Bioscience and Bioengineering
Vol. 3, No. 2, 2017, pp. 11-16
http://www.aiscience.org/journal/bio
ISSN: 2381-7690 (Print); ISSN: 2381-7704 (Online)

A Vast Aquatic Diversity Reveals the Richness of Bagmati Biodiversity

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Abstract

Bagmati is a holy river of Nepal which flows through Kathmandu valley. It has both religious and social value. An assessment was conducted in 2011/12 that showed richness of aquatic biodiversity of Bagmati. The level of flora and fauna also indicated the level of pollution of water. Many bacteria, fungi, aquatic protozoans, fish, and algai were present. Thus there is urgent to address the river to conserve its aquatic biodiversity. It needs to carefully regulate and control human activities, resource use, and waste disposal in order to improve the water quality in the Baghmati. This can best be accomplished in conjunction with improved environment planning and control and inter-sectoral coordination at national, and local levels.

Keywords

Zooplankton, Phytoplankton, Protozoans, Algae and Fungi, Diatoms, Macro Invertebrates

Received: February 9, 2017 / Accepted: February 21, 2017 / Published online: September 27, 2017

1. Introduction

Aquatic biodiversity encompasses freshwater ecosystems, including lakes, ponds, and reservoirs, rivers and streams, groundwater, and wetlands. Itconsists of marine ecosystems, including oceans, estuaries, salt marshes, sea grass beds, coral reefs, kelp beds, and mangrove forests (Macan 1974). Aquatic ecosystems provide a home to many species including phytoplankton, zooplankton, aquatic plants, insects, fish, birds, mammals, and others. They are organized at many levels, from the smallest building blocks of life to complete ecosystems, encompassing communities, populations, species, and genetic levels. Thus aquatic biodiversity includes all unique species and habitats, and the interaction between them (ENPHO 1996).

Bagmatiriver is the most important river of the Kathmandu Valley. Bagmati is not merely a river but a civilization. The main tributary of the river system, Bagmati has been destroyed by pollution, the water is black and poisonous, crawling with flies and contaminated with sewage (FPAN DISVI 1988, Gyawali 2001). In absence of proper plans the river environment is under intense degradation for last couple of decades (Hartmann and Moong 2008). The degradation thus depicts the degradation of the civilization within the valley. The water in the river gives off a terrible stench (Chaube et al 2008). Therefore, there is a serious need of a study, suggesting ways and means to keep the river clean and conserve its biodiversity.

The present study comprises collection, identification, and compilation of existing information in bibliography related to the ecology of Bagmatiriver. The approach is to analyze its water quality and correlate it with the presence of microorganisms, invertebrates and vertebrates population of the river. This study also describes how the deterioration of the river system has affected development in Kathmandu and its tradition.

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2. Methodology

2.1. Biological Sampling

Five sites were used for taking water sample. Sampling weretaken following the standard protocol.

2.2. Quantitative Sampling

A Multi-Habitat Sampling (MHS), (Moog, 1996) was considered as fundamental requisite of evaluate the ecological status of rivers. A sample in MHS included 20 sampling units taken from all habitat types at the sampling site, each with a share of at least 5% coverage. A total of 20 samples were taken and a single composite was prepared.

An AQEM/STAR net sampler with 500 micron mesh size was used for sampling. This sampler was specially developed for multi habitat sampling and preferred than surfer sampler because it reduces the amount of sediments in a sample and hence the time for sorting. The net was attached to rectangular metal frame of size 25*25 square cm, the opening of the net was placed opposite to the flow of the river vertically on the stream bed. The substrate was disturbed by hands up to varying depths depending upon the sampled substrate in order to dislodge the animals from the substrate.

2.3. Sample Processing

Sample preservation and labeling:

Samples were transferred from the net to sample container and preserved in 4% formalin to cover the sample completely, immediately after collection. The sample was stored cool. Site location was placed outside of the container with date.

2.4. Laboratory Methods

Sorting and identification:

Samples were kept for at least a week to allow the specimens to fix in the formaldehyde solution. After that the sample was thoroughly washed in different mesh size and transferred into different white enameled tray for sorting. The specimens were sorted and kept in different Petri dish. The sorted biological specimen was identified up to family level by referring to various identifications keys.

2.5. Aquatic Vertebrates

Biological sampling

Fish collection from the different sites weremade with the help of fisher men. Different nets have been used for this purpose. The quantitative and qualitative observation and relative abundance of their distribution have been made on the spot.

3. Result and Discussion

Phytoplankton

Phytoplankton is the autotrophic component of the aquatic community. Most phytoplanktonsare too small to be seen with the unaided eye. However, when present in sufficient numbers, they may appear green due to the presence of chlorophyll (ordue to varying amount of chlorophyll or the presence of accessory pigments such as phycobiliproteins, xanthophylls, etc.)(HMGN/JICA 2005). The examples of observed phytoplankton are described below.

Diatoms

The diatoms observed at different stations during the investigations are listed below -

Diatomssp., *Fragillariasp*., *Naviculasp*., *Nitzschiapalea*, *Cyclotellasp*., *Melosiragranulate* were foundon all sites along the riverduring the present study. *Amphora sp., Cymbellatumida, Cymbellaaspara, Cymbellahelvestica, Cymbellaventricosa, Cyclotella sp., Diatoma sp., Epithemia sp., Fragillaria sp., Melosira granulate, Novicularadiosa, Noviculamenisculus, Noviculapusio and Nitzschiapalea* (NPC/IUCN 1991).

Table 1. The Diatoms of Bagmatiriver.

Division	Class	Sub-class	Genus
Chrysophyta	Bacillariophyceae	Algae	Diatoms sp., *sp*.,*Naviculasp*., *Nitzschiapalea*, *Cyclotellasp*., *Melosiragranulate*., *Amphora sp., Cymbellatumida, Cymbellaaspara, Cymbellahelvestica, Cymbellaventricosa, Cyclotella sp., Diatoma sp., Epithemia sp., Fragillaria sp., Melosira granulate, Novicularadiosa, Noviculamenisculus, Noviculapusio and Nitzschiapalea*

Zooplanktons

Several species ofzooplankton were found upstream of Gokarna. Their abundance varied from 8 to 15 per litre. The major groups of zooplankton recorded from Bagmati river belonged to Protozoa, Rotifera, Cladocera, Ostracoda, and Copepoda.

Protozoa

A few species of protozoa were identified at Gokarna. The genera were recorded in this order of abundance: *Difflugia*, *Centropyxis*, *Actoinobolus*, *Neblia*, *Actinophrys* and *Styloninchia*.

Rotifera

Rotifers largely contribute to the food chain of fish. Various samples examined showed the presence of *Conochilus*, *Branchionus*, *Keratella*, *Filinig*, *Polyartha* and *Pedalion*; the most common genera. Besides, there were a few genera of *Ploima*, *Monostyla* and *Asplancha*.

Cladocera

Cladocerans were recorded in nursery beds in fair numbers in the Bagmati. In the upstream Gokarna contained common genera of Cladocera representing *Diaphanosoma*, *Siminocephalus*, *Daphnia*, *Ceriodaphania*, *Moina* and *Alona*.

Ostracoda

The population of Ostracods was poorly represented in the upper sections (upstream Gokarna) of the Bagmati. They were represented only by the genus *Stenocypris* and *Heterocypris*.

Copepoda

Common copepods inhibiting the Gokarna site were *Diaptomus* and *Neodiaptomus* which sustain the food chain of larval fish.

Table 2. Zooplanktons of Bagmatiriver (2011-2012).

Phylum	Class	Order	Family	Genus
Protozoa	Rhizopoda	Foraminifera		*Difflugia*
		Heliozoa		*Actinophrys*
		Hypotricha		*Stylonichia*
				Actoinobolus
				Neblia
Aschelminthes	Rotifera	Monogonontida	Brachionidae	*Brachionus*
				Conochilus
				Keratella
				Filinig
				Polyartha
				Pedalion
Phylum	Class	Sub-class	Family	Genus
Arthropoda	Crustacea	Cladocera	Daphnidae	*Daphnia*
				Diaphanosoma
				Siminocephalus
				Ceriodaphania
				Moina
				Alona
		Ostracoda		*Stenocypris*
				Heterocypris
		Copepoda		*Diaptomus*
				Neodiaptomus

Limnetic Vegetation

Many submerged plants flourish in the Bagmatiriver downstream of Sundarijal. In clay bottom areas with slow water current, aquatic plants were found to grow profusely. Among aquatic plants *Chara* (Figure 1), *Najas* (Figure 2), *Potamogeton*, *Vallisneria*, and *Hydrilla* were the most common. In some places, *Ranunculusaquatilis*, *Marshilia*, *Ceratophyllum* and *Cyperus* were frequently observed (Poudel 1998, Pradhan 1998).

Table 3. Limnetic vegetation of Bagmatiriver.

Division	Class	Subclass	Order	Family	Genus
Charophyta	Charophyceae		Charales	Characeae	*Chara*
Pteridophyta	Pteropsida		Filicales	Marsileaceae	*Marsilea*
		Monocotyledoneae		Potamogetanaceae	*Potamogeton*
		Monocotyledoneae	Hydrocharitales	Hydrocharitaceae	*HydrialVallisneria*
		Monocotyledoneae	Naiadales	Naiadaceae	*Naias*
		Monocotyledoneae	Cyperales	Cyperaceae	*Cyperus*
		Dicotypedoneae	Ranales	Ranunculaceae	*Ranunculus*
		Dicotypedoneae	Ranales	Ceratophyllaceae	*Ceratophyllum*

Figure 1. Chara.

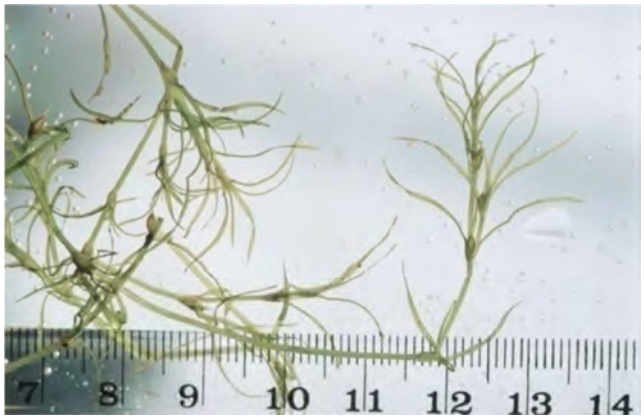

Figure 2. Najas.

Figure 3. Murrel fish.

Figure 4. Cat fish.

Benthic macro invertebrates

The results on the examinations of water for benthic fauna are given below. Taxa belonging to 5 invertebrate groups were recorded: insect nymphs/larvae (18 taxa), Oligochaete worms (3 taxa), leeches (3 taxa), snails (2 taxa) and bivalves (1 taxon) (Sharma 1997).

Insect nymphs/larvae were predominantly present in the Bagmatiriver and its tributaries. In particular, the blood worms (midge larvae, Chironomids) were recorded at all five sampling sites. Midge larvae are regarded as pollution-tolerant macro-invertebrate species. Their presence in the aquatic habitats combined with the absence of pollution sensitive species, i.e. mayflies (Ephemeropteran) and stoneflies (Plecoptera), reflected the poor water quality of river. These were recorded in Gokarna only.

Altogether 27 taxa were identified from five sampling sites of Bagmati River. Their population remarkably declined from Gokarna to Chovar. The taxa are *Acroneuria sp. (*Perlidae); *Alboglossiphonia heteroclite*; *Alboglossiphoniaweberi*; Aeshnidae; Amblemidae; Ampullariidae; Apataniidae; Ancylidae; *Allonaisparaguayensis*; *Amynthascorticis*; *Allonaisinaequalis*; *Asiaticobdella birmanica punyamataensis*; *Asiaticobdella birmanica birmanica*; *Asiaticobdella fuscolineta*; *Baetis sp.* (Baetidae); *Baetiella sp.* (Baetidae); *Barbronia wemeri*; *Barbronia nepalensis meghalayaensis* n. sp.; *Barbronia nepalensis nepalensis* n.sp.; *Barbronia wemeri*; Calamoceratida; *Calicneuria sp.* (Perlidae); Calamoceratidae; *Caridina cf. nilotica;* *Capniidae*; *Capniidae*; *Dendrodrilusrubidus*; *Derocooperi*; *Derodorsalis*; *Derodigitata* etc.

Table 4. Benthic macro invertebrate of Bagmatiriver.

Phylum	Class	Order	Family	Genus
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Baetis sp.* *Baetiella sp.*
			Caenidae	
			Heptageniidae(*Iron sp)*	
		Plecoptera	Perlidae	*Acroneuria sp.* *Calicneuria sp.*
		Trichoptera	Hydropsychidae	
			Glossosomatidae	
			Philopotamidae	

Phylum	Class	Order	Family	Genus
		Coleoptera	Elmidae	
			Hydrophilidae	
		Heteroptera	Apheloceriridae	
		Odonata	Gomphidae	
		Diptera	Simuliidae	
			Muscidae	
			Chironomidae	
			Psychodidae (white)	
			Ceratopogonidae	
			Limoniidae	
		Megaloptera	Corydlidae	
Annelida		Hirudinada	Salifidae	
		Plesiopora	Tubificidae	
Mollusca		Mesogastropoda	Physidae	

Fish population inBagmatiriver

Fish are poor indicators of water pollution than plankton, but present study shows a significant decline in their population.

Upstream of Gokarna the river is virtually pollution free and therefore, supports several fish species viz. snow trout (*Schizothorax*), sucker head fish (*Garra*), stone loach (*Nemacheilus*), Torrent Cat fish (*Glyptothorax*) (Rajbansi 1982).

As Bagmatiriver flows from Sundarijal to Nayapati it gets contaminated by domestic waste water. The water quality deteriorates further near Gokarna as effluent from carpet factories enters the river. Snow trout (*Schithoraxplagiostomus*) disappears in this area, but it is inhabited by sucker heads (*Garragotyla*).

As the river enters the urban areas of Kathmandu near Pashupatinath the Gausala water becomes much polluted with untreated domestic sewage. The sucker head also leaves the area. These areas are inhabited by more pollution resistant fish such as minnow, murrel (figure 3) and cat fish (figure 4). Pollution threatens even these hardy fish, which can be seen dying in the urban section of the river. After the dhobi khola, Bagmati turns almost septic and provides a poor niche for fish.

Further downstream, the Nakhukhola adds considerable amounts of water and dilutes highly polluted Bagmati. The presence of aquatic birds and fish is indicative of less polluted waters that the Nakhukhola contributes to the Bagmati. The river is still polluted, but fish such as murrel and cat fish reappear in this region (Tuladhar 1998, Upadhaya 1982).

Pollution in the Bagmatiriver subsides gradually after Chovar. Plankton and invertebrate life start reappearing and fish fries were observed in nursery beds of shallow water. Sucker heads reappear here, indicating improvement in the water quality.

Table 5. Dominant fishes of Bagmatiriver (2011-2012).

Phylum	Class	Order	Family	Genus
Chordata	Teleostomi	Cypriniformes	Cyprinidae	*Garragotyla*
				Schithoraxplagiostomus
		Cypriniformes	Cobitidae	*Nemacheilus*
		Siluriformes	Sisoridae	*Glyptothorax*

4. Conclusion

Though the river water having high biodiversity, due to polluted water the biodiversity is in danger which should be taken into account. Here are some recommendations for the solution for the regeneration of the rivers of Kathmandu valley: Conventional waste water treatment system, Small bore waste water treatment system, Onsite sanitation system, Ecological sanitation system, and Constructed wetland system. There is an urgent need to carefully regulate and control human activities, resource use, and waste disposal in order to improve the water quality in the Bagmati. This can best be accomplished in conjunction with improved environment planning and control and inter-sectoral coordination at national, and local levels.

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