International Journal of Fisheries and Aquatic Studies 2018; 6(1): 31-36

E-ISSN: 2347-5129
P-ISSN: 2394-0506
(ICV-Poland) Impact Value: 5.62
(GIF) Impact Factor: 0.549
IJFAS 2018; 6(1): 31-36

www.fisheriesjournal.com
Received: 15-11-2017
Accepted: 17-12-2017

Aeron D Mayor
Bureau of Fisheries and Aquatic Resources Region 02, Carig, Tuguegarao City, Cagayan, Philippines

Nico Jayson C Anastacio
Center for Strategic Planning and Policy Studies, College of Public Affairs and Development University of the Philippines Los Baños, College, Los Baños, Laguna, Philippines

Rico C Ancog
School of Environmental Science and Management, University of the Philippines Los Baños, College, Los Baños, Laguna, Philippines

Correspondence
Aeron D Mayor
Bureau of Fisheries and Aquatic Resources Region 02, Carig, Tuguegarao City, Cagayan, Philippines

Food diet of freshwater clam (*Batissa violacea*, Corbiculidae) (Bivalvia) (Lamarck, 1818) in Cagayan River, Northern Philippines

Aeron D Mayor, Nico Jayson C Anastacio and Rico C Ancog

Abstract
This study presents an analysis on the food diet of *Batissa violacea* – a threatened indigenous non-marine edible mollusk, in the largest river ecosystem in the Philippines. The *B. violacea* samples were collected along the Cagayan River using a dredging equipment locally known *"Tako"*. A 240 samples out from collected 1,510 *B. violacea* were dissected and food organisms were estimated using gut analysis. The food diet of *B. violacea* is composed of 80-90% detritus and 10-20% food items such as green algae (35.83%), diatoms (33.13%), euglenophyceae (3.22%) and cryptophyceae (1.94%). These food items could be acquired by the bivalves through suspension feeding and deposit feeding. To ensure success in fishery development on breeding and production of *B. violacea* to replenish natural stocks in Cagayan River and in the prospect of venturing to aquaculture production of *B. violacea* in the future, sufficient supply of these identified food items must be ensured.

Keywords: *Batissa violacea*; food diet; gut content; Cagayan River

1. Introduction

The *Batissa violacea* is a non-marine edible mollusk indigenous in the Cagayan River, Northern Philippines reported to also occur across the western Pacific including Malaysia, Indonesia, Northwestern Australia, Fiji, and Papua New Guinea [14, 15, 16, 18, 26, 31]. The clam can be found on the sandy or muddy beds of rivers, in fresh and brackish, often running water and to almost freshwater areas of mangrove swamp [7, 15, 16, 24].

In the Philippines, the populations of *B. violacea* stocks in the Cagayan River have dwindled due to over-harvesting [13]. The highest *B. violacea* production of 75.00 MT was in 2003 and declined continuously up to 21.95 MT in 2012 [6, 15, 16]. This was the reason of the Bureau of Fisheries and Aquatic Resources (BFAR) Region 02 in categorizing the *B. violacea* as a threatened species in Cagayan River in 2013 [15, 16]. Hence, conservation and species management of *B. violacea* in Cagayan River is urgently needed. However, the incomplete understanding of the feeding ecology of freshwater bivalves, particularly in its preferred food items, impedes successful conservation efforts [25]. For instance, the bivalve conservation efforts have included translocation but mortality rates have averaged to ~50% [8, 25]. Likewise, captive bivalve rearing programs show highly variable survival rates [9, 25].

The *B. violacea* are filter feeders and are important members of the suspension-feeding fauna [11]. They are free living clams, burrowing to a depth of 10 cm to 15 cm in river beds and capable of substantial movement [14, 15, 18, 26, 31]. This burrowing activity is an adaptive strategy used to gain access to water from moist sediments during droughts [15, 16, 18, 31]. This natural behavioral capability also enables *B. violacea* to migrate and survive in estuarine and subsequently lacustrine environments [15, 16, 18, 31].

In Northern Philippines, with only few studies on *B. violacea* so far been conducted [13, 15, 16, 17], the food sources of wild *B. violacea* in Cagayan River is still unknown. Thus, this study aims to determine the food sources of wild *B. violacea* in Cagayan River to be used as an input to the conservation and management efforts of the bivalves. In particular, this could be used for future fishery development on breeding and production of the clam in captivity to replenish natural stocks in the river and when venturing to aquaculture production of *B. violacea*.

2. Materials and Methods
2.1 Sampling areas
The *B. violacea* has been collected using a dredging equipment locally known as *"Tako"* in the identified major harvesting areas of *B. violacea* in Cagayan River, Northern Philippines (Figure 1). The clams were collected during its abundance from the month of June to August 2014 [16] from the six sampling stations along the downstream area of Cagayan River where the *B. violacea* are reportedly found. The average distance between stations is approximately 3.3 km with a range of 1.8 km to 6.4 km. The stations were assigned along the stretch of the river covered by three municipalities of Cagayan province where the *B. violacea* only thrive. The selections of sampling stations and transect lines considered the typical sandy-substrate habitat of *B. violacea* and the dredgeable areas of the river.

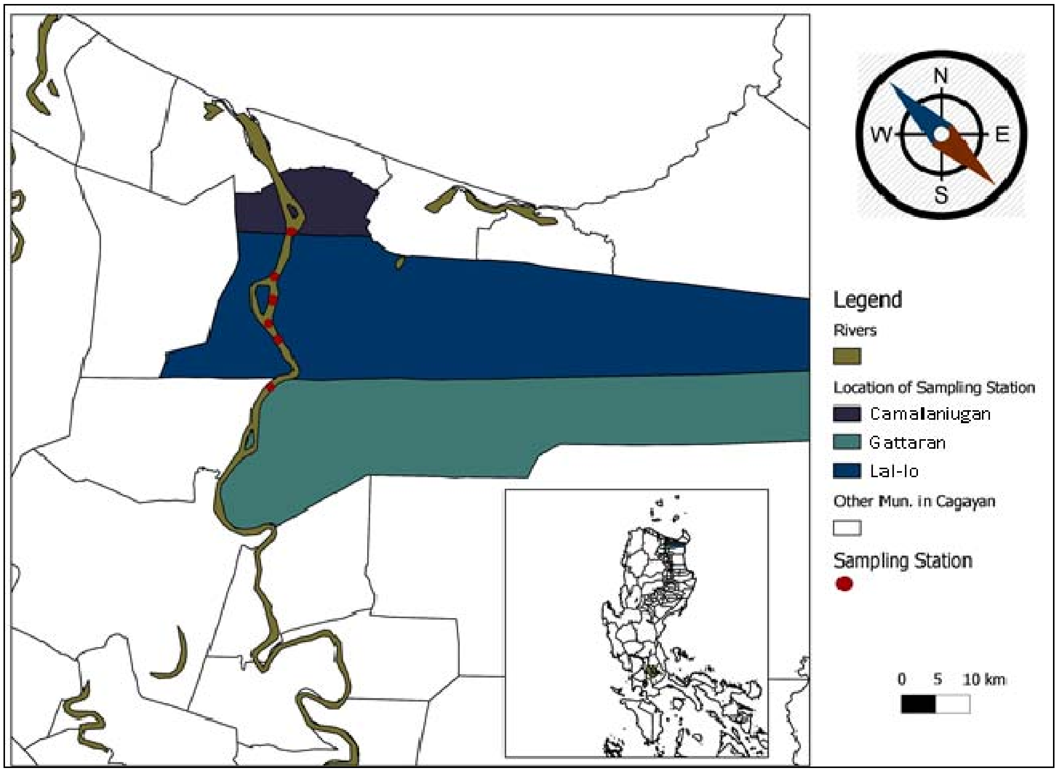

Fig 1: Sampling site of the study along the Cagayan River Basin

The presence of *B. violacea* in the selected sampling stations was validated on field by key informants. Coordinates of each sampling station were taken using a Global Positioning System (GPS) and was likewise photo documented. Six transect line replicates were laid out along a 50m length in each station parallel to the river [15, 17]. Collection of *B. violacea* was done on each of the six sampling stations namely: Station 1 = Aguiguican, Gattaran (18°6'10.98" N - 121°39'20.48" E); Station 2 = Sta. Maria, Lallo (18°8'16.84" N - 121°39'50.29" E); Station 3 = San Lorenzo, Lallo (18°9'5.93" N - 121°39'13.38" E); Station 4 = Catayauan, Lallo (18°10'11.89" N - 121°39'5.72" E); Station 5 = Tucalana, Lallo (18°11'16.97" N - 121°39'33.62" E); and Station 6 = Jurisdiction, Camalaniugan (18°14'40.53" N - 121°40'22.87" E) (Fig. 1.).

2.2 Gut content analysis
A randomly selected 240 samples (40 clam each station) from collected 1,510 *B. violacea* were dissected in the laboratory to estimate food organism of the clam using gut content analysis. The *B. violacea* specimens exhibited a size range of 13mm-85.50mm. The clams were shucked and the intestines were removed. These contents were placed into a petri dish with 70% alcohol.

A 20% portion of the gut was placed in the hemacytometer cell counting slide stained with mythelene blue to provide contrasts. This was scanned under the electronic microscope to identify food items. The counted microorganisms from the 20% portion of gut were multiplied to the remaining 80% gut to estimate the complete gut content of the bivalve. Gut contents were identified to order and family using the taxonomic keys of freshwater algae [1, 2, 3]. The number of phytoplankton cells was determined and the result was expressed as percentage.

3. Results and Discussion
3.1 Food diet of *B. violacea*
The gut content of the clam was 80-90% sediments and detritus and only 10-20% was composed of different food items (Table 1; Figure 2). A total of 1,337 food items of *B. violacea* were estimated in this study, which is comprised of green algae (35.83%) as the most dominant species with *Chlorella* spp. (15.56%) as the most common species across stations, and followed by *Oedogonium* spp. (10.32%). A total of 13 species of diatoms were likewise noted accounting for 33.13%, and with *Brachysira* spp. (6.36%) as the most dominant species across stations. The blue green algae accounted for 4.34% in the gut and intestine of the clam while Euglenophyceae and Cryptophyceae accounted for 3.22% and 1.94% respectively. The remaining 21.54% content of the gut were composed of unidentified structures and species.

Table 1: The microalgae and other food items found in the gut of *B. violacea*

Food Item	Stations (n=240)						Total	%
	1 (n=40)	2 (n=40)	3 (n=40)	4 (n=40)	5 (n=40)	6 (n=40)		
Chlorophyceae								*35.83*
Oedogonium spp.	6	22	10	35	20	45	138	10.32
Ankistrodesmus spp.	5	20	7	11	5	15	63	4.71
Chlorella spp.	16	36	23	41	30	62	208	15.56
Cosmarium spp.	0	10	5	5	5	10	35	2.62
Selenastrum spp.	0	0	5	0	0	30	35	2.62
Bacillariophyceae								*33.14*
Navicula spp.	5	9	7	13	5	15	54	4.04
Meridion spp.	0	6	5	8	0	6	25	1.87
Synedra spp.	0	5	5	10	6	6	32	2.39
Gyrosigma spp.	0	0	6	0	11	15	32	2.39
Cymbella spp.	0	7	5	15	5	15	47	3.52
Pinnularia spp.	0	5	5	10	5	10	35	2.62
Melosira spp.	0	0	5	0	0	8	13	0.97
Fragilaria spp.	0	15	5	15	6	13	54	4.04
Surirella spp.	0	0	0	5	0	6	11	0.82
Cocconeis spp.	0	0	0	6	0	0	6	0.45
Nitzschia spp.	0	0	12	5	0	10	27	2.02
Brachysira spp.	6	17	12	20	7	23	85	6.36
Eunotia spp.	0	5	5	0	0	12	22	1.65
Cryptophyceae								*1.94*
Cryptomonas spp.	0	5	5	5	5	6	26	1.94
Euglenophyceae								*3.22*
Euglena spp.	0	0	0	9	5	7	21	1.57
Trachelomonas spp.	0	7	5	5	0	5	22	1.65
Cyanophyceae								*4.34*
Gomphosphaeria spp.	0	5	5	6	5	8	29	2.17
Gloeocapsa spp.	0	7	0	0	5	12	24	1.80
Rivulria spp./*Calothrix* spp.	0	0	0	5	0	0	5	0.37
Unidentified species/structures	32	58	47	55	43	53	288	21.54
Total	70	239	184	284	168	392	1,337	100

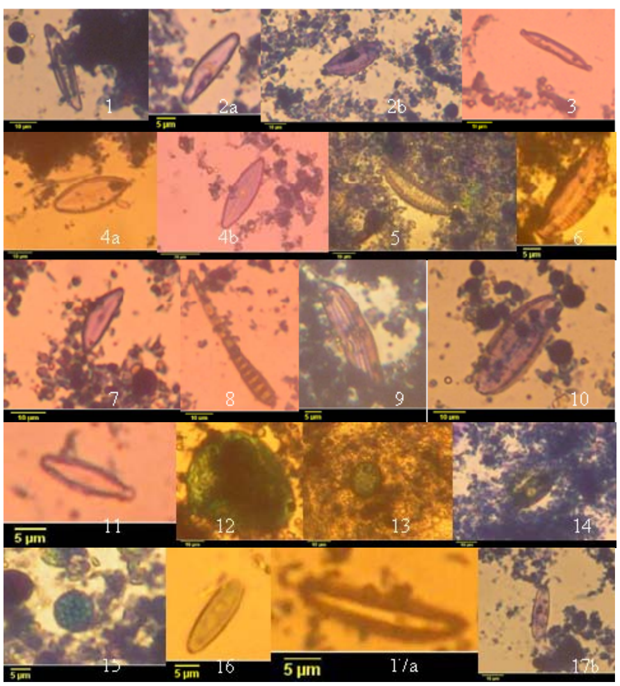

Fig 2: Plankton species found in the gut of *B. violacea.* 1.) *Gyrosigma* spp. 2a.) and 2b.) *Navicula* spp, 3.) *Nitzschia* spp. 4a.) and 4b.) *Brachysira* spp., 5.) *Eunotia* spp. 6.) *Cocconeis* spp. 7.) *Cymbella* spp. 8.) *Meridion* spp. 9.) *Pinnularia* spp. 10.) *Surirella* spp. 11.) *Fragillaria* spp. 12.) *Chlorella* spp. 13.) *Gloeocapsa* spp. 14.) *Cosmarium* spp. 15.) *Gomphosphaeria* spp.16.) *Ankistrodesmus* spp. 17a.) and 17b.) *Euglena* spp.

Sediments and detritus are the main component of food items in the gut of wild-caught *B. violacea* which shows that the clam feed more on organic matter, while different microorganisms serve as minor food source (Table 1.). This observation conforms to the results of earlier studies noting that diet of freshwater bivalves chiefly consist of fine organic detritus dislodged from the substrate and with phytoplankton having minor importance [25].

The food diet consumed by bivalve could not have been only acquired through suspension feeding (removal of suspended particles including phytoplankton from the water column) but also through deposit feeding (consumption of particles from the sediment) given that the bivalve exhibits burrowing activity [14, 15, 16, 18, 31]. This burrowing activity of the bivalve has been used in previous studies to describe the deposit-feeding mode of sphaeriids bivalves within specific context in which direct feeding upon sediment by adults is not usually considered to be typical [17, 25].

Nevertheless, the presence of planktons and other microorganisms in the diet of *B. violacea* also conformed to previous studies indicating that suspension-feeding bivalves can consume zooplankton as well as phytoplankton as part of their diet [5]. For instance, the observed number of diatom species in this current study was consistent with previous study on the analysis of gut content of *Anadara tuberculosa* (Sowerby, 1833) [20]. A total of 102 food items in which 917 corresponded to diatoms (91.5%) was recorded [20]. Also, the presence of different food items of the clam was similar to the recent findings that different microorganisms such as coccal bacteria, spirochetes, monadoid algae, diatoms (*Fragilaria*, *Navicula*, *Pinularia*, *Tabelaria*), green algae (*Scenedesmus*, *Coelastrum*, *Eudorina* sp., *Pediastrum simplex*, *P. duplex*, *Volvox* sp.), Zygnematophycae (*Closterium*, *Zygnema*, *Cosmarium*), ciliophores (in particular Oligotrichea) and euglenophytes were found in the gut of freshwater bivalves *Sphaerium corneum, S. rivicola*, *Pisidium supinum*, *P. casertanum S. nucleus, P. milium* [12].

The *B. violacea* are filter feeders and are important members of the suspension-feeding fauna. Normally, the clams lie buried in the substrate with only the siphons communicating with the sediment surface. Like other filter-feeder bivalves (e.g *M. mercenaria,*), specialized gill cilia draw a respiratory feeding current down the inhalant siphon, through the gills, and out the exhalent siphon. Food particles brought in by the inhalant stream are filtered out by cilia, trapped in mucus strings, and transported to the labial palps, where the material is sorted by size. Material rejected (pseudofeces) from the sorting cilia on the gills or labial palps is concentrated near the base of the inhalant siphon and periodically ejected by forceful closing (adduction) of the valves. The sensory tentacles on the inhalent siphon can reduce the aperture to limit the inhalation of sediment [27].

Bivalves are important in benthic-pelagic coupling, grazing of primary production, transfer of carbon and nitrogen to benthic food chains and through excretion and in rapid recycling particulate nitrogen as ammonia [27]. Studies about the feeding habits of benthic species may provide a unique opportunity to determine not only their role in energy transformation between benthic and pelagic environments, but also the relationship between these two layers in terms of suspended particles [19, 20, 28]. Hence, incomplete understanding of the feeding ecology of freshwater bivalves impedes successful conservation efforts [25].

3.2 Frequency and distribution of food diet of *B. violacea*

The frequency and distribution of twenty-one (21) microalgae species out from 25 total food items of *B. violacea* were found to be significantly different (p<0.05; p<0.025; p<0.010) across stations. These microalgae species are the 12 species of Bacillariophyceae or diatoms; 5 species of Chlorophyceae; 1 species of Euglenophycea; 2 species of Cyanophyceae; and unidentified species. The highest species number of diatoms among microalgae food items was in station 6 than in station 1 that could possibly be explained by sedimentation in station 1 which can be seen to its highest TSS value (728.88 mg/L) as compared to station 6 (573.64 mg/L) [16]. Such river sedimentation has negative effects to diatom assemblages and species diversity [10, 29].

Post Hoc test using Tukey HSD shows that species frequency and distribution of microalgae food items of *B. violacea* significantly varied (p<0.05; p<0.025; p< 0.010) across stations (Table 2). Thirteen (13) species of microalgae food items of *B. violacea* significantly varied between station 1 and 6. This is the highest number of microalgae species that significantly varied between these stations, followed by between station 1 and 4 with 9 species of microalgae; between station 4 and 6 as well as station 5 and 6 (7 species microalgae); 6 microalgae species variation between station 2 and 6. Also, 5 species of microalgae species varied between station 3 and 6; followed by station 3 and 4 (4 species). Similar number of species frequency (3 species) also occurred between station 2 and 1, 4: and 4 and 5; whereas the lowest species frequency occurred in station 1 and 3, 5: station 2 and 3, 5: and station 3 and 5 (1 species).

Table 2: Significant frequency difference of microalgae food item of *B. violacea* across six (6) sampling stations.

Food Item	**Significant Difference across stations**														
	S_1-S_2	**S_1-S_3**	**S_1- S_4**	**S_1-S_5**	**S_1-S_6**	**S_2-S_3**	**S_2-S_4**	**S_2-S_5**	**S_2-S_6**	**S_3-S_4**	**S_3-S_5**	**S_3-S_6**	**S_4-S_5**	**S_4-S_6**	**S_5-S_6**
Chlorophyceae															
Oedogonium spp.	-	-	0.000***	-	0.000***	-	-	-	0.005***	0.002***	-	0.000***	-	-	0.002***
Chlorella spp.	-	-	0.045*	-	0.000***	-	-	-	0.032**	-	-	0.000***	-	-	0.003***
Cosmarium spp.	0.043*	-	-	-	0.043*	-	-	-	-	-	-	-	-	-	-
Selenastrum spp.	-	-	-	-	0.000*	-	-	-	0.000***	-	-	0.000***	-	0.000***	0.000***
Bacillariophyceae															
Synedra spp.	-	-	0.013**	-	-	-	-	-	-	-	-	-	-	-	-
Gyrosigma spp.	-	-	-	0.032*	0.001***	-	-	0.032*	0.001***	-	-	-	0.032*	0.001***	-
Cymbella spp.	-	-	0.003***	-	0.003***	-	-	-	-	-	-	-	-	-	-
Pinnularia spp.	-	-	0.033*	-	0.033*	-	-	-	-	-	-	-	-	-	-
Melosira spp.	-	-	-	-	0.002***	-	-	-	0.002***	-	-	-	-	0.002***	0.002***
Fragilaria spp.	0.012**	-	0.012**	-	0.047*	-	-	-	-	-	-	-	-	-	-
Surirella spp.	-	-	-	-	0.032*	-	-	-	0.032*	-	-	0.032*	-	-	0.032*
Cocconeis spp.	-	-	0.002***	-	-	-	0.002***	-	-	0.002***	-	-	0.002***	0.002***	-
Nitzschia spp.	-	0.013**	-	-	-	0.013**	-	-	-	-	0.013**	-	-	-	-
Brachysira spp.	-	-	-	-	0.017**	-	-	-	-	-	-	-	-	-	0.031*
Eunotia spp.	-	-	-	-	0.000***	-	-	-	-	-	-	-	-	0.000***	0.000***
Euglenophyceae															
Euglena spp.	-	-	0.007***	-	-	-	0.007***	-	-	0.007***	-	-	-	-	-
Cyanophyceae															
Gloeocapsa spp.	-	-	-	-	0.000***	-	-	-	-	-	-	0.000***	-	0.000***	-
Rivulria/Calothrix spp.	-	-	0.011**	-	-	-	0.011**	-	-	0.011**	-	-	0.011**	0.011**	-
Unidentified species /structures	0.027*	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Number of species	3	1	9	1	13	1	3	1	6	4	1	5	3	7	7

Note: S_1= Station 1; S_2=Station 2; S_3=Station 3; S_4=Station 4; S_5=Station 5; S_6=Station 6. Level of significance: *= p<0.05; ** = p<0.025; ***=p< 0.010.

The frequency difference of microalgae food items of *B. violacea* between stations could be explained by the difference of water quality and soil substrate of the Cagayan River. This conforms to findings of several studies that abiotic factors and biotic factors affect the distribution of benthic algae [4, 30]. For instance in this study, species frequency variation of microalgae food items of *B. violacea* between station 1 and 6 could be due to the significant difference of soil pH (p<0.010) of these stations whereas species frequency difference between station 1 and 4 could be due to the significant difference of soil pH (p<0.010), water current (p<0.010), Total Suspended Solids (TSS) (p<0.010), and % sand (p<0.010) [16]. The species frequency variation of microalgae food items of *B. violacea* between station 4 and 6 and 5 and 6 could be due to the significant difference of stations on water depth (p<0.010), water current (p<0.025), TSS (p<0.010), % sand (p<0.010), % silt (p<0.025), and % soil pH (p<0.010) whereas species frequency variation of microalgae food items of *B. violacea* between station 2 and 6 could be due to the significant difference of stations on water depth (p<0.010), TSS (p<0.010), soil pH (p<0.010) and clay (p<0.010) [16]. Lastly, the significant difference of microalgae food items of *B. violacea* between station 1 and 3; station 1 and 5; station 2 and 3; station 2 and 5; and station 3 and 5 could be due to the significant difference between stations of water quality parameters such as water depth (p<0.010), water current (p<0.010), D.O (p<0.050), TSS (p<0.010) and substrate quality such as % sand (p<0.010; 0.025), % silt (p<0.050), % clay (p<0.010), and soil pH (p<0.010; 0.025) [16].

The environmental factors associated with rainfall, particularly current velocity and turbidity, are considered as the most important factors influencing temporal fluctuations of algae in tropical regions [4, 21, 22]. In addition, certain genuses of microalgae have different response to environmental conditions. For instance, the significant high frequency of genus Eunotia in station 6 as compared to station 1, 4 and 5 and significant high frequency of genus Cymbella in station 6 than station 1 and 4. The genus Eunotia seems to favor acidic environment while genus Cymbella to neutral pH [30, 33]. Thus, the presence of high frequency of two genuses Eunotia and Cymbella in station 6 suggests the fluctuation of pH within the tolerance of the two genuses of microalgae food items. However, the presence of significant variation in frequency of other different microalgae food items between stations could suggest that few species are able to tolerate the fast and wide fluctuations of environmental conditions typical to lotic ecosystems [4, 23].

On the other hand, the patterns of spatial distribution of microalgae food items across the six stations may also be due to ecological relationships among the different species of microalgae. This could be observed to the significant difference of frequency and distribution of microalgae genus under family Chlophyceae between station 1 and 2,4: station 6 and 1,2,3,4,5: station 3 and 4; microalgae genus of Bacillariophyceae between station 1 and 2,4,5,6: station 2 and 3,4,5,6: station 3 and 4,5,6: station 4 and 5,6: station 5 and 6; microalgae genuses of Euglenophyceae between station 4 and 1,2,3; microalgae genus of Cyanophyceae between station 1 and 4,6: between station 4 and 2,3,5,6; and station 6 and 3. Some microalgae species in this study possibly have large quantitative dominance and qualitative predominance of few species; niche pre-emption in which one or few species occupy most part of the environmental resources and the other species compete for the remaining resources; and patch distribution in which communities with higher abundance have higher diversity (in species numbers) across stations [4, 23].

Thus, it is an important consideration to future studies that combination of river characteristics (e.g. microhabitat combinations among a set of physical, chemical and biotic characteristics), ecology of algae species and ecological relationship among algae species could influence algal communities and its frequency and distribution in lotic environment.

4. Conclusion and Recommendation

The food diet of the clam is composed of 80-90% sediments/detritus and 10-20% different food items such as green algae (35.83%), diatoms (33.13%), euglenophyceae (3.22%) and cryptophyceae (1.94%). This has been acquired through suspension feeding and deposit feeding because the bivalve exhibits burrowing activity.

The food source of *Batissa violacea* in this study should be considered for future fishery development on breeding and production of the clam in captivity to replenish natural stocks in the river and when venturing to aquaculture production of *B. violacea*. For instance, in rearing and growing *B. violacea* in ponds, tanks and cages, the food sources should contain 80-90% sediments and detritus and 10-20% different food items (e.g. green algae). This is necessary in order to achieve a good result from *B. violacea* aquaculture. On the other hand, further study to determine the feeding ecology of *B. violacea* in Cagayan River could be conducted.

Lastly, species frequency and spatial distribution of microalgae food items of *B. violacea* across stations may be influenced by the interactions of river characteristics (e.g. microhabitat combinations among a set of physical, chemical and biotic characteristics), ecology of algae species and ecological relationship among algae species.

5. Acknowledgement

We wish to thank the fishermen and people who help to collect and dissect our *B. violacea* samples. The authors thank DOST-ASTHRDP, Southeast Asian University Consortium for Graduate Education in Agriculture and Natural Resources and National Research Council of the Philippines (NRCP) for the financial support. Comments from anonymous reviewers were highly appreciated.

6. References

1. Belcher H, Swale E. A beginner's guide to Freshwater Algae. Culture Centre of Algae and Protozoa. 1976, 1-48.
2. Bellinger EG, Sigee DC. A Key to the More Frequently Occurring Freshwater Algae. John Wiley & Sons, Ltd. 2010, 138-254.
3. Borges FR, Necchi Júnior O. Patterns of spatial distribution in macroalgal communities from tropical lotic ecosystems. Revista Brasileira de Botânica. 2006; 29:669-680.
4. Branco CCZ, Krupek RA, Peres CK. Seasonality of macroalgal communities in a subtropical drainage basin in Paraná state, southern Brazil. Brazilian Journal of Biology. 2008; 68(4):741-749.
5. Bricelj MV. The Hard Clam Research Initiative: Factors Controlling *Mercenaria mercenaria* Populations in South Shore Bays of Long Island, NY. 2009.
6. Bureau of Agricultural Statistics. 2013. (http://countrystat.bas.gov.ph).
7. Carpenter KE, Niem VH. The living marine resources of the Western Central Pacific. FAO Species identification guide for fishery purposes. Food and Agricultural Organization of the United Nations, Rome. 1998.
8. Cope WG, Waller DL. Evaluation of freshwater

relocation as a conservation and management strategy. Regulated River Research Management. 1995; 11:147-155.
9. Dunn CS, Layzer JB. Evaluation of various holding facilities for maintaining freshwater mussels in captivity. *In* Cummings KS, Buchanan AC, Mayer CA, Naimo TJ. [eds.], Conservation and management of freshwater mussels. II. Proceedings of a UMRCC symposium. Upper Mississippi River Conservation Committee. 1997, 205-213.
10. Fakioglu O, Kokturk M, Atamanalp M. The application of some biodiversity indices in the Tortum Stream, Erzurum, Turkey. International Journal of Physical Sciences. 2013; 8(46):2069-2076.
11. Hatha AAM, Christi KS, Singh R, Kumar S. Bacteriology of the fresh water bivalve clam *Batissa violacea* (Kai) sold in the Suva market. The South Pacific Journal of Natural Science. 2005; 23:1-3.
12. Korinkova T. Food utilization in fingernail and pill clams. Malacologica Bohemoslovaca. 2011; 10:1-4.
13. Layugan EA, Saegawa S, Laureta LV, Ronquillo JD. Gametogenesis and Spawning Induction in *Batissa violacea* (Lamarck, 1806) at Cagayan River, Philippines. International Peer Reviewed Journal. 2013; 5:1-23. doi:http://dx.doi.org/10.7718/ijec.v5i1.504
14. Ledua E, Matoto SV, Sesewa A, Korovulavula J. Freshwater Clam Resource Assessment of the Ba River. South Pacific Commission, B.P D5, Noumea, New Celedonia Fisheries Division, P.O Box 358, Suva, Fiji, SPC Integrated Coastal Fisheries Management Project Reports Series #1, 1996, 1-31.
15. Mayor AD, Ancog R. Fishery status of freshwater clam (*Batissa violacea,* Corbiculidae) (Bivalvia) (Lamarck, 1818) in Cagayan River, Northern Philippines. International Journal of Fisheries and Aquatic Studies. 2016; 4(3):500-506.
16. Mayor AD, Ancog R, Guerrero III RD, Camacho Ma.VC. Environmental factors influencing population density of freshwater clam *Batissa violacea* (Bivalvia) (Lamarck, 1818) in Cagayan River, Northern Philippines. International Journal of Aquatic Science. 2016; 7(2):69-72.
17. Mcmahon RF, Bogan AE. Mollusca: Bivalvia. – In: Thorp JH, Covich AP. (eds), Ecology and classification of North American freshwater invertebrates, 2nd edition. Academic Press. 2001, 331-429.
18. Morton B. The functional morphology of the organs of the mantle cavity of *Batissa violacea* (Lamark, 1797) (Bivalvia: Corbiculacea). American Malacological Bulletin. 1989; 7(1):73-79.
19. Muñetón-Gómez MS, Villalejo-Fuerte M, Gárate Lizárraga I. Contenido estomacal de *Spondylus leucacanthus* Broderip, 1833 (Bivalvia: Spondylidae) y su relación con la temporada de reproducción y la abundancia de fitoplancton en Isla Danzante, Golfo de California. Revista de biologia tropical. 2001; 49:581-590.
20. Muneton-Gomez MS, Villalejo-Fuerte M, Garate-Lizarraga I. Gut content analysis of *Anadara tuberculosa* (Sowerby, 1833) through histological sections. CICIMAR Oceanides. 2010; 25(2):143-148.
21. Necchi-Júnior O, Dip MR, Góes RM. Macroalgae of a stream in southeastern Brazil: composition, seasonal variation and relation to physical and chemical variables. Hydrobiologia. 1991; 213(3):241-250.
22. Necchi-Júnior O, Pascoaloto D. Seasonal dynamics of macroalgal communities in the Preto River basin, São Paulo, southeastern Brazil. Archive fur Hydrobiologie. 1993; 129(2):231-252.
23. Necchi Júnior O, Branco CCZ, Branco LHZ. Distribution of stream macroalgae in São Paulo State, southeastern Brazil. Algological Studies. 2000; 97:43-57.
24. Poutiers JM. Bivalves. Acephala, Lamellibranchia, Pelecypoda. In Carpenter KE, Niem VH. 1998, 123-362.
25. Raikow DF, Hamilton SK. Bivalve diets in a midwestern U.S. stream: A stable isotope enrichment study. Limnology and Oceanography. 2001; 46(3):514-522. doi:10.4319/lo.2001.46.3.0514
26. Richards A. With contributions from Maciu L, Subodh S, Krishna S. (Compilers). Fiji Fisheries Resources Profiles. FFA Report 1994, No.94/4.
27. Roegner CG, Mann R. Hard Clam: *Mercenaria mercenaria*. Gloucester Point, Virginia, 1991, 17.
28. Shumway SE, Selvin R, Schick DF. Food resources related to habitat in the scallop *Placopecten magellanicus* (Gmelin, 1791). Journal of Shellfish Research. 1987; 7:77-82.
29. Simson KS, Benfield EF, Macko SA. Food web structure and the role of epilithic biofilms in cave streams. Ecology. 2003; 84:2395-2406.
30. Tang T, Cai Q, Liu R, Li D, Xie Z. Distribution of Epilithic Algae in the Xiangxi River System and Their Relationships with Environmental Factors. Journal of Freshwater Ecology. 2002; 17(3)345-352.
31. Thangavelu A, David B, Barker B, Geneste J, Delannoy J, Lamb L *et al*. Morphometric analyses of *Batissa violacea* shells from Emo (OAC), Gulf Province, Papua New Guinea. Archaeology Oceania. 2011; 46:67-75.
32. Van Vuuren JS, Taylor J, Gerber A, Van Ginkel C. Easy identification of the most common Freshwater Algae. A guide for the identification of microscopic algae in South African freshwaters. 2006, ISBN 0-621-35471-6.
33. Winterbourn MJ, Hildrew AG, Orton S. Nutrients algae and grazers in some British streams of’ contrasting pH. Freshwater Biology. 1992; 2:173-182.