest relative abundance (RA) by 0.777 while lowest RA was showed by order Decapoda with 0.001 (Table 3). Maximum diversity (Hs=3.25) and minimum diversity (Hs=3.22) was recorded in Lieho and Chiiriizhu respectively while maximum dominance Ds=0.95 and the least dominance Ds=0.98 was recorded in Dziimetou and Chiiriizhu respectively.

The presence of only a small number of dominant taxa, a lack of any sensitive species, a stronger dominance of these dominant taxa, and a greater abundance of aquatic insects that are tolerant to pollution are the characteristics of aquatic insect communities at degraded sites. Lieho (upstream) has better diversity indices than Chiiriizhu (downstream) and Dziimetou (mid-stream). Downstream rivers are connections with floodplains and connected side-arms. As a result, biodiversity in the most polluted and physically altered sections of present-day rivers is frequently far lower than it should be.

Freshwater biodiversity is in peril as a consequence of humans exploiting rivers with water diversions and pollution for centuries. Native flora and fauna of rivers have a negative impact from human influence such as pollution, damming, embankments and deforestation of the catchment area. Finding pristine locations where rivers are free-flowing and possess a natural biocenosis is today exceedingly challenging. The upper streams tend to remain untapped but human habitation, forestry, and agricultural activities are increasingly influencing downstream areas. Therefore, knowledge of the ecology of natural rivers is an amalgam of remnants of more or less undisturbed parts of rivers around the globe.

Biodiversity conservation is one of the major issues and aquatic environments are in serious threat, therefore it is necessary to protect and develop research and systematic conservation planning to protect freshwater biodiversity. Cooperative efforts across the entire landscape is necessary for the long-term maintenance of species and their management.

Table 1: Aquatic fauna recorded at each study site.

SL. No	Class	Order	Family	Scientific name
1	Amphibia	Anura	Ranidae	*Rana naganensis*
2	Amphibia	Anura	Ranidae	*Amolops nidorbellus*
3	Actinopterygii	Siluriformes	Sisoridae	*Exostoma berdmori*
4	Actinopterygii	Cypriniformes	Cyprinidae	*Schizothorax richardsonii*
5	Actinopterygii	Cypriniformes	Cyprinidae	*Garra mcclellandi*
6	Coleochaetophyceae	Coleochaetales	Coleochaetaceae	*Coleochaete* sp.
7	Gastropoda	Architaenioglossa	Ampullariidae	*Pila globosa*

8	Gastropoda		Pachychilidae	*Brotia* sp.
9	Insecta	Plecoptera	Perlidae	*Acroneuria* sp.
10	Insecta	Odonata	Aeshnidae	*Anax junius*
11	Insecta	Plecoptera	Perlidae	*Calineuria* sp.
12	Insecta	Odonata	Aeshnidae	*Anax* sp.
13	Insecta	Odonata	Libellulidae	*Sympetrum* sp.
14	Insecta	Diptera	Tipulidae	*Tipula* sp.
15	Insecta	Odonata	Coenagrionidae	*Nehalennia* sp.
16	Insecta	Megaloptera	Corydalidae	*Corydalus cornutus*
17	Insecta	Odonata	Libellulidae	*Crocothemis servilia*
18	Insecta	Odonata	Aeshnidae	*Anax* sp.
19	Insecta	Ephemeroptera	Heptageniidae	*Epeorus* sp.
20	Insecta	Ephemeroptera	Ephemeridae	*Ephemera* sp.
21	Insecta	Blattodea	Blattidae	*Periplaneta* sp.
22	Insecta	Odonata	Cordulegastridae	*Cordulegaster* sp.
23	Insecta	Megaloptera	Corydalidae	*Corydalus cornutus*
24	Insecta	Diptera	Tipulidae	*Tipula* sp.
25	Insecta	Decapoda	Potamidae	*Indochinamon* sp.
26	Insecta	Plecoptera	Perlidae	*Calineuria* sp.
27	Insecta	Ephemeroptera	Ephemeridae	*Ephemera* sp.
28	Insecta	Ephemeroptera	Heptageniidae	*Epeorus longimanus*
29	Insecta	Ephemeroptera	Heptageniidae	*Epeorus* sp.
30	Insecta	Trichoptera	Leptoceridae	*Adicella* sp.
31	Insecta	Odonata	Libelluidae	*Crocothemis servilia*
32	Insecta	Odonata	Cordulegastridae	*Anotogaster* sp.
33	Malacostraca	Decapoda	Cancridae	*Cancer* sp.
34	Malacostraca	Decapoda	Potamidae	*Indochinamon* sp.
35	Malacostraca	Decapoda	Palaemonidae	*Palaemon* sp.
36	Malacostraca	Decapoda	Gecarcinucidae	*Maydelliathelphusa lugubris*
37	Osteichthyes	Cypriniformes	Balitoridae	*Nemacheilus manipurensis*

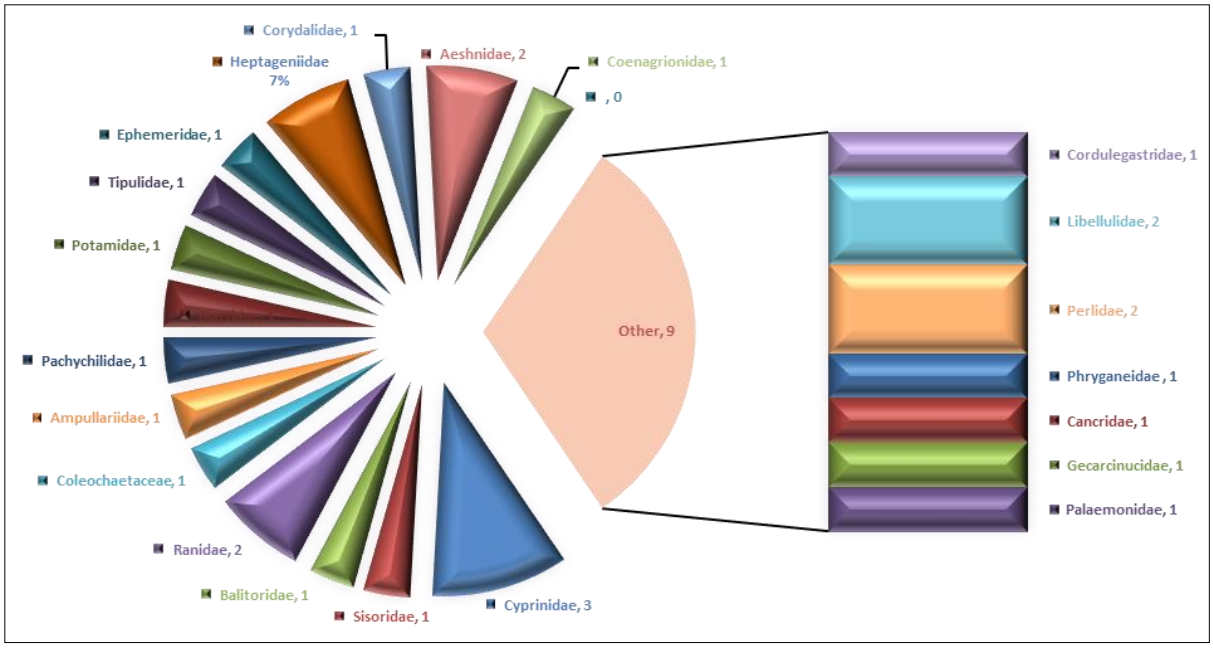

Fig 1: Percentage composition of aquatic fauna families of Dzuna river.

Table 2: Family-wise distribution of aquatic fauna showing number of species and individuals

Family	Species (% occurrence)	Individuals (% occurrence)
Sisoridae	1 (2.703)	16 (1.728)
Cyprinidae	2 (5.405)	69 (7.451)
Ranidae	2 (5.405)	11 (1.188)
Coleochaetaceae	1 (2.703)	43 (4.644)
Ampullariidae	1 (2.703)	30 (3.240)
Pachychilidae	1 (2.703)	13 (1.404)
Aeshnidae	3 (8.108)	78 (8.423)
Blattidae	1 (2.703)	11 (1.188)
Coenagrionidae	1 (2.703)	46 (4.968)

Cordulegastridae	2 (5.405)	23 (2.484)
Corydalidae	2 (5.405)	67 (7.235)
Ephemeridae	2 (5.405)	34 (3.672)
Heptageniidae	3 (8.108)	95 (10.259)
Leptoceridae	1 (2.703)	19 (2.052)
Libellulidae	3 (8.108)	86 (9.287)
Perlidae	3 (8.108)	110 (11.879)
Tipulidae	2 (5.405)	120 (12.959)
Cancridae	1 (2.703)	13 (1.404)
Potamidae	2 (5.405)	20 (2.160)
Palaemonidae	1 (2.703)	1 (0.108)
Gecarcinucidae	1 (2.703)	9 (0.972)
Balitoridae	1 (2.703)	12 (1.296)
Total	37	926

Table 3: List of species and relative abundance of aquatic fauna recorded in the three study sites

SL. No	Order/Family	Zoological name	Common name	D	L	C	RA
1	Plecoptera	*Acroneuria* sp.	Common Stoneflies	27	16	2	0.044
2	Aeshnidae	*Anax* sp.	Common Green Darner	9	3	11	0.026
3	Plecoptera	*Calineuria* sp.	Common Stoneflies	19	12	7	0.04
4	Odonata	*Sympetrum* sp.	Dragonfly	8	2	15	0.029
5	Diptera	*Tipula* sp.	Crane flies	31	18	22	0.077
6	Odonata	*Nehalennia* sp.	Damselfly	23	14	9	0.048
7	Megaloptera	*Corydalus cornutus*	Eastern dobsonfly	5	8	12	0.029
8	Odonata	*Crocothemis servilia*	Scarlet skimmer	10	17	25	0.061
9	Odonata	*Anax* sp.	Dragonfly	6	2	8	0.018
10	Ephemeroptera	*Epeorus* sp.	Caucasiron	14	10	5	0.03
11	Ephemeroptera	*Ephemera* sp.	Mayfly	18	7	0	0.024
12	Blattodea	*Periplaneta* sp.	Cockroach	4	1	6	0.013
13	Odonata	*Cordulegaster* sp.	Spiketails	2	5	0	0.007
14	Anura	*Rana naganensis*	Frog	1	3	4	0.01
15	Architaenioglossa	*Pila globosa*	Snail	8	13	9	0.034
16	Pachychilidae	*Brotia* sp.	Snail	9	3	1	0.013
17	Coleochaetales	*Coleochaete* sp.	Stone fly	24	16	3	0.043
18	Decapoda	*Cancer* sp.	Crab	2	4	7	0.016
19	Decapoda	*Indochinamon* sp.	Crab	5	8	2	0.016
20	Decapoda	*Palaemon* sp.	Prawn	0	1	0	0.001
21	Decapoda	*Maydelliathelphusa lugubris*	Freshwater crabs	1	5	3	0.011
22	Megaloptera	*Corydalus cornutus*	Hellgrame	11	18	13	0.047
23	Diptera	*Tipula* sp.	Leatherjackets	28	16	5	0.049
24	Decapoda	*Indochinamon* sp.	Freshwater crabs	2	0	3	0.006
25	Anura	*Amolops nidorbellus*	Spotted Stinky Torrent Frog.	0	2	1	0.004
26	Siluriformes	*Exostoma berdmori*	Blyth sisorid	10	5	1	0.016
27	Cypriniformes	*Schizothorax richardsonii*	Alwan Snow Trout	14	9	2	0.025
28	Cypriniformes	*Garra mcclellandi*	Cauveri garra	21	16	7	0.046
29	Cypriniformes	*Nemacheilus manipurensis*	Manipuri loach	6	2	4	0.013
30	Plecoptera	*Calineuria* sp.	Stoneflies	17	10	0	0.026
31	Ephemeroptera	*Ephemera* sp.	Common burrowers	1	2	6	0.011
32	Ephemeroptera	*Epeorus longimanus*	Flathead mayflies	22	19	14	0.059
33	Ephemeroptera	*Epeorus* sp.	Rocky mountain species	4	1	6	0.013
34	Leptoceridae	*Adicella* sp.	long-horn caddisflies	2	7	10	0.023
35	Odonata	*Anax junius*	Common green darner	7	13	19	0.046
36	Odonata	*Crocothemis servilia*	Scarlet Skimmer	3	1	5	0.01
37	Odonata	*Anotogaster* sp.	Spiketails	8	3	5	0.017
			Total species	35	36	33	--
			Total Individuals	382	292	252	--

D=Dziimetou, L=Lieho, C=Chiiriizhu, RA=Relative Abundance

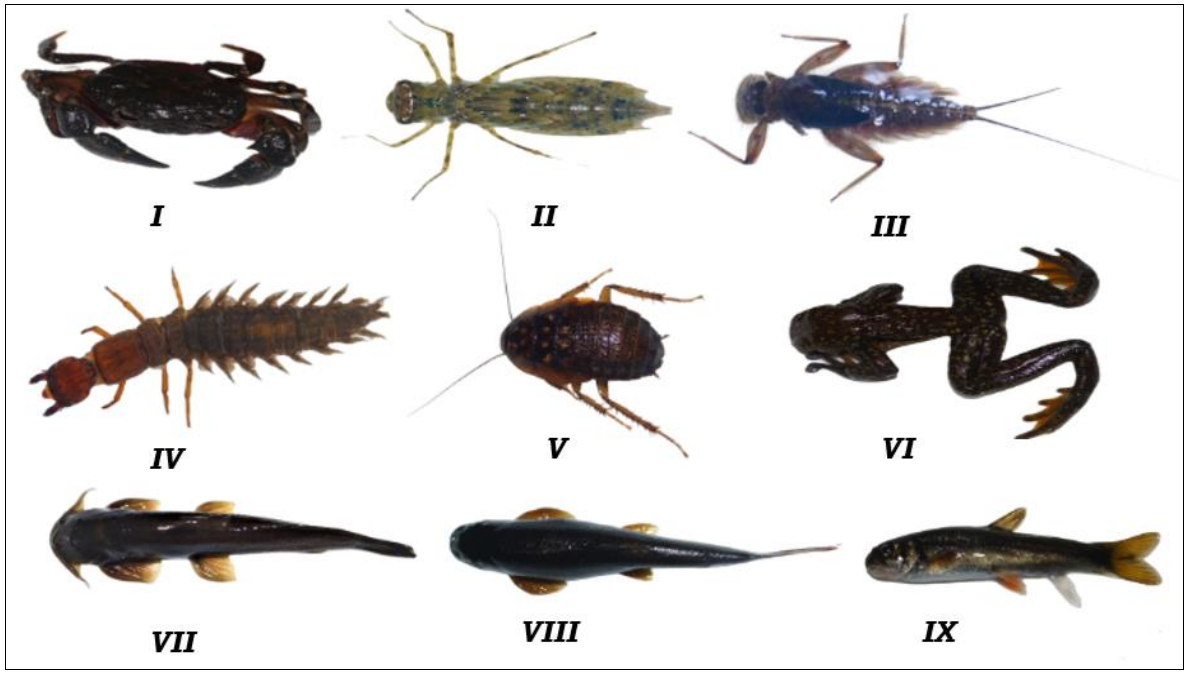

Fig 1: I. *Indochinamon* sp. II. *Crocothemis servilia* III. *Epeorus* sp. IV. *Corydalus cornutus* V. *Periplaneta* sp. VI. *Amolops nidorbellus* VII. *Exostoma berdmori* VIII. *Garra mcclellandi* IX. *Schizothorax richardsonii.*

Conclusion

Generally, this study has offered the first comprehensive set of ecological condition and taxonomical data defining aquatic fauna with regard to three selected sites of Dzuna River. Majority catch lists were made up of aquatic insects, which have been found to be potentially good quality indicators in the study location and the large number of taxa captured could be a useful source of information. However, there is a need for more intensive study along the entire length of the river basin to fully comprehend the general freshwater fauna of the rivers involved. As aquatic insects continue to be a major indicator of pollution in aquatic ecosystems, orders with more diverse taxa *viz* Ephemeroptera, Diptera, Odonata and Trichoptera that offer a wide range of pollution tolerance or sensitivity have the potential to be included in Dzuna river biomonitoring programs.

Acknowledgement

The authors acknowledged the Head of department of Zoology, Kohima Science (Govt. PG) College, Jotsoma for providing the laboratory equipment and also every individual who has immensely contributed to this work.

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