SSR Institute of International Journal of Life Sciences
ISSN (O): 2581-8740 | ISSN (P): 2581-8732
Kadam *et al*., 2024
DOI: 10.21276/SSR-IIJLS.2024.10.1.40

Research Article

open access

Physicochemical Analysis and Diversity of Fish and Aquatic Insect in Hatnur Dam in Maharashtra and Ukai Dam in Gujarat, India

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Received: 25 Sep 2023/ Revised: 20 Oct 2023/ Accepted: 16 Nov 2023

ABSTRACT

Background: Abiotic and biotic factors of an ecosystem are indicators of its physical and biological conditions. There is a scarcity of research related to riverine system dominated by Tapi River in north Maharashtra and South Gujarat, wherein the water of Tapi is mainly used for irrigation, domestic purpose and power generation.

Methods: Physicochemical parameters of water samples collected from Hatnur reservoir and Ukai dam were estimated by standard methods described by American Public Health Association (APHA) and statistically compared. Collected fish and insect species from both reservoirs were identified using standard keys.

Results: A field study at both reservoirs indicated that the estimated values of physicochemical parameters of water samples were within the range described by APHA. From March 2022 to February 2023, 30 species of insects and 35 fish species, including major carp and catfish in river Tapi were the major findings.

C**onclusion:** During the study period, the presence of 30 species of insects and 35 fish species, including major carps and catfish indicated river Tapi might provide favorable physicochemical conditions to sustain regional diversity of biota.

Key-words: Diversity, Fish, Hatnur, Odonates, Physicochemical parameters, Ukai, Tapi

INTRODUCTION

Aquatic biodiversity is the variability among living organisms from all sources, including marine and freshwater ecosystems and their ecological complexes. This includes diversity within species, between species, and of ecosystems. Aquatic insect and fish populations are highly dependent upon the characteristics of their marine habitat, which supports all their biological functions [1]. The North Maharashtra region's water bodies, mainly Jalgaon, Dhule and Nandurbar districts represent unique riverine ecosystems that are highly rich in aquatic insect and fish fauna.

How to cite this article
Kadam SJ, Patil AG, LoharPS. Physicochemical Analysis and Diversity of Fish and Aquatic Insect in Hatnur Dam in Maharashtra and Ukai Dam in Gujarat, India. SSR Inst Int J Life Sci., 2024; 10(1): 3719-3725.

Access this article online
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Hatnur dam on River Tapi is one of the biggest dams in Maharashtra, which supply water for agricultural, domestic use, hydroelectric power generation, fishery, etc [2].

River Tapi (or Tapti) flows westward through the states of Madhya Pradesh, Maharashtra, and Gujrat and finally drains into the Arabian Sea near Surat, around 700 km in length. Before 1968, there were no dams on this river, but progressively, six dams were constructed later, and two were constructed on river Tapi within a stretch of 298 Km. In South Gujrat, the river Tapi is impounded by Ukai dam [2]. The present study is undertaken by considering the aim to know the status of diversity indices of aquatic insects and fish by comparing their past and present landing records in river Tapi in addition to the comparative analysis of limnological features of water samples collected at Hatnur dam in Maharashtra and Ukai dam in South Gujrat. Fisheries are significant sources of food, nutrition, and recreation.

DOI: 10.21276/SSR-IIJLS.2024.10.1.40

Fish habitats can be damaged in obvious and subtle ways and by big or small changes [3]. For example, a large hydropower project or a poorly installed culvert that blocks the migratory route of endangered and vulnerable fish species can damage a fish's habitat. Dams do not solely cause population depletion of aquatic insect and fish species, and many abiotic and biotic factors play a role. Increase of silt and contaminants in the water, formation of a reservoir on a free-flowing river, removal of sand or gravel from river beds, and industrial and municipal waste discharge are other causes of habitat destruction [4]. The most common threats to aquatic insect and fish habitats are those associated with damming of rivers [5].

Odonata is an order of flying insects that includes the dragonflies and damselflies. Odonata are often good indicators of the quality and integrity of aquatic habitats, sometimes including adjacent riparian or coastal areas. Although some authors have assessed Odonata as poor water quality indicators [6], they have been used successfully in this role for almost four decades [7]. Schmidt pointed out that a characteristic assemblage of species may be more indicative of habitat quality than any single species, and assessment of such assemblages has been used to gauge recovery of degraded wetlands [8]. Clark and Samways showed that adult male Odonata was quite helpful at identifying habitat characteristics that were important or essential for the maintenance of many species and are likely to have implications for the conservation of other aquatic macroinvertebrates [9]. Koparde *et al*. [10] established habitat correlates of Odonata species diversity in the northern Western Ghats. Almost nothing has been known about the Odonates of River Tapi for four decades, so the present study is planned.

Karamchandani and Pisolkar studied ichthyofauna of river Tapi. After a gap of about three decades [11], Pisolkar contributed to the declining fish species of Tapi [12]. Lohar and Borse studied the diversity of fish fauna in Tapi, which was depleted, compared to fish landing records made by previous researchers [13]. Regarding the available literature on fish fauna, it became clear that there is a lack of research on the diversity of ichthyofauna in the Tapi River, the principal river of northwest Maharashtra. Since there was a lack of recent fish landing records in River Tapi and their comparison with previous fish landing records, it became worth acquiring knowledge about the present status of fish fauna in River Tapi.

MATERIALS AND METHODS

Research study proceed during March 2022 to February 2023 in the Department of Zoology of Dhandai College, Amalner, District Jalgaon, Maharashtra, India.

Study areas visited- Hatnur Dam on river Tapi in Jalgaon district of Maharashtra (75^0 90'E, 21^0 12'N) and Ukai Dam on the river Tapi in Songad tehsil of Surat district of Gujarat (73^0 85'E, 21^0 10'N) were selected as the sites for study. The geographical locations of both dams are given in Fig. 1.

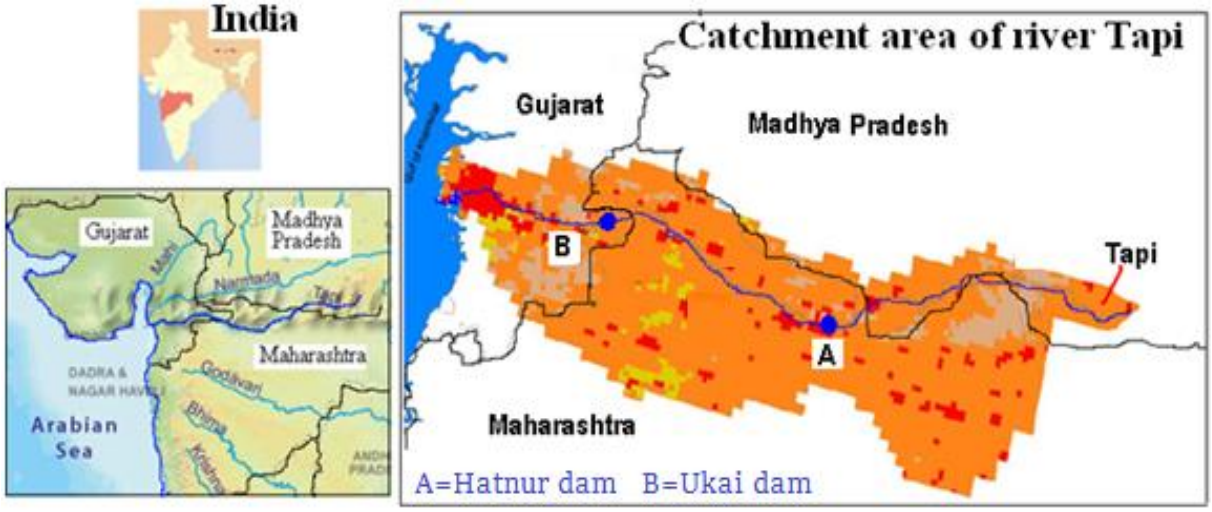

Fig. 1: Study area showing geographical map (A) Hatnur Dam (B)Ukai Dam

DOI: 10.21276/SSR-IIJLS.2024.10.1.40

Limnological study of water samples collected from Hatnur and Ukai dam- Hatnur and Ukai dam visited twice each season. Water samples were collected for physico-chemical analysis using standard methods described by APHA [14].

Survey of Hatnur and Ukai dam to collect scientific information about different species of aquatic insects and fish species- With the help of local fishermen, fish species were collected from reservoirs and aquatic insects captured using insect nets and identified with standard keys [15,16].

Statistical Analysis- The present status of a diversity of aquatic insect and fish inhabiting in both dams was evaluated, and the comprehensive data was prepared and statistically analyzed.

RESULTS

Both dams were visited from March 2022 to February 2023 to note the seasonal variations in water quality parameters. Limnological parameters of water samples collected from Hatnur dam and Ukai dam are given in Tables 1 and 2, respectively.

Table 1: Seasonal variations in limnological properties of Hatnur dam

Parameters	Hatnur dam on River Tapi (Maharashtra)			
	Mar-May 2022	June-Aug 2022	Sept-Nov 2022	Dec 2022- Feb 2023
pH	7.03- 7.88	7.12-7.92	7.08-7.62	6.94-7.61
Water Temperature	23-29 ^{o}C	21-25^{o}C	22-27^{o}C	19-23^{o}C
Transparency	18-28.0 cm	16-26.4 cm	19-32.3 cm	17-29.5 cm
Turbidity (NTU*)	20-38	25-46	23-43	22-36
Total dissolved solids	132-385	114-302	108-287	98-290
Dissolved Oxygen	3.1-6.4	4.6-8.2	4.2-7.8	5.0-8.7
Free CO_2	1.12-8.2	2.78-9.6	2.54-8.7	2.12-9.3
Biological Oxygen Demand	7.3-10.5	8.9-11.5	8.3-10.5	8.5-11.2
Chemical Oxygen Demand	39.5-60.8	35.9-53.7	36.4-47.8	38.5-57.8
Alkalinity	90.5-194	85.8-182	88.9-169	89.9-178
Total Hardness ($CaCO_3$)	123-175	105-154	112.8-142	118.6-163
Chloride	32.5-85.8	42.8-88.7	40.9-78.5	41.9-82.1
Nitrate	0.45-1.8	0.58-2.9	0.54-2.3	0.50-2.2
Phosphorous	0.038-0.087	0.056-0.097	0.052-0.088	0.043-0.067

**Nephelometer turbidity unit; Measurement unit for parameters 5 to 12 is mgL^{-1}*

Estimated values of physicochemical parameters in water samples collected from Hatnur reservoir indicated that seasonally there were statistical differences in each parameter i.e. the range of estimated values of pH was 7.03 -7.88 (during summer, Mar-May 2022), 7.12-7.92 (during monsoon, June-Aug 2022),7.08-7.62 (during post-monsoon, Sept-Nov 2022) and 6.94-7.61(during Dec 2022- Feb 2023).

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Table 2: Seasonal variations in limnological properties of Ukai dam

Parameter	Ukai dam on River Tapi (Gujarat)			
	Mar-May 2022	**June-Aug 2022**	**Sept-Nov 2022**	**Dec 2022- Feb 2023**
pH	7.32-8.03	7.54-8.27	7.32-8.03	7.54-8.27
Water Temperature	19-26 °C	18-23°C	17-25 °C	14-19°C
Transparency	15-21.9 cm	18-26.4 cm	26-35.6 cm	23-30 cm
Turbidity (NTU*)	22-42	21-38	20-40	19-39
Total dissolved solids	142-325	155-385	153-367	148-337
Dissolved Oxygen	3.5-6.7	4.2-8.4	3.8-7.8	3.9-8.1
Free CO_2	1.04-7.1	1.02-8.7	1.10-7.5	1.06-7.5
Biological Oxygen Demand	7.8- 26.6	7.4-22.8	7.6- 24.2	7.3-24.4
Chemical Oxygen Demand	34.5-58.7	29.4-48.2	32.2-49.2	32.8-49.9
Alkalinity	106-204	81.4-174	88,8-189	92.3-194
Total Hardness ($CaCO_3$)	124-198	108-159	110-167	113-179
Chloride	56.8-92.7	48.5-78.8	54.3-88.7	52.7-84.8
Nitrate	0.52-3.5	0.42-2.05	0.47-2.9	0.48-3.4
Phosphorous	0.042-0.105	0.034-0.085	0.038-0.09	0.039-0.125

** Nephelometer turbidity unit; Measurement unit for parameters 5 to 12 is mgL^{-1}*

Similar to Hatnur reservoir, the estimated values of physicochemical parameters in water samples collected from Ukai reservoir indicated that seasonally there were statistical differences in each parameter, i.e. the range of estimated values of pH was 7.32-8.03 (during summer, Mar-May 2022), 7.54-8.27 (during monsoon, June-Aug 2022),7.32-8.03 (during post-monsoon, Sept-Nov 2022) and 7.54-8.27 (during Dec 2022- Feb 2023).

Based on the comparative study of estimated values of each physicochemical parameter in water samples collected from both reservoirs, it was noted that the seasonal variations of the water temperature range of Hatnur reservoir were always higher than that of the Ukai reservoir.

Diversity of Insect species belonging to Order Odonata- During a periodic visit to both dams, aquatic insects of the order Odonata are to be collected with the help of an insect net. Its taxonomic position was identified using standard keys and assistance from Zoological Survey of India, Pune.

Dragonflies and damselflies were collected, photographed, and identified using standard taxonomic literature field guides and surveys released from 2015 to 2020. Odonata includes some of the most ancient and beautiful insects that ever-roamed Earth and some of the largest flying invertebrates ever to have lived. The order of Odonata is very diverse, with about 5000 species, and its members are closely associated with water bodies. A total 30 species of insects belonging 2 suborders and 9 families belonging to the order Odonata were recorded around both dams. The list of insects is as follows:

Order: Odonata
Suborder: Anisoptera
Family: Aeshnidae (3)
1.*Anaciaeschnajaspidea* (Burmeister, 1839)
2. *Hemianax ephippiger* (Burmeister, 1839)
3.*Gynacantha bayadera* (Selys,1891)
Family: Gomphidae (3)
1.*Ictinogomphus rapax* (Rambur, 1842)
2.*Paragomphus lineatus* (Selys, 1850)
3.*Gomphidiakoda guensis*(Fraser,1923)
Family: Libellulidae (12)
1.Acisoma panorpoides (Rambur, 1842)
2.Aethriamanta brevipennis (Rambur, 1842)
3.Crocothemis servilia (Drury, 1770)
4.Lathrecista asiatica (Fabricius, 1798)

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5.Neurothemis fulvia (Drury, 1773)
6.Neurothemis intermedia (Rambur, 1842)
7.Brachythemis contaminate (Fabricius,1793)
8.Diplacodes trivialis (Rambur,1842)
9. Orthetrums abina (Drury,1773)
10.Pantala flavescens (Fabricius,1798)
11.Trithemis pallidinervis (Kirby,1889)
12.Urothemis signata (Rambur,1842)
Suborder: Zygoptera
Family: Chlorocyphidae (1)
1.*Libellago lineata* (Burmeister, 1839)
Family: Coenagrionidae (4)
1.*Ceriagrion coromandelianum* (Fabricius, 1798)
2.*Ischnura aurora* (Brauer, 1865)
3.*Ceriagrion coromandelianum* (Fabricius,1798)
4.*Pseudagrion decorum* (Rambur,1842)
Family: Platycnemididae (1)
1,*Copera marginipes* (Rambur, 1842)
Family: Aeshnidae (2)
1.*Anax guttatus* (Burmeister, 1839)
2.*Gynacantha bayadera* (Selys,1891)
Family: Gomphidae (2)
1.*Heliogomphus promelas* (Selys,1873)
2.Microgomphus torquatus (Selys,1854)
Family: Libellulidae (2)
1.*Orthetrum sabina* (Drury,1773)
2.*Rhyothemis variegate* (Linnaeus,1763)

Diversity of fish species- With local fishermen's help, the fish species inhabiting both dams are surveyed, identified, and systemically placed using standard keys and assistance from the Zoological Survey of India, Pune. The fish catches were dominated by major carps and catfish belonging to the subclass Teleostomi and 5 Families viz. Cyprinidae, Silirudae, Claridae, Channidae, and Mestacembelidae. A total of 35 fish species were found during the study period, as given below:

Superclass: Pisces
Class: Osteichthyes
Subclass: Telestoi
[1] Family: Cyprinidae
1*Amblypharyngodon mola* (Ham.)
2. *Cyprinus carpeo* (Linn.)
3. *Catla catla* (Ham.)
4. *Tor tor* (Ham.)
5. *Cirrhinus mrigala* (Ham.)
6. *Labeo rohita* (Ham.)
7. *Labeo bata* (Ham.)
8. *Labeo calbasu* (Ham.)
9. *Labeo boggut* (Sykes.)
10. *Labeo fimbriatus* (Bloch.)
11. *Puntius sarana* (Ham.)
12. *Puntius sophore* (Ham.)
13. *Noemacheilus botia* (Ham.)
14. *Labeo lunatus* (Sykes.)
15.*Cirrhinus reba*(Day)
16.*Aspidoparia morar*(Ham.)
17.*Aspidoparia jaya*(Ham.)
18.*Barillus bakeri*(Day)
19.*Barilius bendelisis*(Ham.)
20.*Labeo dussumieri*(Val.)
21.*Labeo cylindricus*(Peters)
22.*Puctius sarana sarana*(Ham)
23. *Puntius sophore*(Ham.)
24.*Oreochromus aureus* (Steind.)
25.*Oreochromus niloticus*(Linnaeus)
26.*Crossocheilus latius* (Ham.)
[2] Family: Siluridae
1. *Wallago attu* (Schn.)
2.*Ompak bimaculatus* (Bloch.)
3.*Mystus bleekeri* (Day)
4.*Mystus cavasius* (Ham.)
[3] Family: Claridae
1.*Clarius batrachus* (Linn.)
[4] Family: Ophiocephalidae (Channidae)
1.*Channa punctatus* (Bloch.)
2.*Channa striatus* (Bloch.)
[5] Family: Mestacembelidae
1.*Mestacembelus armatus* (Lacepede)
2.*Macrognathus aculeatus* (Jayaram)

DISCUSSION

Freshwater resources are life-supporting systems, and every natural ecosystem shows variations in its physical, chemical and biological composition. Based on the comparative study of estimated values of each physicochemical parameter in water samples collected from both reservoirs, it was noted that the seasonal variations of the water temperature range of Hatnur reservoir were always higher than that of the Ukai reservoir. This was due to differences in geographical location and climatic conditions of dams. Hatnur reservoir is located in the Jalgaon district, where there

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were scorching climatic conditions in summer compared to south Gujarat, where the Ukai dam was constructed. Lohar and Patel [17] studied the physicochemical parameters of river Tapi near Savkheda village in Amalmer tehsils of Jalgaon district and reported similar seasonal variations in ambient and water temperatures.

In the present investigation, family-wise percentage of insect and fish species was also studied, and statistical data revealed that among 30 species of insects, the family Libellulidae (40%) was dominated. Among fish species, the family Cyprinidae (74%) was dominated [18,19]. Samways and colleagues developed the "Dragonfly Biotic Index", which often can be an excellent index of aquatic habitat quality [20,21]. The survey of adult dragonflies and fish species at Hatnur and Ukai reservoir and adjoining wetland over one year indicated a decline in regional biota with particular reference to aquatic insects and fish. Restoring human-damaged habitats must allow for continuing conservation of the diversity of aquatic insects and fish in the study area.

The availability of food, water temperature, water current and dissolved oxygen made the suitable environment for fish to flourish [17]. As compared to the fish landing record in river Tapi studied by Pawara *et al*. [22], Sonawane [23], Siddiqui [24] and Talwar and Jhingran [25] in the present investigation, there was a decline in number of fish species, which might be due to increased anthropogenic activities in and around the Tapi rivers leading to habitat destruction and unbalance aquatic ecosystem at study site [26].

CONCLUSIONS

Based on estimated values of the physicochemical parameters studied during different seasons at Hatnur and Ukai reservoirs, it is concluded that geographical location and climatic conditions in and around Hatnur dam in Jalgaon district of Maharashtra are significant contributory factors that caused variation in the limnology of Hatnur dam to remain higher than that of Ukai dam in South Gujarat district. Fish is a rich source of protein and utilized for human consumption, increasing human intervention in wetlands and leading to daily depletion in fish diversity. In the present investigation, fish catches were dominated by 35 fish species, including major carps and catfish, which was statistically less in number as compared to the previous fish landing record. River Tapi and its tributaries contribute the major share of freshwater resources in North Maharashtra. Both dams on the Tapi River play significant roles in providing breeding grounds, shelter and food for precious aquatic fauna and birds. Over the decades of study, it became clear that increasing anthropogenic activities, including overfishing, lead to the continuous decline in fish species. Hence, there is an urgent need to protect the precious diversity of aquatic fauna by implementing stringent action plans by the Government or Non-governmental organizations as a part of the conservation strategy. The stringent action plan should be implemented to protect the fish inhabiting river Hatnur and Ukai reservoirs.

CONTRIBUTION OF AUTHORS

Research concept-Sanjay J. Kadam
Research design- Sanjay J. Kadam
Supervision-Prakash S. Lohar and Anil G. Patil
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Data collection-Sanjay J. Kadam
Data analysis and Interpretation- Sanjay J. Kadam and Prakash S. Lohar
Literature search- Sanjay J. Kadam
Writing article-Sanjay J. Kadam
Critical review-Sanjay J. Kadam
Article editing-Prakash S. Lohar and Anil G. Patil
Final approval-Prakash S. Lohar

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