Studies on Benthic Fauna with relation to physio chemical parameters in Betana Wetland, Morang, Nepal

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Abstract

This study examined the benthic fauna and its relation to the physic chemical parameters in Betana wetland, Morang, Nepal from December 2020 to May 2021. Over the course of six months, the study found two genera of Annelida (Hirudinea and Lumbricina), eight genera of Arthropoda (Macrobranchium, Chironomus, Cyclops, Cypridopsis, Blasturus, Diptera, Coeleptera, and Naupli), and four species of Mollusca (Bellamya bengalensis, Parreysia flavidens, Lamellidens marginalis, and Indoplanorbis exutus). Arthropods were more prevalent in the spring due to the increase in temperature. The average maximum water temperature was 23.66°C in the spring and the minimum was 20.25°C in the winter. The maximum soil temperature was 24.9°C in the spring and the minimum was 21.08°C in the winter. The pH was highest in the spring (7.67) and lowest in the winter (7.21). The highest dissolved oxygen (DO) was found in the winter (7.6 mg/l) and the lowest was in the spring (7 mg/l). The maximum free CO_2 was found in the spring (26.83 mg/l) and the minimum was in the winter (21.25 mg/l). Total alkalinity was highest in the spring (113 mg/l) and lowest in the winter (105 mg/l). Total hardness was highest in the spring (83.51 mg/l) and lowest in the winter (69.25 mg/l). Water temperature and soil temperature had a high correlation coefficient (0.93) with benthic fauna, while DO and pH showed a high negative correlation coefficient (-0.93 and -0.92), respectively.

Keywords: Benthic fauna, Mesh size, Macro invertebrates, Taxa.

Introduction

Benthic macroinvertebrates are small aquatic animals and insect larvae that live on the bottom of water bodies. They can be easily seen and often attach themselves to rocks, vegetation, logs, or burrow in sand and sediments. These creatures are used to assess the health of water bodies and are reliable indicators of pollution tolerance. Biologists have been studying benthic macroinvertebrate communities for decades, and their abundance and variety give insight into the biological condition of a water body. Healthy water bodies support a diverse range of macroinvertebrate taxa, while those with only pollution-tolerant species or low diversity may indicate an unhealthy water body.

Researchers such as Dhakal (2006), Chhetry and Pal (2012), Pokharel (2013), Ghimire et al., (2013), Mishra and Gupta (2015), Shrestha and Adhikari (2016), and Tachamo shah et al., (2020) have extensively studied the benthic fauna of Nepal. Benthic macroinvertebrates are small aquatic animals and insect larvae that live on the bottom of water bodies. They can be easily seen and often attach themselves to rocks, vegetation, logs, or burrow in sand and sediments. These creatures are used to assess the health of water bodies and are reliable indicators of pollution tolerance. Biologists have been studying benthic macroinvertebrate communities for decades, and their abundance and variety give insight into the biological condition of a water body. Healthy water bodies support a

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Materials and Methods

Study area

The Betana Wetland is located in Belbari municipality, Province No. 1, Morang, Nepal with coordinates of 26.65-26.66°N and 87.4-87.43°E, an elevation of 123 msl, and an area of 174.91 ha. The study was conducted for six months across four sites, namely sites 1-4, which were selected from W1 (three sites) and W2 (one site) of Betana Wetland (Fig1).
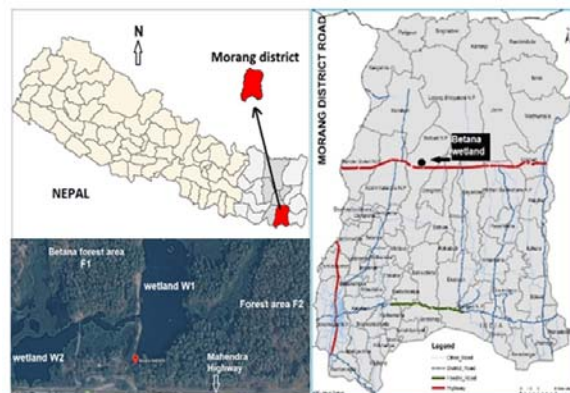
Site 1 is located at 26°39'33.8"N and 87°25'57.7"E with an elevation of 124 m. Site 2 is at 26°39'38.7"N and 87°25'57.9"E with an elevation of 135 m. Site 3 is at 26°39'37.7"N and 87°25'55.8"E with an elevation of 130 m, while site 4 is located at 26°39'36.4"N and 87°25'50.8"E with an elevation of 128 m. The wetland area is surrounded by Sal forest on the east, north, and west sides, while the East-West Highway is adjacent to the south.

The pond's depth ranges from 0.5 to 1.5 m in the dry season and 1 to 2.5 m in the monsoon season. The study area experiences a tropical monsoon climate, with winter, summer, and rainy seasons in a year. The soil type is alluvial, and the average annual temperature is 24.6°C. The average rainfall is 2256 mm per year, with about 90% of rainfall occurring within three months of the monsoon seasons (June, July, and August) (Kharel, 2018). The Betana Wetland is located in Belbari municipality, Province No. 1, Morang, Nepal with coordinates of 26.65-26.66°N and 87.4-87.43°E, an elevation of 123 msl, and an area of 174.91 ha. The study was conducted for six months across four sites, namely sites 1-4, which were selected from W1 (three sites) and W2 (one site) of Betana Wetland (Fig1).

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Figure1: Satellite map of Betana Wetland (Source- Kharel, 2018).

Sample collection

A total of 54 samples were collected from 3 different sites (3 samples from each site) of Betana wetland, monthly from December 2020 to May 2021.

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Data analysis

To analyze the benthic fauna, we referred to the works of Needham and Needham (1962), Adoni (1985) and APHA (2012) for qualitative analysis. For quantitative analysis, we counted the different species using either naked eyes or a compound

microscope. We picked up larger macro invertebrates with hand or forceps and put them in separate vials. We listed all the genera found in all habitats of the three sites and established a relationship between the abundance of benthic fauna and water parameters such as color, transparency, temperature, DO, pH, total hardness, and total alkalinity. We also determined the effect of physiochemical parameters on the abundance of benthic fauna using Karl Pearson's correlation coefficient and Chi-square test. Additionally, we measured standard deviation and used Microsoft Excel and statistical function of computer software for analysis.

Result and Discussion

The presence of 14 genera of taxa, 13 orders and seven classes of taxonomic group of organisms were recorded belonging to three phyla i.e. Annelida, Arthropoda and Mollusca (Tab. 1).

Table 1. Total genera, families, order and classes of benthic fauna reported from Betana wetland.

Phylum	Class	Order	Family	Scientific Name
Annelida	Clitellata	Archynchobdellida	Hirudinidae	*Hirudinea sp.*
Annelida	Clitellata	Haplotaxids	Lumbricidae	*Lumbricina sp.*
Arthropoda	Malacostracans	Decapods	Palaemonidae	*Macrobranchium sp.*
Arthropoda	Insecta	Diptera	Chironomidae	*Chironomas larvae*
Arthropoda	Hexanauplia	Cyclopoida	Cyclopidae	*Cyclops sp.*
Arthropoda	Insecta	Podocopoida	Cyprididae	*Cypridopsis sp.*
Arthropoda	Insecta	Ephemeroptera	Leptophlebiidae	*Blasturus sp.*
Arthropoda	Insecta	Odonata	Aeshnidae	*Anax sp.*
Arthropoda	Insecta	Coeleoptera	Carabidae	*Coeloptera*
Arthropoda	Crustacea	Copepoda	Cyclopidae	*Naupli sp.*
Mollusca	Gastropoda	Architaenioglossa	Viviparidae	*Bellamya bengalencis*
Mollusca	Gastropoda	Unionoida	Unionidae	*Parreysia flavidens*
Mollusca	Bivalves	Unionoida	Unionidae	*Lamellidens marginalis*
Mollusca	Gastropoda	Hygrophila	Planorbidae	*Indoplanorbis exustus*
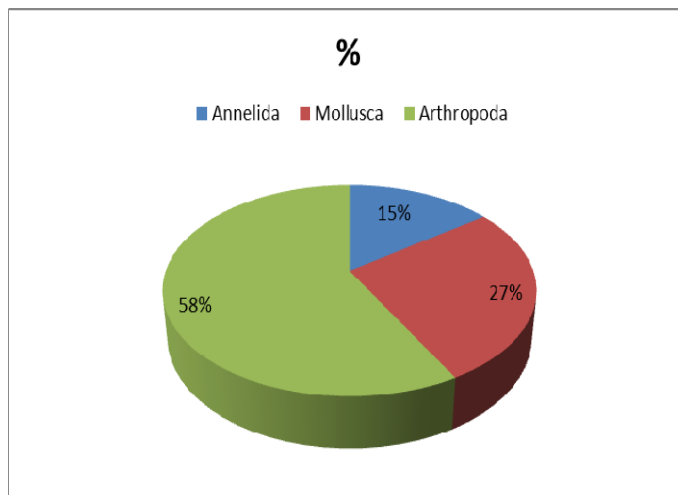
Figure 2. Phylum-wise representation of total benthic fauna of Betana wetland.

The pie chart displays the abundance of Arthropoda (58%), Mollusca (27%), and Annelida (15%) during a six-month study from December 2020 to June 2021. The pie chart displays the abundance of Arthropoda (58%), Mollusca (27%), and Annelida (15%) during a six-month study from December 2020 to June 2021. The pie chart displays the abundance of Arthropoda (58%), Mollusca (27%), and Annelida (15%) during a six-month study from December 2020 to June 2021. The pie chart displays the abundance of Arthropoda (58%), Mollusca (27%), and Annelida (15%) during a six-month study from December 2020 to June 2021.

Table 3- Availability of benthic animals in different months.

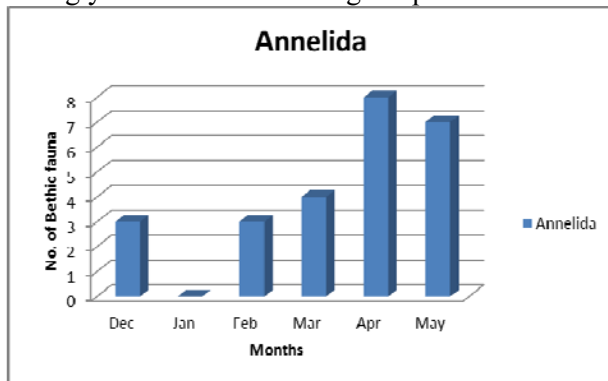| PHYLUM ↓	GENUS	MONTHS					
		Dec	Jan	Feb	Mar	Apr	May
Annelida	*Hirudinea*	✓	×	✓	✓	✓	✓
	Lumbricina	×	×	×	×	✓	✓
Arthropoda	*Macrobranchium*	✓	×	×	✓	✓	✓
	Chironomus	×	×	×	✓	✓	✓
	Cyclops	✓	×	✓	✓	✓	✓
	Cypridopsis	×	×	×	✓	✓	✓
	Blasturus	×	×	×	✓	✓	✓
	Anisoptera	✓	×	×	✓	✓	✓
	Coeleptera	×	×	×	✓	✓	✓
	Naupli	×	✓	×	×	✓	✓
Mollusca	*Bellamya*	✓	✓	×	✓	✓	✓
	Parreysia	✓	✓	✓	×	✓	✓
	Lamellidens	✓	×	✓	✓	✓	✓
	Indoplanorbis	✓	×	×	✓	✓	✓

✓   Indicates the presence of organisms.
×   Indicates the absence of organisms.

During the research on the benthic fauna of Betana Wetland in Morang, Nepal, 14 different genera of benthic fauna were observed. The highest number of genera were seen during April and May, with Arthropods being the most common. Among Arthropods, eight different genera were found, with Chironomus larvae and Blasturus being the most prevalent. Other Arthropods observed included Michrobranchium sp., Cyclops sp., Cypridopsis sp., Naupli sp., Odonota sp., and Coeleptera sp. Four genera of Mollusca were also observed. The least common animals found were Annelids, specifically Hirudinea and Lumbricina. Different species of Hirudinea were found, while *Lumbricina* was only observed in April and May. Two species of Unionoida were also seen, which were Parreysia flavidens and *Lamellidens marginalis*. The class Insecta had the highest number of species, followed by Gastropods. The annelids, Hirudinea, had the highest population throughout the study period, while Lumbricus and Indoplanorbis had the lowest. The larval stages of most species were more abundant in the spring season than winter, possibly due to the higher water temperature and availability of nutrients. It was also observed that the growth of aquatic insects was strongly correlated with rising temperatures. During the research on the benthic fauna of Betana Wetland in Morang, Nepal, 14 different genera of benthic fauna were observed. The highest number of genera were seen during

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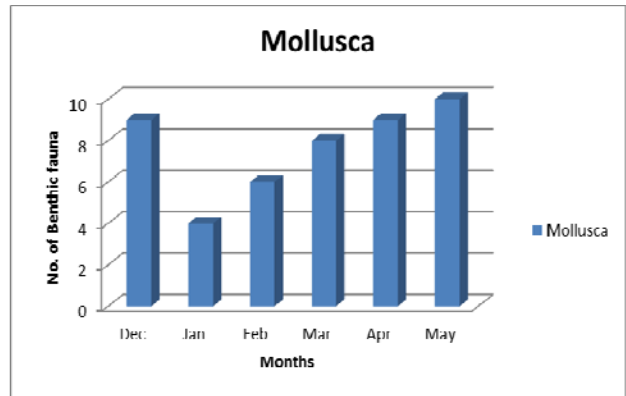

Figure3. Availability of Annelida in different months.
The abundance of Annelida was highest in the month of April and absence in January.
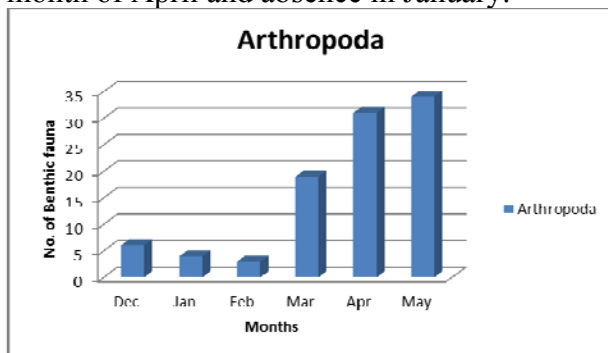
Figure4. Availability of Arthropoda in different months.
The abundance of Arthropoda was highest in the month of May and lowest in February

Figure5. Availability of Mollusca in different months.
The abundance of Mollusca was highest in May and lowest in January.

Table4- Monthly variation of benthic fauna.

Seasons	Months	No. of genera recorded
Winter	December	9
	January	5
	February	5
Spring	March	11
	April	14
	May	14

The highest genera of benthic fauna was found in Spring season on the months of April and May and the lowest was found in Winter season in the months of January and February.

Water parameters
According to Table 5, the average water temperature at Betana wetland was highest in May at 26°C and decreased to 19.75°C in January. The soil temperature had a maximum of 26°C in May and a minimum of 18.75°C in December.

The water parameter results showed fluctuations during the six-month study period (as seen in Tab. 1), which helped to identify variations in the wetland's flora and fauna. Water transparency was highest in February at 40.25, and lowest in December at 36. The maximum pH reading was 7.97 in January, while the minimum was 7 in May. DO had a maximum reading of 8 in January, and a minimum of 6.8 in May. Free CO_2 was highest in December and May at 28, and lowest in January at 12.5. Total alkalinity was highest in March at 129,

and lowest in January at 78. Total hardness was highest in May at 99.5 and lowest in January at 59.75. According to Table 5, the average water temperature at Betana wetland was highest in May at 26°C and decreased to 19.75°C in January. The soil temperature had a maximum of 26°C in May and a minimum of 18.75°C in December.

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Table5- Standard deviation values of different physico-chemical parameters with respect to different months.

Parameters	Months					
	December	January	February	March	April	May
Water colour	Clear	Clear	Clear	Clear	Brown	Brown
Water temperature	21±0.40	19.75±0.47	20±0	21±0.7	24±0.91	26±1.22
Soil temperature	18.75±1.48	21±0.7	22±2.4	23.5±1.65	25.2±2.02	26±1.58
Transparency	36±0.57	37.5±0.28	40.25±2.95	39.5±2.84	40±2.7	39±3.53
pH	7.35±0.40	7.97± 0.47	7.7±0.12	7.47±0.23	7.17 ± 0.37	7±0.50
Dissolved oxygen	7.22±0.19	8±0	7.8±0.23	7.3±0.15	7±0.50	6.8±0.25
Free CO_2	28±1.58	12.5±2.21	24±1.82	26±2.94	26.5±3.52	28±3.39
Total alkalinity	78±0.81	115.75±1.10	121±0.91	129±1.22	108±6.37	102±5.43
Total hardness	85±3.53	59.75±5.55	63±6.98	80.75±6.98	70.25±6.82	99.5±3.90

Table6- The average physico-chemical parameters in winter and spring seasons.

Physico-chemical Parameters	Seasons	
	Winter	Spring
Water colour	Clear	Brown
Water temperature (°C)	20.25	23.66
Soil temperature (°C)	21.08	24.9
Transparency (cm)	37.9	39.5
pH	7.67	7.21
DO (mg/l)	7.6	7

Contd….

Free CO_2 (mg/l)	21.25	26.83
Total alkalinity (mg/l)	105	113
Total hardness (mg/l)	69.25	83.51

Table7- Karl Pearson's Correlation coefficient of benthic fauna and physico- chemical parameters of Betana Wetland with probable error value P.

Water parameters	Correlation coefficient	P.E	Remarks
Water temperature	0.93	0.038	NS
Soil temperature	0.93	0.038	NS
Transparency	0.35	0.242	NS
pH	-0.92	0.043	NS
Dissolved Oxygen (DO)	-0.93	0.038	NS
Free CO_2	0.70	0.140	NS
Total alkalinity	-0.14	0.271	NS
Total hardness	0.68	0.148	NS

The water parameters like water temperature and soil temperature shows strong correlation with the benthic fauna and pH and DO shows strong negative correlation with benthic fauna as shown in Table7.

Statistical analysis.

Table 7- Chi-square test for significance of monthly variation in the number of genera found in wetland.

O	E	(O - E)	(O - E)²	$\dfrac{(O-E)^2}{E}$
9	9.66	0.66	0.43	0.044
5	9.66	-4.66	21.71	2.24
5	9.66	-4.66	21.71	2.24
11	9.66	1.34	1.79	0.18
14	9.66	4.34	18.83	1.94
14	9.66	4.34	18.83	1.94
EN =58				$x^2 = 8.58$

$$x^2{}_{cal} = \frac{(O-E)^2}{E} = 10.86$$

The tabulated value of x^2 at 25% level of significance for 25 d.f is 6.63.

The tabulated value of x^2 at 5% level of significance for 5 d.f is 11.070.

$x^2 0.05 = 11.070$

$x^2 0.25 = 6.63$

Based on the calculated value of Chi-sq., which is 8.58, it appears that there is no significant variation in the number of observed genera on a monthly basis. This is because it is less than the tabulated value at 5 degrees of freedom. However, when the calculated value was tested at a 25% level of

significance, it was found to be greater than the tabulated value. This suggests that there may be a significant variation in monthly observed number of genera after all. Based on the calculated value of Chi-sq., which is 8.58, it appears that there is no significant variation in the number of observed genera on a monthly basis. This is because it is less than the tabulated value at 5 degrees of freedom. However, when the calculated value was tested at a 25% level of significance, it was found to be greater than the tabulated value. This suggests that there may be a significant variation in monthly observed number of genera after all.

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