GASTROPODS AS MARKERS IN BABURA RIVER AT NORTH SUMATRA

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Abstract

Gastropod from the Babura river were taken by hand and an eckman grab. There were 6 research station, (I) in upstream areas, (II) after plantation areas, (III) after pig farm, (IV) after sand mining, (V) after settlements, and (VI) in downstream areas, sampling from March 2017 to January 2018. Gastropod samples were sent for identification to LIPI Cibinong so that the results obtained were more accurate. Diversity, similarity and dominance index of the gastropod spesies were determined. Data were sratistically verified by PCA using SAS 9.1.3 package. Gastropod community in the river consisted of : 6 genera, namely, (1) Pomacea, (2) Filopaludina, (3) Lymnaea, (4) Terebia, (5) Melanoides, (6) Thiara and 1 sub-genera, namely Clea (Anentome). Diversity at station 4 is low and at stations 2, 5, and 6 is moderate. Similirity at stations 3 to 6 is high. The dominance at stations 3, 5, and 6 is low and at station 4 is medium. Parameters that greatly affect the presence of each species of gastropods in the Babura River are: *Pomacea canaliculata* by DO, *Thiara scraba* by current flow, *Tarebia granifera* by BOD, *Melanoides tuberculata* by pH, *Lymneae rubiginosa* by current flow, *Filopaludina javanica* by temperature, and *Clea (Anentome)helena* by current flow. The gastropods markers in the Babura river are *Lymnaea rubiginosa* and *Clea (Anentome) helena*.

Keywords: Markers, dominance, gastropod, correlation and parameters.

Introduction

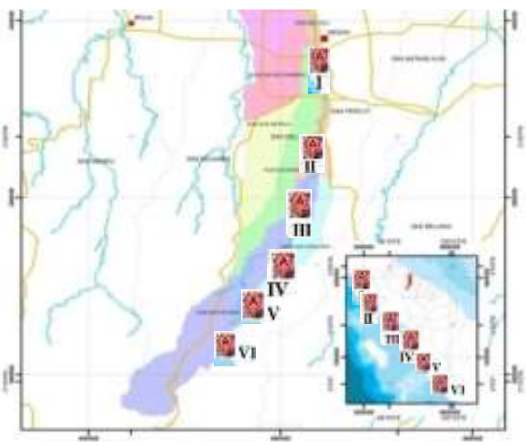
Gastropods play an important role in an ecosystem because of their ability as a filter feeder that filters dissolved substances in the water (Kushadiwijayanto *et al*, 2022) and can be used as a bioindicator of water quality because it is sensitive to water pollution (Afwanudin *et al*, 2019 & Harahap A,. 2021.). *Melanoide tuberculatus* has a high tolerance for environmental changes and is one of the invasive gastropods (Abdelhady *et al*, 2018). According to Sinambela *et al* (2019), 6 species of gastropods were found in the Babura river.

Babura river water comes from seeps, the upstream is located in the village of Keci-keci Bingkawang Sibolangit forest. The Babura River crosses the area of plantation, pig farms, sand mining, settlements, and downstream in Petisah, Medan city. The river has a long flow as the source of life by humans, like bathing, washing, and so on as a livelihood (Shinta *et al*, 2020 & Harahap, A., et all 2022). Currently, there have been many studies conducted on river water with the aim of monitoring and controlling water quality (Satar, 2017). This study aims to determine gastropod as markers in Babura river at North Sumatra.

Gastropod

Gastropods communities are the most diverse class of mollusc and considered as foremost constituent in the freshwater ecosystems (Hamli *et al*, 2020 & Harahap, A., et all 2022.). The occupied by gastropods have been continuously disrupted by various factors (Jung & Seuk, 2020). Gastropods can be life in the characteristics of waters are sand, muddy and muddy sand (Kushadiwijayanto *et al*, 2022 & K.Khairul, A Harahap, 2019), gastropods are also found in freshwater (Hamli *et al*, 2020). Gastropods include macrozoobenthos which can be observed with the naked eye (Moghdani *et al*, 2013). Ancient lakes in Sulawesi show cases of diversification of freshwater gastropod groups (Albrecht *et al*, 2020). Gastropods have developed a unique metabolite that acts as a potential competitive slug deterrent, (Raw et *et al*, 2015; Kushadiwijayanto *et al*, 2022).

Figure 1. Sampling Research Station on the Babura River



The Babura Watershed (DAS) administratively covers part of Deli Serdang Regency and the Medan city, covering an area of ± 4921.88 Ha, from upstream in Sibolangit District, Deli Serdang to downstream in Petisah Medan. Its up stream comes from springs and see pages from cliffs so that the water discharge is relatively small. In the middle part of Namorambe district, several sand excavations were found. The lower reaches of the Babura river is where it meets the Deli river (Narayan *et al*, 2023), (Narayan *et al*, 2022).

The research stations were detemined based on the environmental baseline, namely station I in the upstream area with coordinate point 3021'22.6"N 98035'34.3"E, station II after people's gardens with coordinate point 3024'13.0"LU 98037'17.9"E, station III after pig farming with coordinate point 3029'48.5"N 98039'11.8"E, station IV after sand mining with coordinate point 3024'52.6"N 98038'52.6"E, station V after settlement with coordinates point 3030'34.9"N 98039'31,5"BT, station VI in the city of Medan downstream area with coordinate point 3034'30.0"N 98040'08.0"BT (Figure 1), sampling from March 2017 to January 2018. Identification of gastropod to the Zoology laboratory of LIPI Cibinong Bogor (Sinambela *et al*, 2019) and analysis of water samples to BTKL in Medan city (Babu *et al*, 2020)

Data Analysis

Diversity index (H'), similarity index (E), and dominance (C) are searched based on the formula. To obtain more accurate results used PCA (Begon, 2006; Legendre & Legendre, 1998) using SAS 9.1.3 package.

The diversity index is calculated using the Shannon-Wiener formula (H')

$$H' = -\sum PiLnPi \quad (1)$$

Similirity Index (E)

The Similirity index is known by using the formula: $E = H' / H\max$ (2)

Dominance Index

Dominance is known by using the formula:

$$C = \sum (ni / N)^2 \quad (3)$$

Results and Discussion

Six genera gastropods found in the Babura river, namely, (1) Pomacea, (2) Filopaludina, (3) Lymnaea, (4) Terebia, (5) Melanoides, (6) Thiara and 1 sub genera, namely Clea (Anentom) (Table. 1). (Narayan *et al*, 2023).

Table 1. Classification of Gastropods in the Babura River to genera/sub-genera

Class	Ordo	Family	Genus	Sub genus	Species
Gastropoda	Architaenio Glossa	Ampulridae	Pomacea		*Pomacea Canaliculata*
		Viviparidae	Filopaludina		*Filopaludina Javanica*
	Higropila	Lymnaeidae	Lymnaea		*Lymnaea Rubiginosa*
	Caenogastropoda	Thiaridae	Terebia		*Terebia granifera*
			Melanoides		*Melanoides Tuberculata*
			Thiara		*Thiara scraba*
	Neogastropoda	Nassariidae	Clea (Anentome)	*Clea (Anentome) Helena*	Neogastropoda

Freshwater gastropods have 18 species from 14 genera and nine families, including four non-native species (Ng *et al*, 2017).

There are no molluscs that dominate on the Kabung island (Kushadiwijayanto *et al*, 2022).

Table 2. Diversity Index (H'), Similarity Indeks (E), and Dominance (D) of Gastropos at Sampling Station

No	Genera/sub genera	Sampling I	II	III	IV	V	VI	Total	Average
1.	Pomacea	-	-	-	-	6,00	14,38	20,38	3,40
2.	Filopaludina	-	-	-	-	5,25	2,88	8,13	1,35
3.	Lymnaea	-	-	-	0,38	-	-	0,38	0,06
4.	Tarebia	-	-	67,13	7,88	-	6,50	55,00	9,17
5.	Melanoides	-	-	57,75	3,50	22,50	2,75	86,50	14,42
6	Thiara	-	-	121,13	-	9,13	-	130,25	21,71
7.	Clea (Anentome)	-	-	-	0,50	-	-	0,50	0,08
	Total ($\sum Di$)	-	-	246,00	12,25	42,88	26,50	492,00	50,19
	Average	-	-	35,14	1,75	6,13	3,79		7,17
	Diversity Index (H')	-	-	1,03	0,87	1,18	1,13		

Similarity Index (E)	-	-	0,94	0,63	0,85	0,81
Dominance (C)	-	-	0,14	0,48	0,34	0,37

Diversity at station IV is low and at stations II, V, and VI is moderate. Similarity at stations III, IV, V, and VI is high. The dominance at stations III, V, and VI is low and at station IV is moderate.

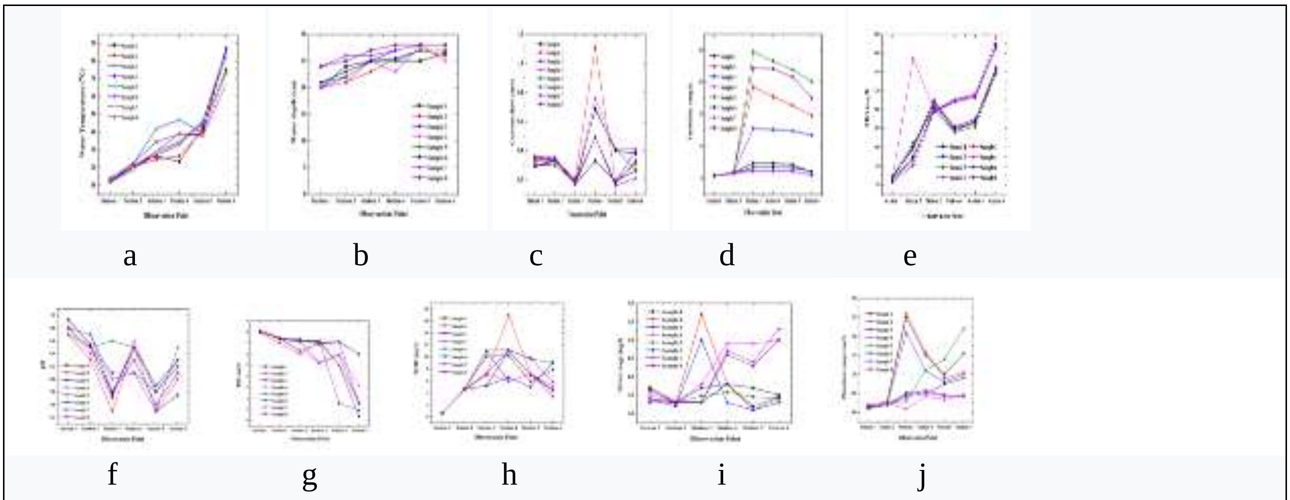
The substrate in the Babura river consists of sand, silt, and clay, with the percentage composition of the substrate as presented in Table 3.(Faiz *et al*. 2022).

Table 3. Type of Substrate in Babura River

Station	**Substrate %**			**Substrate Type**
	Sand	**Silt**	**Clay**	
I	86,80	9,7,80	3,29	Sand Clay
II	75,70	18,50	5,80	Sand Clay
III	78,70	11,30	9,90	Sand Clay
IV	6,20	45,80	44,40	Silt Clay
V	66,70	14,30	19,00	Silt Clay
VI	6,50	65,70	27,70	Silt Clay

The physical and chemical parameters contained in each station are presented in Figures 2.

The temperature in the Babura river is in the range of 20^0C -28^0C. There is no difference that fluctuates at each station. The highest temperature is at station IV and the lowest temperature is at station I (a). The depth in the Babura river are 11.6 cm -86.5 cm, the highest depth is at station VI and the lowest is at station I. At III and IV there is a difference in the third sampling, at station V overall there is very little difference, and at station VI there is a slight decrease. in the seventh sampling (b). Current floware 0.13 m/s-1.11 m/s, the highest current is at station IV and the lowest is at station III. At stations I, II, and III it is almost evenly distributed, at station IV in the second sampling more high, and at station VI there was a difference in current flow for each sampling (c). The turbidityare 0.70 mg/l-20.50 mg/l, at stations I and II it was evenly distributed for each sampling, at stations III to VI it increased in the 2, 3, 4, and 5 samplings. and 8, the highest at station III and the lowest at station I (d). TDS are 25 m/s-145 m/s, the highest TDS at station VI and the lowest is at station I. At station I there is a slight difference in each sampling, at station II it is very high in sampling 4, at station III there is only a slight difference, at stations IV, V, and VI there is an increase in sampling 1, 3, and 7 (e).



Figures 2. The physical and chemical parameters contained in each station

a. Diagram of water temperature (^{0}C), b. Diagram of water depth (cm), c. Diagram of current flow (m/dtk), d. Diagram turbidity (mg/l), e. Diagram, TDS (mg/l), f. D iagram pH, g. Diagram DO (mg/l), h. Diagram BOD (mg/l), i. Diagram Nitrate (mg/l), j. Diagram Phosphate (mg/l).

The pH are 5.5 to 6.93, each sampling is slightly different, the highest pH is at station II and the lowest is at station III (f). DO are 0.40 mg/l-8.12 mg/l, at stations III, IV, and V the difference was large, and at station VI the difference was striking. At stations I and II the DO was > 2 mg/l, at station V at the 8 sampling and at station IV at the third, 4, and 5 sampling the DO <2 mg/l, the highest DO is at station I and the lowest at station VI (f). The highest BOD is at station IV and the lowest is at station I (g). The nitrates are 0.10 mg/l-3.10 mg/l, the highest at station IV and the lowest at station II. At station I it is slightly different for each sampling, at station II it is almost evenly distributed, at stations III, IV, V, and VI different for each sampling (g). Phosphate was in the range of 0.10 mg/l-2.60 mg/l, the highest phosphate was at station IV and the lowest phosphate was at station II (Tyagi et al . 2023) .At stations III to VI there are differences in each sampling (h). The results of testing the hypothesis by species, that in each sampling there is no difference. The results of hypothesis testing based on stations during sampling, the significant difference was only at station III, namely, sampling 1, 3, 4, 5, 6, 7. The results of the hypothesis test of physical and chemical parameters, turbidity and nitrate showed significant differences in taking 1, 2, 3, 4, 5, and 6 Parichelra *et al.* 2022) .The correlation between physical and chemical parameters with the number of species is; (1) temperature, depth, turbidity, DO, nitrate, and phosphate with a very low correlation between the number of species, (2) TDS and BOD with a low correlation between the number of species, (3) current strength and pH with the number of species have an inverse correlation, which means if the current is high then the number of species is low and if the current is low then the number of species is large (Pramanik *et al.* 2021).

Relationship Between Each Parameter With Each Species

The test results for each parameter that affect each species, which are very significantly different, namely (1) temperature, depth, TDS to *Pomacea canaliculata*, (2) depth, pH, nitrate to *Filopaludina javanica*, (3) current flow to *Lymnaea rubiginosa*, (4) TDS to *Melanoides tuberculata*, (5) current flow and TDS to *Terebia granifera*, (6) current flow to *Thiara scraba* and *Clea (Anentome)helena*. While the significant differences were (1) nitrate to *Pomacea canaliculata*, (2) temperature to *Filopaludina javanica*, (3) turbidity to *Lymnaea rubiginosa*, (4) temperature, current flow, turbidity to *Melanoides tuberculata*, (5) depth to *Terebia granifera*, while DO, BOD, and phosphate have no effect. The test results for each parameter that affect each species, which are very significantly different are (1) temperature, depth, TDS to *Pomacea canaliculata*, (2) depth, pH, nitrate to *Filopaludina javanica*, (3) current flow to *Lymnaea rubiginosa*, (4) TDS to *Melanoides tuberculata*, (5) current flow and TDS to *Terebia granifera*, (6) current flow to *Thiara scraba*, and *Clea (Anentome)helena*, and the significant differences were (1) nitrate to *Pomacea canaliculata*, (2) temperature to *Filopaludina javanica*, (3) turbidity to *Lymnaea rubiginosa*, (4) temperature, current flow, turbidity to *Melanoides tuberculata*, (5) depth to *Terebia granifera*, while DO, BOD, and phosphate have no effect. *Lymnaea rubiginosa* and *Clea (Anentome)Helena* are found only at station IV so they are markers in the water of Babura river. According to Lomartire *et al*, 2021, the most widely used biomarkers are benthic organisms and fish, which provide a more specific indication of the stessor in the environment Srivastava *et al.* 2022),(Swaney et al. 2023).

Principal Component Analysis (PCA)

Parameters affecting gastropod species in the Babura river were then analyzed using PCA statistics. The diagram representing the distribution of gastropods on the F1 and F2 axes shows the presence of three groups. First, *Pomacea canaliculata* forms a positive F1 axis; second consists of *Filopaludina javanica*, *Lymnaea rubiginosa*, and *Clea (Anentome)helena*f form the negative F1 axis, and the third *Melanoides tuberculata* and *Terebia granifera* which contributes to the positive F2 axis. Based on the location of the distribution, *Lymnaea rubiginosa* and *Clea (Anentome) helena* have similarities because they form an angle that is <45^0, as well as between *Melanoides tuberculata* and *Terebia granifera*.

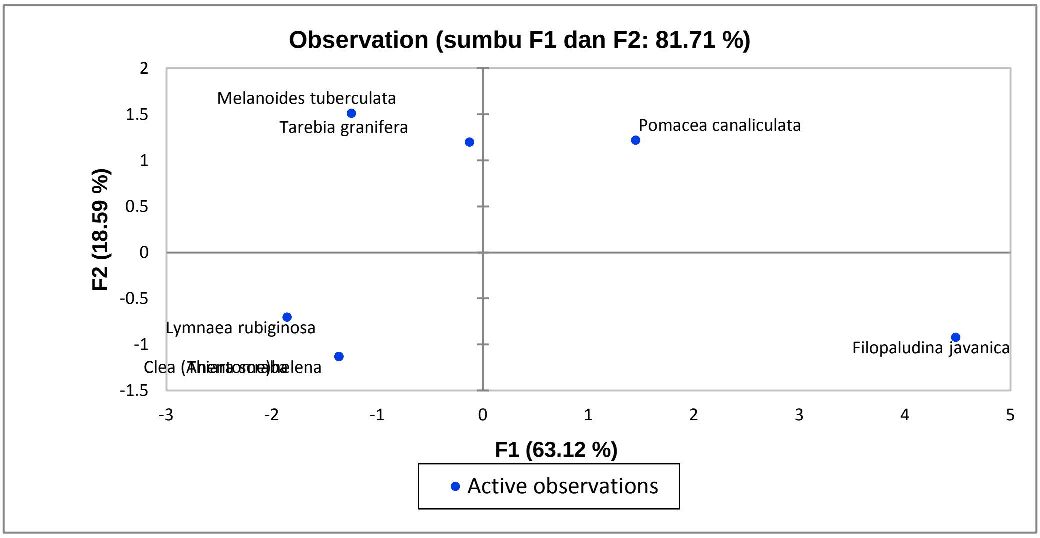


Figure 3. Grouping of Gastropods Based on PCA Analysis

The diagram representing the distribution of gastropods with the influence of pysical/chemical parameters on the F1 and F2 axes shows the presence of three groups of gastropods. *Pomacea canaliculata* is affected by TDS, temperature, and depth on the positive F1 axis; *Lymnaea rubiginosa* and *Clea (Anentome) helena* were affected by currents, flow, *Filopaludina javanica* was affected by nitrate and the pH on the F1 axis was negative, *Melanoides tuberculata* and *Terebia granifera* were affected by turbidity.

PCA results on axis 1 (F1) with an effect of 63.12% and axis 2 (F2) with an effect of 18.59%. The results of PCA on axis 1 (F1) with a diversity of 42.73% and axis 2 (F2) with a diversity of 23.58 % showed that the population of large and medium-sized lokan clams spread on a substrate of dust, clay and high organic matter and negatively correlated with conditions pH and temperature (Figure 4).

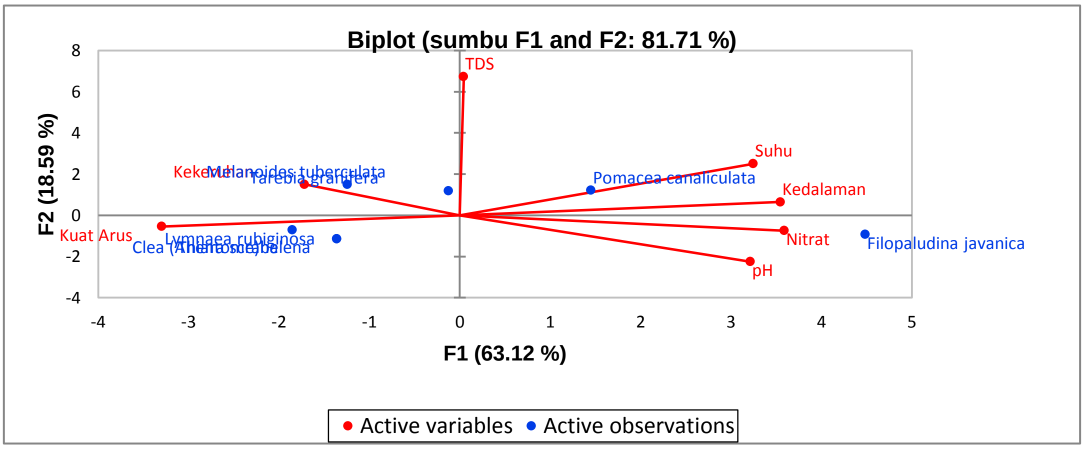


Figure 4 . Parameters Affecting Gastropods With PCA Analysis

There were 7 species of gastropods found in the Babura river, but not found at stations I and II, because the temperature ranged from 18^{0}C-20^{0}C. Gastropods were found 8 species in all station, as many as 5 researh station with temperature between 25.90^{0}C-26.77^{0}C (Moghdani *et al*,2013). There are two species, namely *Cassidula nucleus* and *Cassidula angulifera* (Ariyanto *et al* 2018), fewer than those in the Babura River. The larger number is 11 species from 8 families (Normalasari *et al*., 2019) the highest diversity index is as moderate, the dominance index level is no dominates (Afwanudin *et al*, 2019), 7 gnera, and from 6 families from 4 order (Hecca *et al*., 2017). According to (Tobing and Harahap (2021). the physical/chemical parameters in the Pandayangan river support gastropod life with 230 individuals consististing of 7 species found. Current flow in the Babura river is slow because the water discharge is small and has many turns but the number of species is small. *Terebia granifera* and *Melanoides tuberculata* were found at stations III, IV, and VI,. Where as at station V only *Melanoides tuberculata* was found, *Terebia granifera* was not found, in accordance with (Perissinotto *et al*., 2014) the two species did not coexist. There were three genera found because of their low substrate diversity, which will have an impact on food sources and habitat forb gastropods (Rahmayanti *et al*, 2018). The temperature increase in the present study might be due to the fact that the river segment on that stretch is more open (Chatanga, 2018). DO and water pH are physical and chemical parameters that affect the distribution and diversity of macrozoobenthos with a strong correlation category (0.776) (Dimenta *et al*., 2020). The statistical analysis with Principal component analysis (PCA) was calculated for measuring the affiliation between environmental variables and number of individuals in sampling sites (Rheca, 2021).

After PCA analysis, continued with multiple regression analysis, presenter in table 4-10.

Table 4. Determinant Coefficient of *Pomacea canaliculata*

No	Regression equation	Determinant coefficient (R2)
1	$Y = 17{,}15- 2{,}21X_7$	47,40%
2	$Y = 7{,}78- 1{,}35X_7 + 0{,}10X_2$	53,41%
3	$Y = 9{,}37- 1{,}45X_7 + 0{,}13X_2-0{,}02X_5$	54,07%
4	$Y = 5{,}04- 1{,}43X_7 + 0{,}12X_2-0{,}02X_5 + 0{,}19X_1$	54,39%
5	$Y = 6{,}11- 1{,}43X_7 + 0{,}12X_2-0{,}02X_5 + 0{,}13X_1 + 0{,}02X_4$	54,50%
6	$Y = 6{,}37- 1{,}41X_7 + 0{,}12X_2-0{,}02X_5 + 0{,}14X_1 + 0{,}02X_4-1{,}63X_3$	54,70%
7	$Y = 6{,}47- 1{,}41X_7 + 0{,}12X_2-0{,}02X_5 + 0{,}13X_1 + 0{,}02X_4-1{,}49X_3-0{,}08X_9$	54,72%
8	$Y = -37{,}70- 1{,}41X_7 + 0{,}10X_2 + 0{,}00X_5 + 0{,}50X_1 + 0{,}01X_4-6{,}29X_3-0{,}03X_9 + 5{,}63X_6$	61,83%
9	$Y = -46{,}50- 0{,}74X_7 + 0{,}06X_2 + 0{,}05X_5 + 0{,}94X_1 + 0{,}11X_4-2{,}98X_3 + 0{,}07X_9 + 4{,}63X_6 – 0{,}90X_8$	65,77%
10	$Y = -25{,}69- 0{,}83X_7 + 0{,}09X_2 + 0{,}03X_5 + 0{,}59X_1 + 0{,}12X_4 + 0{,}77X_3 + 1{,}54X_9 + 2{,}57X_6 – 0{,}77X_8 – 2{,}93X_{10}$	69,84%

Table 5. Determinant Coefficient of *Thiara scraba*

No	Regression equation	Determinant coefficient (R2)
1	$Y = 57{,}34- 102{,}45X_3$	12,82%
2	$Y = 237{,}36- 75{,}27X_3 – 30{,}19X_6$	17,96%
3	$Y = 65{,}80- 119{,}99X_3 – 5{,}94X_6 + 5{,}94X_8$	27,88%
4	$Y = 12{,}98- 143{,}19X_3+2{,}54X_6 + 5{,}66X_8 + 12{,}23X_{10}$	31,02%
5	$Y = 58{,}80- 146{,}93X_3 – 13{,}33X_6 + 5{,}33X_8 + 15{,}28X_{10} + 8{,}82X_7$	40,88%
6	$Y = 59{,}67- 147{,}01X_3 – 13{,}37X_6 + 5{,}36X_8 + 15{,}30X_{10} + 8{,}77X_7 – 0{,}00X_5$	40,88%
7	$Y = 58{,}24- 147{,}24X_3 – 13{,}15X_6 + 5{,}36X_8 + 15{,}66X_{10} + 8{,}77X_7 – 0{,}00X_5 – 0{,}34X_9$	40,89%
8	$Y = 49{,}20- 158{,}16X_3 – 8{,}43X_6 + 7{,}85X_8 + 16{,}99X_{10} + 6{,}54X_7 – 0{,}12X_5 – 1{,}00X_9 – 0{,}70X_4$	42,16%
9	$Y = 144{,}22- 155{,}28X_3 – 12{,}33X_6 + 8{,}93X_8 + 14{,}55X_{10} + 5{,}12X_7 – 0{,}13X_5 – 0{,}19X_9 – 0{,}65X_4 – 2{,}71X_1$	42,75%
10	$Y = 152{,}22- 154{,}58X_3 – 12{,}81X_6 + 9{,}14X_8 + 14{,}06X_{10} + 5{,}19X_7 – 0{,}16X_5 – 0{,}07X_9 – 0{,}67X_4 – 2{,}99X_1 + 0{,}08X_2$	42,78%

Table 6. Determinant Coefficient of *Tarebia granifera*

No	Regression equation	Determinant coefficient (R2)
1	$Y = -2{,}48+ 2{,}77X_8$	11,12%
2	$Y = 76{,}70+ 2{,}19X_8-12{,}08X_6$	14,19%
3	$Y = 6{,}86+ 3{,}49X_8 + 0{,}94X_6 – 56{,}40X_3$	24,23%
4	$Y = 23{,}00+ 3{,}77X_8-1{,}04X_6 – 56{,}88X_3-0{,}05X_5$	24,67%
5	$Y = 2{,}44+ 3{,}76X_8 + 2{,}57X_6 – 69{,}96X_3-0{,}08X_5 + 6{,}76X_{10}$	28,07%
6	$Y = 2{,}64+ 3{,}76X_8 + 2{,}54X_6 – 69{,}92X_3 + 0{,}08X_5 + 6{,}71X_{10}– 0{,}04X_9$	28,07%
7	$Y = -22{,}92+ 2{,}67X_8-0{,}06X_6 – 67{,}61X_3 + 0{,}11X_5 + 7{,}20X_{10}– 0{,}32X_9 + 4{,}81X_7$	33,73%
8	$Y = -26{,}92+ 3{,}77X_8 + 2{,}02X_6 – 72{,}44X_3 + 0{,}05X_5 + 7{,}79X_{10}– 0{,}61X_9 + 3{,}82X_7 – 0{,}31X_4$	34,65%
9	$Y = 32{,}31+ 4{,}45X_8-0{,}40X_6 – 70{,}65X_3 + 0{,}05X_5 + 6{,}26X_{10}– 0{,}11X_9 + 2{,}93X_7 – 0{,}27X_4 – 1{,}69X_1$	35,49%
10	$Y = 17{,}29+ 4{,}06X_8 + 0{,}49X_6 – 71{,}96X_3 + 0{,}11X_5 + 7{,}17X_{10}– 0{,}34X_9 + 2{,}79X_7 – 0{,}23X_4 – 1{,}18X_1 – 0{,}15X_2$	35,86%

Table 7. Determinant Coefficient of *Melanoides tuberculata*

No	Regression equation	Determinant coefficient (R2)
1	$Y = 163{,}46- 23{,}76X_6$	16,46%
2	$Y = 136{,}76- 17{,}38X_6 – 38{,}51X_3$	23,23%
3	$Y = 42{,}40- 4{,}04X_6 – 63{,}11X_3 + 3{,}26X_8$	36,40%
4	$Y = 102{,}16- 7{,}15X_6 – 63{,}68X_3 + 4{,}00X_8-1{,}77X_1$	38,07%
5	$Y = 100{,}42- 6{,}97X_6 – 63{,}94X_3 + 4{,}05X_8-1{,}75X_1 – 0{,}02X_4$	38,08%
6	$Y = 109{,}74- 10{,}04X_6 – 65{,}99X_3 + 4{,}67X_8-0{,}91X_1 – 0{,}12X_4 – 0{,}14X_5$	41,06%
7	$Y = 79{,}08- 6{,}76X_6 – 75{,}31X_3 + 4{,}63X_8-0{,}37X_1 – 0{,}17X_4 – 0{,}17X_5 + 4{,}56X_{10}$	42,78%
8	$Y = 86{,}63- 7{,}73X_6 – 74{,}23X_3 + 4{,}63X_8-0{,}44X_1 – 0{,}16X_4 – 0{,}18X_5 + 3{,}16X_{10} + 1{,}27X_9$	42,90%
9	$Y = 58{,}94- 6{,}32X_6 – 76{,}20X_3 + 3{,}88X_8 + 0{,}46X_1 – 0{,}08X_4 – 0{,}07X_5 + 4{,}71X_{10} + 0{,}87X_9 – 0{,}25X_2$	44,09%

10	$Y = 51,13- 6,56X_6 – 75,59X_3 + 3,60X_8 + 0,63X_1 – 0,05X_4 – 0,04X_5 + 4,82X_{10} + 0,82X_9 – 0,25X_2 + 0,64X_7$	44,17%

Table 8. Determinant Coefficient of *Lymnaea rubiginosa*

No	Regression equation	Determinant coefficient (R2)
1	$Y = -0,28+ 0,99X_3$	34,57%
2	$Y = -0,36+ 0,92X_3 + 0,01X_8$	37,87%
3	$Y = -0,36+ 0,92X_3 + 0,01X_8 – 0,00X_4$	37,94%
4	$Y = -0,36+ 0,96X_3 + 0,02X_8 – 0,00X_4 – 0,04X_{10}$	39,10%
5	$Y = -0,22+ 0,95X_3 + 0,02X_8 – 0,00X_4 – 0,04X_{10} – 0,00X_1$	39,23%
6	$Y = -0,06+ 0,96X_3 + 0,02X_8 – 0,00X_4 – 0,04X_{10} – 0,01X_1 – 0,00X_7$	39,41%
7	$Y = -0,06+ 0,95X_3 + 0,02X_8 – 0,00X_4 – 0,04X_{10} – 0,00X_1 – 0,01X_7-0,00X_2$	39,51%
8	$Y = 1,34+ 1,18X_3 + 0,01X_8+0,00X_4 – 0,06X_{10} – 0,01X_1 – 0,00X_7-0,00X_2 – 0,19X_6$	42,93%
9	$Y = 1,27+ 1,17X_3 + 0,01X_8+0,00X_4 – 0,05X_{10} – 0,01X_1 – 0,00X_7-0,00X_2 – 0,18X_6 – 0,01X_9$	43,01%
10	$Y = 1,60+ 1,16X_3 + 0,03X_8 – 0,00X_4 – 0,06X_{10} – 0,02X_1 – 0,01X_7 + 0,00X_2 – 0,20X_6 – 0,00X_9 – 0,00X_5$	43,72%

Table 9. Determinant Coefficient of *Filopaludina javanica*

No	Regression equation	Determinant coefficient (R2)
1	$Y = -12,17+ 0,54X_1$	22,10%
2	$Y = -11,61+ 0,51X_1 – 0,005X_2$	22,21%
3	$Y = -11,64+ 0,51X_1+0,00X_2-0,00X_5$	22,25%
4	$Y = -14,38+ 0,66X_1 – 0,00X_2 + 0,00X_5 – 0,17X_8$	24,10%
5	$Y = -21,80+ 0,79X_1+0,00X_2 + 0,01X_5 – 0,31X_8 + 0,50X_7$	28,34%
6	$Y = -22,16+ 0,80X_1+0,00X_2 + 0,02X_5 – 0,36X_8 + 0,54X_7 +0,01X_4$	28,51%
7	$Y = -21,21+ 0,78X_1+0,00X_2 + 0,02X_5 – 0,32X_8 + 0,52X_7 +0,01X_4 – 1,14X_3$	28,96%
8	$Y = -21,88+ 0,81X_1+0,00X_2 + 0,01X_5 – 0,34X_8 + 0,52X_7 +0,01X_4 – 1,53X_3 + 0,29X_9$	30,05%
9	$Y = 36,82+ 0,90X_1 – 0,00X_2 + 0,02X_5 – 0,23X_8 + 0,45X_7 – 0,00X_4 – 3,65X_3 + 0,30X_9 + 2,15X_6$	35,02%
10	$Y = -37,64+ 0,91X_1 – 0,00X_2 + 0,02X_5 – 0,24X_8 + 0,45X_7 – 0,00X_4 – 3,80X_3 + 0,24X_9 + 2,23X_6 + 0,11X_{10}$	35,05%

Table 10. Determinant Coefficient of *Clea(Anentome)helena*

No	Regression equation	Determinant coefficient (R2)
1	$Y = -0,27+ 0,90X_3$	35,47%
2	$Y = -0,31+ 0,87X_3 + 0,008X_8$	36,42%
3	$Y = -0,30+ 0,89X_3 + 0,001X_8 + 0,003X_4$	37,64%
4	$Y = -0,30+ 0,91X_3 + 0,002X_8 + 0,003X_4-0,02X_{10}$	37,97%
5	$Y = 0,70+ 1,12X_3-0,008X_8 + 0,004X_4-0,04X_{10} – 0,16X_6$	41,40%
6	$Y = 0,83 + 1,11X_3 - 0,007X_8 + 0,004X_4 - 0,03X_{10} – 0,17X_6 – 0,001X_2$	41,91%
7	$Y = 0,83+ 1,11X_3-0,007X_8 + 0,004X_4-0,03X_{10} – 0,17X_6 – 0,00X_2+0,001X_7$	41,91%
8	$Y = 0,83+ 1,11X_3-0,007X_8 + 0,004X_4-0,03X_{10} – 0,17X_6 – 0,00X_2+0,00X_7 – 0,00X_5$	41,91%
9	$Y = 1,54+ 1,13X_3 + 0,002X_8 + 0,004X_4-0,04X_{10} – 0,20X_6+0,00X_2 – 0,007X_7 – 0,00X_5 – 0,02X_1$	43,04%
10	$Y = 1,23+ 1,09X_3 + 0,001X_8 + 0,004X_4 + 0,001X_{10} – 0,17X_6 – 0,00X_2 – 0,006X_7 – 0,00X_5 – 0,01X_1 – 0,04X_9$	44,25%

Description: temperature (X1), depth (X2), current flow (X3), turbidity (X4), TDS (X5), pH (X6), DO (X7), BOD (X8), nitrate (X9), phosphate (X10), number of spesies (Y)

Based on multiple regression analysis, the determinat coefficient of *Pomacea canaliculata* ranged from 14.6%-40.89%, *Thiara scraba* ranged from 12.82%-35.86%, *Tarebia granifera* ranged from 11.12%-35.86%, *Melanoides tuberculata* ranged from 16.46%-44.17%, *Lymneae rubiginosa* ranged from 4.57%-43.72%, *Filopaludina javanica* ranged from 22.10%-35.05%, Clea (Anentome)helena ranged from 35.47%-44.25%.

From table 4-10, it can be seen that the order of the variable X (physical/chemical parameters) from the highest to the lowest, which can affect each gastropod species found in the Babura river.

Conclusion

Gastropod community in the river consisted of : 6 genera, namely, (1) Pomacea, (2) Filopaludina, (3) Lymnaea, (4) Terebia, (5) Melanoides, (6) Thiara and 1 sub-genera, namely Clea (Anentome). Diversity at station 4 is low and at stations 2, 5, and 6 is moderate. Similirity at stations 3 to 6 is high. The dominance at stations 3, 5, and 6 is low and at station 4 is medium. Parameters that greatly affect the presence of each species of gastropods in the Babura River are: *Pomacea canaliculata* by DO, *Thiara scraba* by current flow, *Tarebia granifera* by BOD, *Melanoides tuberculata* by pH, *Lymneae rubiginosa* by current flow, *Filopaludina javanica* by temperature, and *Clea (Anentome)helena* by current flow. The gastropods markers in the Babura river are *Lymnaea rubiginosa* and *Clea (Anentome)helena*.

Recommendations

We recommend the extend observed station and also the chemical parameters which are possible influence the gastropod properties. We also recommend the other river like the Deli's river in order to know the properties of gastropod.

Ethical clearance

The methodology of sampling caused no harm to the environment and the associated fauna and flora in Babura River.

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