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Mehnaza Rashid
Department of Life Sciences, Rabindranath Tagore University, Raisen, Madhya Pradesh, India

Pragya Shrivastava
Department of Life Sciences, Rabindranath Tagore University, Raisen, Madhya Pradesh, India

Corresponding Author:
Mehnaza Rashid
Department of Life Sciences, Rabindranath Tagore University, Raisen, Madhya Pradesh, India

Assessment of trophic status and aquatic insect diversity of Kaliasot River

Mehnaza Rashid and Pragya Shrivastava

Abstract
An assessment was made to accesses the trophic status and aquatic insect diversity of the kaliasot river. During the present study the results documented higher values in physico-chemical parameters. The river was categorized as alkaliphilous and alkaline with pH ($\overline{x}$ = 7.9 units). On the basis of average values observed for electrical conductivity ($\overline{x}$ =301.7 µScm^{-1}) the water body falls under Mesotrophic condition. Higher average alkalinity values (75.3 mgl^{-1}) categorizes the water body as nutritionally rich. Increased average nitrate content puts the water body into the eutrophic condition. The overall study predicts the eutrophic nature of Kaliasot River. A total of 29 genera of aquatic insects belonging to 5 orders were recorded from the kaliasot during the present study.

Keywords: Trophic status, Aquatic insects, kaliasot

Introduction
Trophic status is a classification system for water bodies that describes the operations of the system in terms of production. The fact that it is directly tied to the incoming sewage and other wastes in the aquatic systems makes it a crucial feature that needs to be regularly monitored. Waterbodies in different parts of the world, particularly in developing nations, are dealing with a variety of concerns related to anthropogenic activities and unsustainable use of their resources. The quality of the water and the health of the aquatic ecosystem are very sensitive topics. Predicting a water body's trophic state heavily relies on chemical characteristics. pH, conductivity, total alkalinity, phosphorus, and nitrate-nitrogen are the key indicators of a water body's trophic condition. No single evaluation variable can accurately reflect the level of eutrophication in a given water body due to the dynamic nature of productivity and eutrophication as a result of natural and anthropogenic processes [Xu *et al*., 2001 [2]; Padisak *et al*., 2009 [3]]. To reduce negative environmental and economic effects, the aquatic environment must be continuously monitored and assessed for eutrophication.

Study Area
A tributary of the River Betwa, the Kaliasot is a river in Central India. The river begins as an overflow from the Kaliasot Dam in Bhopal and flows southeast. It travels a distance of around 29 km from the source to the destination (before joining the river Betwa at Bhojpur). With the exception of the monsoon season, the river has very little flow from its source up to Bhojpur. Only one location, the river's confluence with the river Betwa near Mandideep, is regularly inspected for water quality. It is approximately 13 km from the village of Samardha to Bhojpur (where the River Betwa joins) that is designated as polluted.

Methodology

The major physico-chemical parameters were analysed in accordance with the protocols outlined in [Adoni *et al*., 1985] [5] and [APHA 2005] [6] as standard operating procedures. The majority of the aquatic insect collection took place in the morning. A variety of nets, including D-hand nets (30 30 cm frame), 250 mm, and 20 mm mesh size nets, were used for sampling. In a 1m^2 region, the nets were scooped out of the water for quantitative investigation. Throughout the sampling station, a net was pulled to count insects qualitatively. The material was then sieved (mesh size: 10 and 25 m) after being gathered by nets. Water was sprayed on the sample during sifting. The aquatic insects were then collected using forceps and a brush while being viewed via a 10X lens. Following the efforts of (Pennak 1978 [7] and Subramanian 2005 [10], aquatic insects were identified down to the genus level.

Results and discussions

The physico-chemical characteristics as given in Table 1 depict the considerable variation during the present study.

Table 1: Shows the Parameters and Present study (2020)

Parameters	Present study (2020)
Air temperature	22-34 ($\bar{x}$= 29.8)
Water temperature	19-34 ($\bar{x}$= 25.45)
pH	6.9-8.7 ($\bar{x}$= 7.9)
Electrical conductivity	170-542 ($\bar{x}$= 301)
Total dissolved solids	115-270 ($\bar{x}$= 187)
Dissolved Oxygen	4-9.6 ($\bar{x}$= 7.11)
Total alkalinity	24-140 ($\bar{x}$= 75.3)
Total hardness	109-245 ($\bar{x}$= 160)
Calcium hardness	0-20 ($\bar{x}$=3.8)
Chlorides	16-116 ($\bar{x}$= 60.13)
Nitrate	0.39-2.18 ($\bar{x}$= 0.72)
Orthophosphate	0.32-0.98 ($\bar{x}$= 0.27)

Atmospheric temperature during the present study ranged between 22-34 ºC. According to [Welch 1952] both atmospheric and water temperature play an important role on the physico-chemical and physiological behavior of the aquatic system. Water temperature during the present investigation ranged from 29-34 ºC.

PH during the present study ranged between 6.9-8.7 units. The results are in conformity with the (Rahman *et al.*, 2021) [36] which reported the pH range between 6.11 mgl^{-1} to 8.37 mgl^{-1} for Turang River in Bangladesh. Chandra *et al.* (2011) also recorded pH values 6.78 mgl^{-1} to 7.87 mgl^{-1} during their study in Ganga and Hoogli River in India.

Total Alkalinity values during the present study ranged from 24-140 mgl^{-1}. As per [Spence (1964)] water bodies having alkalinity upto 15 mgl^{-1}are nutrient poor, those having alkalinity upto 60 are considered as moderately rich while the water bodies with alkalinity values higher than 60 are considered nutrient rich, Kaliasot river also comes under this category. The higher alkalinity values of a water body suggest higher pollution load [Bath and Kaur (1999) [15]].

During the present study Total hardness varied from109-245 mgl^{-1}. As per [Sawyer 1960] [16] water can be classified into three categories as soft (0.00 - 75 mgl^{-1}), moderately hard (75.00 - 150.00 mgl^{-1}) and hard (151.00 -300.00 mgl^{-1}) on the basis of hardness. As per [Sawyer 1960] [16] classification Kaliasot is categorized among moderately hard water type of water body.

During the present study Chloride values ranged from 16-116 mgl^{-1}. Chloride is an anion, which occur naturally in all natural waters in the form of Ca, Mg and Na salt, chlorine as such is non-toxic to human beings but its elevated levels can be considered as the "advance warning" of the existence of other toxic contaminants in water. Hence, concentration of chloride content is an indicator of pollution in fresh water (Kelly *et al.*, 2012) [38]. The source of chloride in the Kaliasote River were due to the runoff containing inorganic fertilizers coming from agricultural fields, animal feeds and irrigation drainage.

Electrical conductivity during the present study recorded an average value of 301.7 mg/l. As per [Alikunhi 1957] [17] classification kaliasot is categorized among the productive while as per [Lee *et al.*, 1981] [18] classification kaliasot is categorized among eutrophic.

Calcium, an important mineral for organisms, regulating various physiological functions also plays a vital role in antagonizing the toxic effects of various ions and neutralizing surplus acid produced. During the present study calcium values ranged from 0-20 mgl^{-1}. According to [Ohle 1934] [20] water bodies having calcium more than 25 mg/l are rich while those having 10-25mg/l are medium. Following the above classification kaliasote tends to be again in the medium to rich nature.

Dissolved oxygen acts as an indicator of trophic status and the extent of eutrophication [Edmondson 1996] [21]. Dissolved oxygen is vital and very often a limiting factor for maintaining aquatic life whose diminution in water is probably the most frequent result of certain forms of water pollution [Srivastav *et al*., 2009] [22]. During the present study DO values ranged from 4 mgl^{-1} – 9.6 mgl^{-1}

The main nitrogen sources in the kaliasot are the domestic sewage, agricultural runoff and decomposition of autochthonous matter. During the present study Nitrate Nitrogen values varied from 0.39 – 4.37 mgl^{-1}. Wetzel (1975)] has classified water bodies on the basis on nitrate content into Oligotrophic (0.2 mgl^{-1}) mesotrophic (0.2-0.4 mgl^{-1}) and eutrophic (0.5-1.5 mgl^{-1}. Following this classification Kaliasot river is categorized under the eutrophic nature type. On the basis of phosphate content (Wetzel) 1975 classified water bodies into the Oligotrophic (0.005 mgl^{-1}), mesotrophic (0.005-0.01 mgl^{-1}) and eutrophic (0.03-0.1 mgl^{-1}). During the present study the orthophosphate content ranged from (0.32-0.98 mgl^{-1}). Following this classification on the overall average basis Kaliasot is again categorized under the eutrophic type.

During the present study 29 species of aquatic insects belonging to 5 orders were recorded from the Kaliasot River. Among these 5 recorded orders, Odonata, coleopteran and hemiptera contributed equal number of species (7 spp.), each which was followed by Diptera and ephemeroptera contributing 5 species and 3 species respectively (Table 2).

The orders recorded in the present investigation followed the following sequence of dominance:

Odonata = Hemiptera = Coleoptera > Diptera > Ephemeroptera

Table 2: List of Aquatic insects recorded from Kaliasot River (2020)

Arthopoda	Insecta	Diptera	Chironomidae	Chironomus chironomus
			Chaoboridae	Chaoborus chaoborus
			Culicidae	Culex sp.
			Simuliidae	Simuluim sp.
			Tabanidae	Tabanus sp.
		Odonata	Gomphidae	Aphylla sp.
				Gomphus sp.
			Cordulegastridae	Cordulegaster sp.
			Aeshnidae	Anax sp.
			Coenagrionidae	Hagnius sp.

				Argia sp.
				Enallagma sp.
		Hemiptera	Corixidae	Sigara sp
				Notoneta sp.
			Nepidae	Ranatra sp.
				Nepa sp.
			Gerridae	Gerris sp.
			Veliidae	Rhagovelia sp.
			Naucoridae	Pelocoris sp.
		Ephemeroptera	Caenidae	Caenis sp.
			Ephemerellidae	Ephemerella sp.
			Baetidae	Baetis sp.
		Coleoptera	Crabronidae	Dineutus sp.
			Haliplidae	Peltodytes sp.
			Hydraenidae	Hydraena sp.
			Dytiscidae	Dytiscus sp.
			Carabidae	Bembidium sp.
			Elmidae	Stenelmis sp.
			Hydrophilidae	Berosus sp.

In the present study species such as *Chironomous* sp., *Culex* sp., *Berous* sp., *Cybister* sp. and *Ephemera* sp. were resistant to high organic load, thus acting as indicators of pollution. *Chironomous* sp. has been reported as a pollution indicator [Paine and Gaufin 1956 [24] and Servia *et al*., 1998] [26] while [CPCB 2017] [27] reported *Chironomous* sp. to be inhabiting less to moderate polluted waters. High abundance of chironomids in aquatic systems is also an indicative of eutrophic nature of the water body. According to Saether (1975) [28] and Langdon *et al*. (2006) [30], chronomid species diversity and their susceptibility to eutrophic conditions have been used to categorise lakes into oligotrophic, mesotrophic, and eutrophic categories. Following the classification the present water body is categorized among eutrophic category. *Culex* sp. has been reported to be inhabiting polluted waters [Paine and Gaufin 1956] [24] however, *Culex* sp and *Berosus* sp. inhabit water bodies with moderate pollution [CPCB 2017] [27]. *Diplonychus* sp. not recorded during the present study from the eutrophic waters have also been reported from Upper lake Bhopal (Ganie *et al*. 2018) [39] water bodies with heavy metal pollution [Ahmed *et al*., 2017] [31] However, the same species has been reported to be common in less polluted to highly polluted waters [CPCB 2017] [27].

During the present study ephemeroptera like *Ephemera* sp were more abundant in kaliasot through-out the year which has been classified as eutrophic, however most of their species are present in both mesotrophic and oligotrophic lakes [Barbour *et al*., 1999 and Bauernfeind and Moog 2000] [33]. CPCB (2017) [27] also reports *Cybister* sp. in moderate polluted waters whose presence during summer is also reported [Choudhary and Ahi 2015] [34] from Lakhabanjara lake Sagar, M.P. Species. Thus it can safely be concluded that *Ephemera* sp is of ubiquitous nature inhabiting almost all types of waterbodies.

Conclusion

Study of different Physico- chemical parameters and nutrients of surface water samples of kaliasot revealed that the intensity of pollution is on rise due to continuous flow of domestic sewage and agricultural wastes into the water body. The rising pollution has been found to change the trophic status of kaliasot towards eutrophic condition. This is further confirmed by the presence of ubiquitous species like *Ephemera* and *Libellula*. Since the present water body is one of the prime source of the agricultural practices as such awareness needs to be generated towards maintaining the healthy metabolic processes into the system. Otherwise there is every chance of losing the present quality of the waterbody.

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