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RESEARCH ARTICLE

CORRELATION BETWEEN THE EDIBLE FRESHWATER BIVALVES AND SOME ECOLOGICAL FACTORS AT SELECTED SITES OF CAGAYAN RIVER.

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Abstract

The edible freshwater bivalves identified in Cagayan River were: *Batissa childreni*, *Corbicula manilensis* and *Psammotaea virescens*. *Corbicula manilensis* was the most abundant species collected. High density and bigger sized bivalves were collected in the months of May, which was the peak season. A high density of *Batissa childreni* was noted as the temperature of water was low. Total hardness and organic content significantly influenced the density of *Corbicula manilensis* and *Psammotaea virescens*. Lesser density of *Corbicula manilensis* resulted as the total hardness decreased while high density of *Psammotaea virescens* was noted as the organic content of the substrate increased. Relative abundance was greatly affected by the total water hardness. A positive correlation existed between relative abundance of *Corbicula manilensis* and total hardness. Shell sized of *Corbicula manilensis* was bigger as the total hardness increased and bigger sized *Psammotaea virescens* was noted as the organic content of the substrate increased. No predictor variables were significantly correlated with relative abundance of *Psammotaea virescens* and the shell sized of *Batissachildreni*.

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Introduction:-

The province of Cagayan is blessed and known for its great river system, the Rio Grande de Cagayan, with its rushing southern headwaters rising partly in the cross ranges of the Caraballo Sur mountain. Some thirty kilometres from the mouth of the Cagayan River lies the source of livelihood of the inhabitants of Gattaran, Lal-lo, Camalaniugan and Aparri. The inhabitants are mostly farmers whose principal crop is rice. For them, the Cagayan River is the only source of aquatic products. In the muddy-sandy bed of the Cagayan River thrive bivalves locally known as “cabibi”, “bennec”, or “tulya” and “unnoc” which are the staple diet of the people and the source of income for fishermen. These bivalves are present throughout the year although the season of gathering is from January to July only. The peak of the fishing season is from February to May. Gathering stops at the beginning of the rainy season when the river gets flooded making it possible for dredges to operate.

La-lo and some parts of Gattaran are the only places in Cagayan where “cabibi” and “unnoc” thrive abundantly. Castillet (1960) attributes this phenomenon to some natural conditions which are not found in other localities. Likewise, the intensity of catch fluctuates every year. There are seasons when bivalves are abundant and times when

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they are scarce. Few studies (Hosillos, 1957; Escritor, 1959 and Layugan, 1988) have been made regarding the bivalve fishery but the causes of their fluctuation are still unknown.

Objectives of the Study

1. To collect, identify and classify the edible freshwater bivalves presently found in Cagayan River.
2. To determine the shell size (length and width) and density of edible freshwater bivalves as indicators of secondary activity.
3. To determine the relative abundance of different species of edible freshwater bivalves collected.
4. To correlate some physico-chemical parameters of the river water and it's substrate with relative abundance, shell size and density of the edible freshwater bivalves identified.

Methodology:-

Study Area

Cagayan River, situated in Cagayan Valley is the longest river in the country. It is about 380 kilometers long and has an average width of about 100 meters. The Cagayan River basin covers an area of about 28,110 square kilometers (Cortes, 1980). The river crosses the provinces of Cagayan north, Isabela in the central portion, Nueva Viscaya and a narrow strip of Quezon province in the south. It flows over the entire length of the valley in the northerly direction from its head Nueva Viscaya to its mouth in the Babuyan Channel near Aparri. On the other side of this fertilizing and mighty river lie the open stretches of Cagayan Valley.

The study area is situated at the northernmost part of Cagayan at approximately latitude $10^{\circ} 00''$ to $18^{\circ} 23''$, longitude $121^{\circ} 38''$ to $121^{\circ} 43''$. It is about thirty kilometers from the mouth of the river starting from station I. the area was divided into four stations designated as Station 1 (Gattaran), Station 2 (Lal-lo), Station 3 (Camalaniugan) and Station 4 (Aparri).

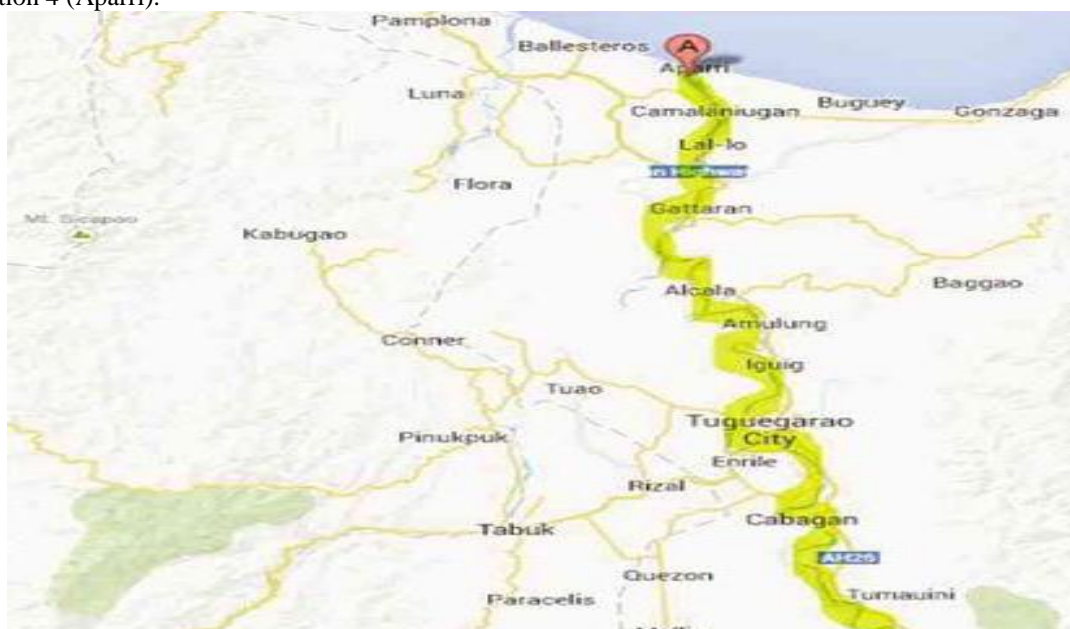


Figure 1:-Map showing the Cagayan River Traversing the Municipality of Lallo, Cagayan, Philippines

Biological collection

Two sampling areas from each town were chosen. Collection of bivalves was done once a month for a period of six months. Dredging time was 20 minutes per 10 meters of distance traveled in each sampling site.

The clams collected were counted and sorted according to species and area of collection. Samples for identification were preserved in 10 % formalin solution.

Water and substrate samples were collected from different sampling sites in each station by a hired fisherman/diver. The water and substrate samples were transferred in labeled bottles and plastic bags, respectively, for analyses in the laboratory.

Dredging

An indigenous submarine dredge was used. It is composed of one flat-bottom row boat or motor boat about 10 meters long, 1 meter wide and 0.36 meter deep at the center, a “tako” or dredge (Fig. 2) and a pair of boho, Bambusa spp. mattings or “sawali” (Fig 1) about 3.1 x 1.3 meters.

Upon reaching the fishing ground and after ascertaining the depth of the bed, the dredge was dropped. When the dredge reaches the bottom, the pair of “sawali” wings was set into position in the water, about one and one half meter from the bow end, one at each side in a wing-like formation. The “sawali” wings intercept the volume of current that maintains the boat in a downward dredging position.

After the dredge has been set, the boat was allowed to drift with the current, the dredging path changed occasionally the wings. The dredge was hauled every 20 minutes in the four stations.



Figure 1:-A pair of boho, Bambusa spp. mattings or “Sawali”



Figure 2:-Dredge of “Tako”

Shell Size and Density

Shell size was determined using a Vernier Calliper through the measurement in centimeters.

The density of each bivalve species was expressed as number of bivalves/ square meter area dredged collected after 20 minutes dredging. An average of 10 meters in each sampling site was measured and used to compute for the density of each bivalve species.

Physico-chemical Parameters

The following Physico-chemical characteristics of water from the four stations of the river were monitored once a month.

1. Temperature of water at two levels (that is at the bottom and at the surface) was taken by the use of an ordinary laboratory thermometer, both temperature was measured by lowering a thermometer tied with a graduated string and a weight at the bottom. After few minutes, the thermometer was retrieved rapidly. An average of two readings was considered.
2. River depth was measured by the use of an improvised depth gauge (nylon string with metric calibration and with one end tied with weight).
3. Dissolved oxygen content (DO) was determined by Iodometric Method or Winkler's Method.
4. pH was determined by the use of a portable pH meter, model HM – 1K.
5. Total water hardness was determined by titration (EDTA Titrimetric Method).
6. Salinity and conductivity was determined by the use of a Salinity and Conductivity Meter, USI Model 33.
7. Transparency was measured using Secchi Disc. The depth at which disc disappeared and reappeared was averaged and reported as Secchi Disk Transparency.

Substrate Analysis

Type and characteristics of the substrate from the four stations of the study area were determined. Samples of substrate collected in each sampling site per stations were air dried and analyzed in the laboratory for its organic content.

Total organic content was determined using the Walkley-Black Method (Allison, 1965). The organic carbon percentage was determined and multiplied by a conversion factor 1.724 to obtain organic matter percentage. Another set of substrate samples was oven and sieved to determine the size and type of particles.

Statistical Analysis:-

Monthly values of the average shell size (length and width) and density for the population of the different species of edible bivalves in the four stations were computed and tabulated. Likewise, the mean of the physico-chemical characteristics of the river water and substrate: temperature, transparency, depth, pH, salinity, conductivity, hardness, dissolved oxygen and organic content were computed and tabulated per month (February to July) from the four stations of the study area.

The relative abundance of collected bivalves was computed using the formula:

$$\text{Relative Abundance} = n_1 / n$$

where n_1 - is the number of individuals of each species

n - is the total number of individuals collected

The monthly relative abundance for the population of each bivalve species was also computed and tabulated.

Analysis of variance was used to determine the significant differences of the mean of the physico-chemical factors, density, relative abundance and shell size from the four stations. The Simple Pearson Correlation (r) was used to find the correlation between shell size (length and width), density, relative abundance of each bivalve species and the physico-chemical parameters of the water and the organic content of the substrate. Correlation was used to establish the degree of association between pair of variables.

Results And Discussions:-

Identification, Description and Distribution

The three species of edible bivalves collected and identified in Cagayan River were *Batissa childreni* (Gray 1878), *Corbicula manilensis* (Reeve, 1857) and *Psammotea virescens* (Deshayes, 1855).

Batissa childreni and *Corbicula manilensis* belongs to Family Corbiculidae and *Psammotaea virescens* belongs to Family Psammobiidae. *Batissa childreni* locally named “cabibi” and *Corbicula manilensis* locally named as “bennece” or “tulya” belong to Subclass Heterodonta, Order Veneroidea, Superfamily Corbiculacea, Family Corbiculidae and Subfamily Corbuculinae. *Psammotaea virescens* belongs to Subclass Heterodonta, Orders Veneroidea, Superfamily Tellinacea, family Psammobiidae and Subfamily Psammobinae. This bivalve is locally known as “unnoc”.

“Cabibi” scientifically named *Anodonta sp.* was a freshwater clam known to occur only in that part of Cagayan River along the municipality of Lallo and vicinity, (Hosillos, 1957) and (Escritor, 1959) pointed out that the “cabibi” grounds were situated from the southern tip of Camalaniugan extending southward to the southern tip of Lallo. However, an assessment was made by Layugan (1988) on the edible mollusks found in Cagayan river. There were three species of bivalves identified, ‘unnoc’, ‘bennece’ or ‘tulya’ and ‘cabibi’ scientifically name *Batissa violacea*. “Cabibi” was scientifically named *Cyrena sp.* According to Sowerby (1878), *Cyrena sp.* was a big clam that inhabit rivers and estuaries, most likely the same as that of *Batissa childreni* which were smaller in size. *Cyrena sp.* and *Batissa childreni* (Gray, 1878) and *Batissa violacea* (Lamarck, 1818) had the same local name as “cabibi”. In this study, “cabibi” was identified as *Batissa childrreni* (Gray, 1878) contrary to the findings of Layugan, 1988 and Mayo, A.D., et al., 2016 which is *Batissa violacea* (Lamarck, 1818). This could be due to some revisions on the identification and authentication of some species made by taxonomists.

Batissa childreni has a rounded shell, smooth with few growth lines and greenish to yellowish in color. The shell is more or less thick. The shell of *Corbicula manilensis* is triangular with striated surface, brownish black periostracum. *Psammotaea virescens* is a small species with thin shell, colored purplish to brownish.



Fig 3:-BatissachildreniCorbiculammanilensisPsammotaeavirescens

The three edible freshwater bivalves that thrived in Cagayan River were distributed in some identified areas. *Batissa childreni* were found only in Station 1 and 2 (Gattaran and Lallo). There were more bivalves of this species in Station 2 but bigger clams were noted in Station 1. *Corbicula manilensis* was collected from Station 1, 2 and 3. A large number were dredged in the month of May. *Psammotaea virescens*, a small species of bivalves were found only in Station II and III.

Physico-Chemical Factors

Depth –

The shallowest depth of the river recorded was 8.25m at Station 1 in the month of February. It, however became deeper from March to July.

Transparency-

It was in July when transparency had the lowest value at because of the heavy downpour of rain. When it rains, run-off coming from nearby farms and mountains flow to the river. Run-off carries fine soil particles that make the river water very turbid thereby light can no longer penetrate in the water.

Temperature –

Water temperature (surface and bottom) did not fluctuate significantly. The highest temperature was observed in April and June in all stations because of the strong heat of the sun during these months, while low temperature occurred in February.

Dissolved Oxygen-

The average DO at Station 1 shows a decreasing trend, the highest value was observed in the month of February. Station II was shown to have the highest DO and lowest in Station 4.

pH and Total Hardness-

A pH reading slightly lower than neutral was observed in the month of February and relatively alkaline in the month of June. However, the pH values were almost similar from the four stations. Total hardness was very high at Station 1 and 2, which is classified as very hard. These stations were surrounded with rocks, the river bank was full of fossils shells. Rainwater carries Ca^{++} , Mg^{++} , other polyvalent metals, carbonates and bicarbonates and goes to the river making the water to be hard.

Salinity and Conductivity –

Station 1 and 2 had a zero salinity while it was expected that Station 4 (Aparri) had the highest because of its proximity to the sea. Station 4 having the highest salinity was expected to have the highest conductivity. It was also noted to have high pH and relatively high temperature. The reasons for these relationship may be assumed on the concentration of ionized substances present brought about by the salt ions and both the H^+ and OH^- .

Substrate quality –

Station 1 and 2 had a sandy substrate, the texture was observed to be coarse. Loamy sand was the type of substrate in Station 3 and Station 4 had a silty loam substrate and had the highest organic content. Stations 1, 2 and 3 had a zero organic content in February and March but there was an increased in April.

Population Density

The survey of population density of each bivalve species shows that *Batissa childreni* was present only in Station 1 and 2 with highest density at Station 2. Lowest density (3.56/m² area dredged) was noted in the month of April while highest value (413.53/m² area dredged) was in March (Fig 4).

Figure 5 shows that *Corbicula manilensis* thrived only in Stations 1, 2 and 3. An increase of density from February to July was observed from the three stations.

Psammotaea virescens was absent in Stations 1 and 4. In Stations 2 and 3, an increase of density from February to May was observed (Fig 6).

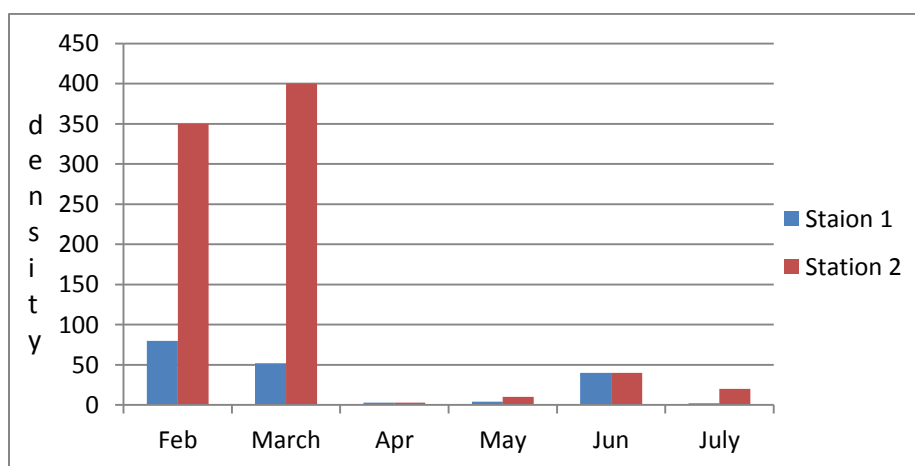


Figure 4:-Density of *Batissa childreni* collected from Stations 1 and 2

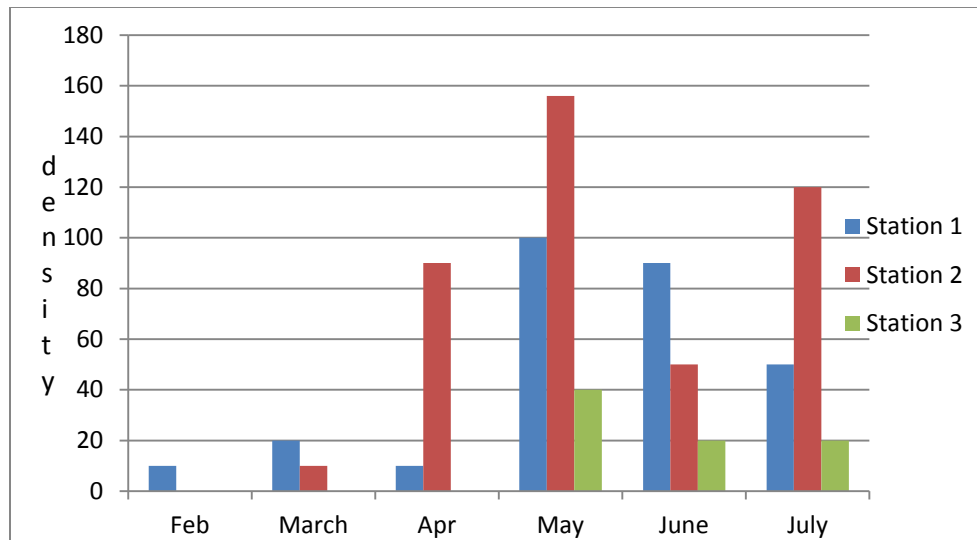


Figure 5:-Density of *Corbicula manilensis* collected from Stations 1, 2 and 3

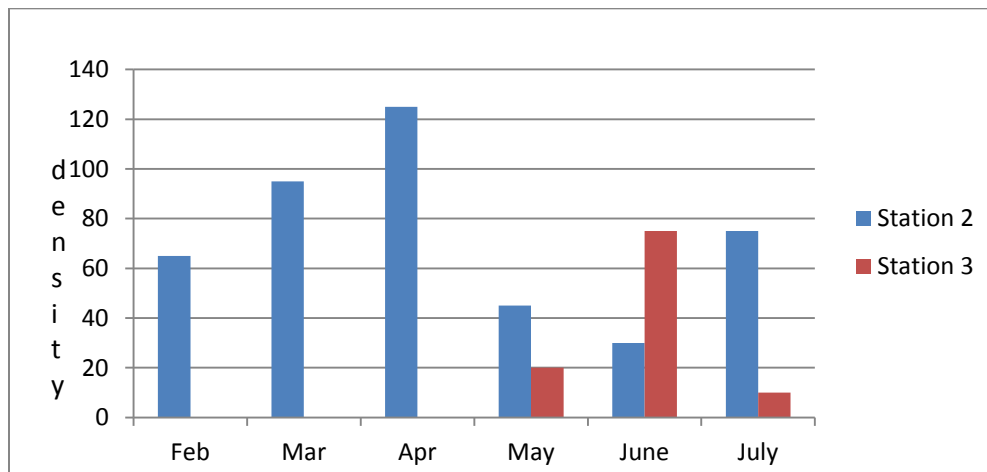


Figure 6:-Density of *Psammotaea virescens* collected from Station 2 and 3

Based on the analysis of variance on the mean density of *Batissa childreni*, *Corbicula manilensis* and *Psammotaea virescens*, there were relatively significant differences on the density from the four stations. *Batissa childreni* was found only in Station 1 and 2, while *Corbicula manilensis* was found only in Station 1, 2 and 3. For *Psammotaea virescens*, this species were present only in Station 2 and 3 and totally absent in Station 1 and 4.

The density of *Batissa childreni* was greatly affected by the temperature of water. This was shown in the adjusted effects of the variables of density and correlation analysis. As the temperature of water decreased, more bivalves were collected in the study area, thus the density was high. Apparently, the water temperature and density of *Batissa childreni* were negatively correlated.

Crumb, S.E. (1977) reported that the density of macrobenthos of Delaware River seemed to be the function of temperature. The maximum amount of oxygen that can dissolve in water at 5 °C is 12.8 mg/L. This means that 1L of water at 5 °C can dissolve no more than 12.8 mg of oxygen. At 15 °C the maximum concentration of oxygen in water is 10.1 mg/L. At 20 °C it is only 9.1 mg/L. It is clear that the maximum concentration of DO in water decreases as the temperature increases (UPSEC, 1986). In this study, the mean density of *Batissa childreni* was highest in the months of February and March when there was low temperature and the DO was high compared to other months. Thus, these bivalves were supplied with a great amount of oxygen in a lowest temperature resulting in a greater number of individuals. There is a moderate positive correlation of the population density of *Batissa violacea* on water quality of the river like water depth, current and temperature (Mayor, A.D., et al., 2016).

Natural population of freshwater mollusk show extreme variation in the pattern of shell formation which may or may not be related to water hardness (Russel-Hunter, 1981). This was particularly true to *Corbicula manilensis* in which the density and relative abundance was high when the water has low total hardness. The present study shows that as the total hardness was low, the density of this clam was high and they were more abundant. Density of *Corbicula manilensis* may not be related to the hardness of water but to other factors. *Corbicula fluminea* is denser in a fine sand substrate, well-oxygen lotic system with optimum environmental conditions (Belanger, S.E., et al. 1985)

Harrison and Rankin (1978) showed that the greatest densities of *Pisidium punctiferum* occurred where there was the greatest percentage of organic material in the substrate.

Relative Abundance

Relative abundance of *Batissa childreni* was highest in February at Station 2. There was a gradual increase from February to July with Station 1 that has the highest relative abundance (Fig. 7). In Station 3 and 4, there was no *Batissa childreni* that was dredge while *Corbicula manilensis* did not thrive in Station 4. The relative abundance of *Psammotaea virescens* decreased from February to July while *Corbicula manilensis* increased in number (Figs. 8 & 9). *Corbicula manilensis* is the most abundant during the six-months study.

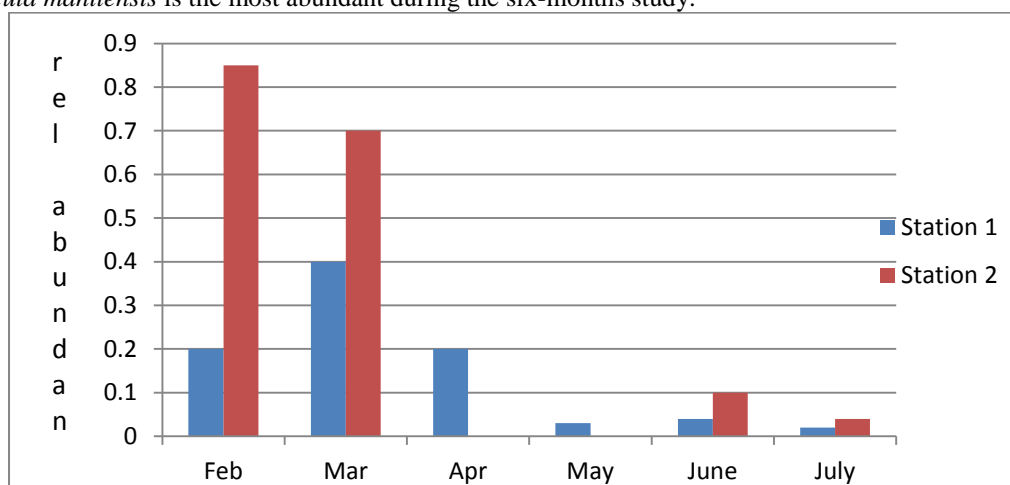


Figure 7:-Relative Abundance of *Batissa childreni* collected from Stations 1 and 2

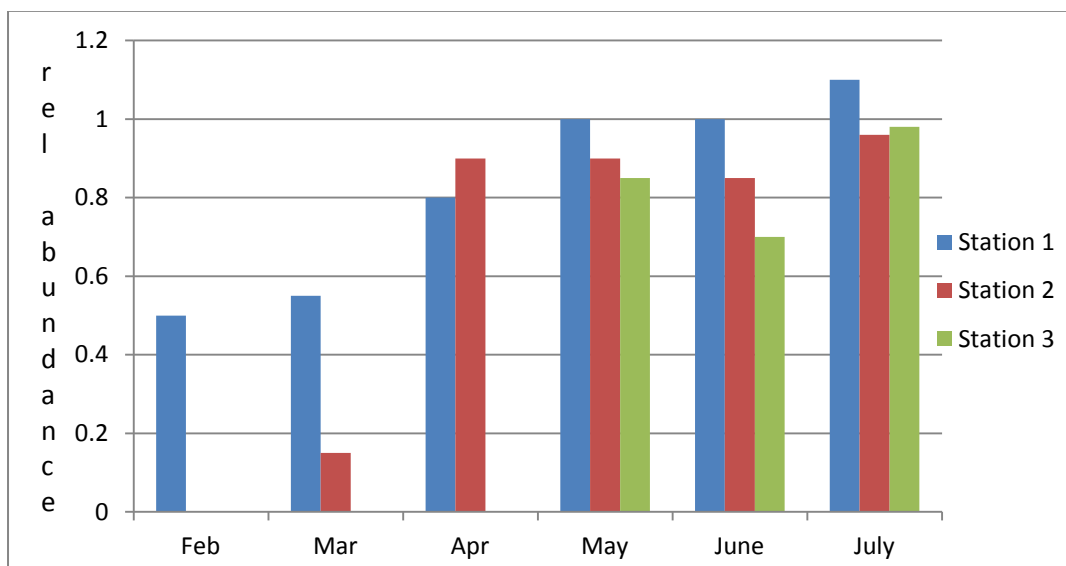


Figure 8:-Relative Abundance of *Corbicula manilensis* collected from Station 1, 2 and 3

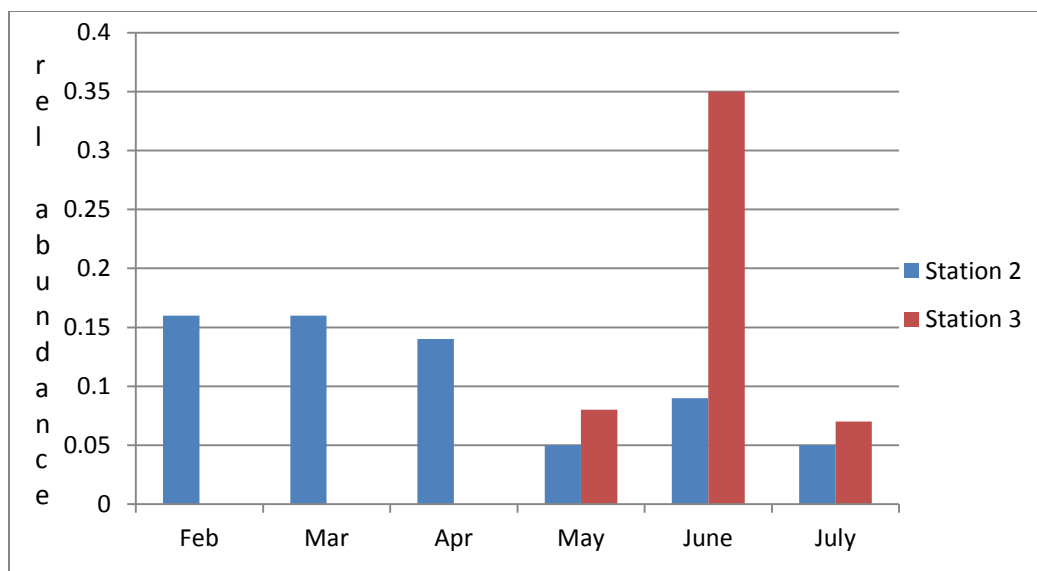


Figure 9:-Relative Abundance of *Psammotaea virescens* collected from Stations 2 and 3

A number of studies indicate that “hardwater” is better than “soft” for mollusks. Macan(1938), group mollusks according to hardness of water in which freshwater mollusks were found more. This was particularly true to *Batissa childreni* in which this species was more abundant in stations with high total hardness. Boycott (1936) reported that fifty percent of the species of mollusk are hardly ever found in water with less than 20mg/L Ca. With decreasing amounts of Calcium below this concentration, the number of species becomes progressively fewer.

Shell Size (Length and Width)

Figure 10 shows that there was an increase of the shell size in the month of April and June. It was observed that the values of the mean length was higher than the width except for some months where the mean width was higher than the length.

For *Corbicula manilensis*, the longest mean length was observed in July and April and the widest width was present in May. The values of the mean length were higher than the mean width. There was an increase in shell length from February to April while increase in shell width was from February to May (Figure 11).

Figure 12 shows the mean shell size of *Psammotaea virescens*. Big sized clams occurred in May. There was increase in length as the width increased. Longest mean length was noted in May and widest mean width was observed in May. Small sized clams were noted in April.

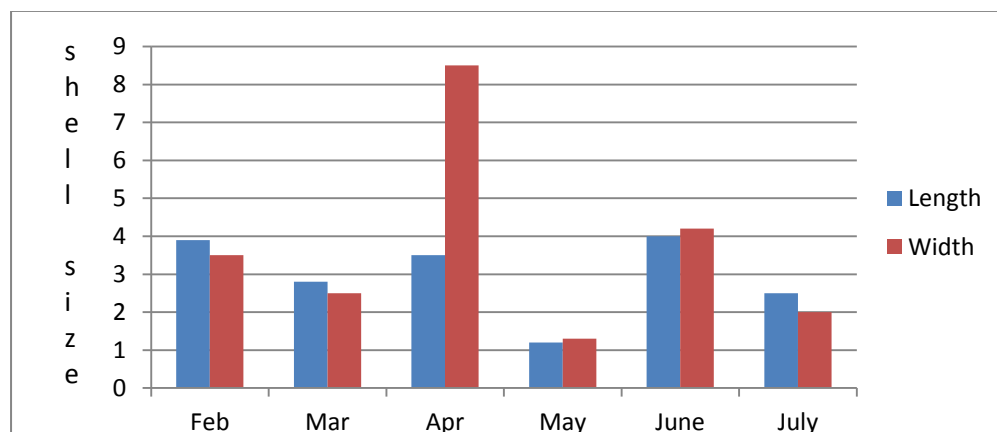


Figure 10:-The Mean shell size (L and W) of *Batissa childreni* collected from Stations 1 and 2

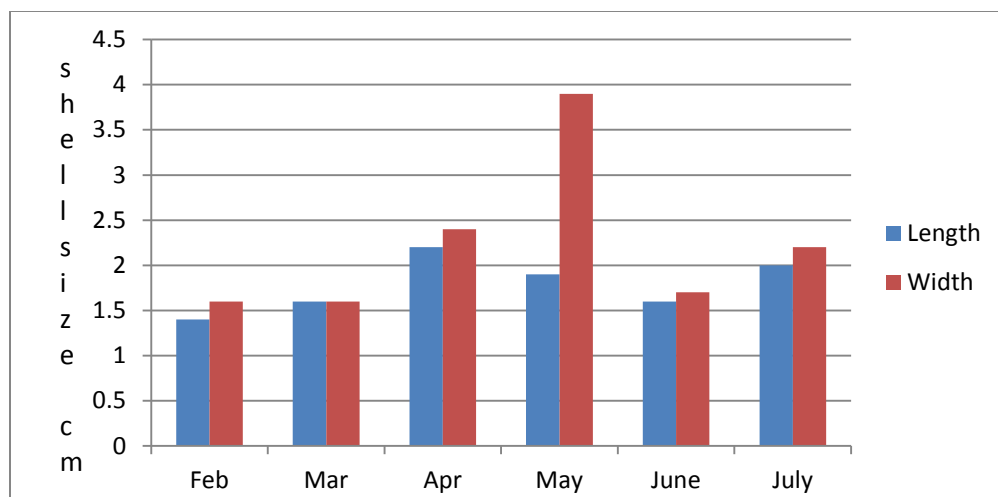


Figure 11:-The Mean of the Shell Size (L and W) of *Corbicula manilensis* collected from Stations 1,2 and 3

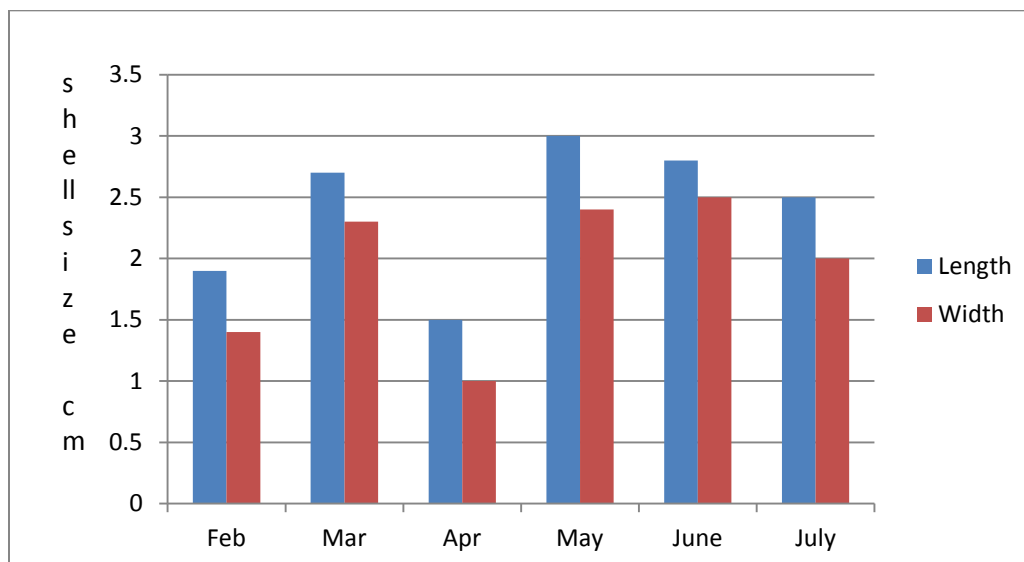


Figure 12:-The Mean of the Shell Size (L and W) of *Psammotea virescens* collected from Stations 2 and 3

The correlation coefficient between the shell size and the physico-chemical parameters shows that temperature was highly correlated with the shell size of *Batissa childreni*. As the temperature decreased, bigger bivalves were observed indicating a negative correlation.

Total hardness influenced the shell size of *Corbicula manilensis*. The higher the total hardness, the bigger bivalves collected. The lower the hardness, there were small sized bivalves collected.

The length and width of *Psammotea virescens* was accounted to the organic content of substrate. As the organic content of the substrate increased, the size also increased indicating a positive correlation. *Psammotea virescens* (Deshayes, 1855) is one of the nine species under Family Veneroidea that are found and identified throughout Onagawa Bay, Northeastern Japan. Most of these bivalves occurred in the muddy sand bottom with high organic matter (Sasaki, K., 1996).

In this study, the three species of edible bivalves thrived on their natural habitat feeding mostly with organic materials. In the study of Mayor.A.D, et al., (2018), sediments and detritus are the main component of foods of *Batissa violacea*, thus these species feed more on organic matter.

Conclusions:-

1. The species of edible freshwater bivalves collected and identified in Cagayan River were *Batissa childreni*, *Corbicula manilensis* and *Psammotaea virescens*.
2. High density and bigger sized bivalves were observed in the months of March to May.
3. *Corbicula manilensis* was the most abundant species collected. Temperature, total hardness of water and organic content of the substrate influenced the density and relative abundance of the three bivalves.
4. The shell size of the bivalves were positively correlated to the total hardness of water and organic content of the substrate.

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