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Research Article

# Aspects of Habitat Ecology of *Macrobrachium vollenhovenii* (Herklots, 1857) on the Lower Volta River, Ghana

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## Abstract

Water quality parameters, river sediment texture, percentage abundance of species, fish and plants associated with the habitat of African giant prawn, *M. vollenhovenii* (Herklots, 1857) were studied at the Eastern Region of Ghana on Lower Volta River Basin Channel between June-2015 and May- 2017. Analysis of the physico-chemical properties revealed a low level of seasonal fluctuations as obtained values for pH, salinity, temperature, ammonia and phosphates were not significantly different ($p$>0.05) based on seasonality. Results of this study revealed that most water quality parameters including heavy metals ions were within the thresholds recommended for surface water and fresh-water fish aquaculture except for $K^+$, $Ca^{2+}$, $Cu^{2+}$, $Zn^{2+}$ and $Pb^{2+}$ ions. The river sediments' texture was sandy loam with low organic matter percentage compositions and an average pH value range (4.96±1.33-5.33±0.95) which is weakly acidic. The water depths across the sampling locations ranged between 5.13±2.6fts and 15.80±4.92 fts and showed that the prawn is a sub-lithoral animal. Catch statistics revealed higher percentages of males at both seasons. *Oreochromis niloticus*, *Parachana obscura* and *Atya gaboniensis* were found foraging with *M. vollenhovenii;* while *Eichhornia crassipes, Ipomoea aquatica, Diplazium sammatii and Leptochloa caerulescens* were flora species providing hiding spots for *M. vollenhovenii* in this habitat. Conclusively, *M. vollenhovenii* population around this study location inhabits an exclusively fresh-water ecosystem which can be simulated for captive culture of this prawn. Aquaculture of this prawn is therefore recommended.

**Key words:** Habitat, Ecology, *M. vollenhovenii,* Volta River, Ghana, Water quality requirements

## Introduction

In West Africa, *Macrobrachium vollenhovenii* is one of the most popular species of fresh water prawns in the family palaemonidae. It is endemic and has a wide distribution across the countries spanning through Eastern Atlantic Coast (F.A.O., 1981). This prawn is believed to complete its entire life cycle in fresh water (Anatekhai, 1986; Marioghae, 1990). Other scientific observations revealed that *M. vollenhovenii* occupies a wide range of habitats ranging from coastal brackish water to upstream riverine environments which provide the prawn with potentials for local adaptations (Jimoh *et al.*, 2013). Nwosu, (2000) reported that specimen attaining adult sizes of up to 190mm were collected in Cross River Estuary, Nigeria. Food and Agricultural Organization of the United Nations (F.A.O., 2000) report opined that *M. vollenhovenii* can be equated in quality attributes to the widely cultured *M. rosenbergii*. This ecological attributes and its economic potentials qualify it as one of the ideal species to be targeted for prawns' aquaculture which is currently attracting interests in many countries across the West African region (Lawal-Are and Owolabi, 2012). Despite the economic and staple utility of this prawn, very little research work has been documented on its ecology, biology, genetics and its production techniques in West Africa. The most referred documentation available to science on this species from Ghana was that of Rutherford, (1971) which provides scientific information strictly on species identification of fresh-water shrimps in the area of Cape Coast. Rutherford (1971), emphasized on the neglect of this animal in scientific investigations of researchers in West Africa and clamored that fresh water-shrimps be given more attention as an important component of fresh water communities. Search results from on-line sources for available relevant scientific information on *M. vollenhovenii* revealed more contributions from researchers in Nigeria than in any other countries of West Africa.

The present poor status of prawns' aquaculture in West Africa compared to Asia, Europe and America may not be unconnected with low the level of applicable scientific know-how which stemmed from the past neglect of this organism in most ecological and live-stocks domestication related researches. However, this present study is designed to provide scientific information on some aspects of habitat ecology of this prawn around the Eastern Region of Lower Volta River, Ghana, to open-up further qualitative research interests on this organism.

## Materials and Methods

### Description of Study Location

This study location was a section of lower Volta River, located at the Eastern Region of Ghana. The water is exclusively fresh water and has an elevation of 84m above sea level according to GPS data recorded during the study. The water course is bounded by hills on both sides with dense vegetation of emergent trees growing around the hills. The river flows through Lake Volta from the Northern region of the country where it shares the boundary with Burkina-Faso (FAO-AQUASTAT, 2005). The river surface is partly covered by *Eichhornia crassippes* and other species of macrophytes with the river substratum basically sandy and having rocky intrusions. This river is the main water course in Ghana that drains directly into the Gulf of Guinea and supports the prawn fishery (FAO-AQUASTAT, 2005). The three sampling sites established for the study are: Kotokukope section of Lake Volta, Atimpoku section of Volta River and Akuse Dam section of Volta River.

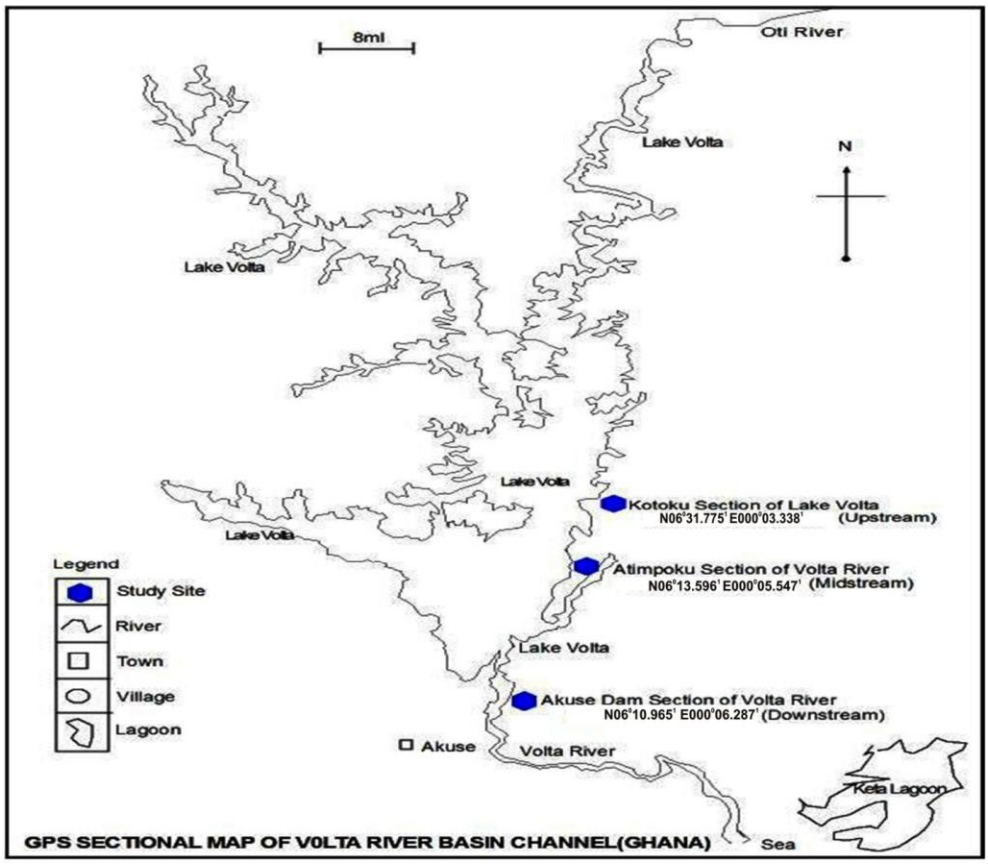


Figure 1. shows map of study locations on Volta River, Ghana with their spatial positioning.

**Prawn Sampling Technique**

Prawn basket traps were used across the three sampling stations for specimen collection. Traps were set on river substrate and left for a minimum of 72 hours or more before being hulled up to collect the catches. Catches were transported to Water Research Institute Laboratory (ARDEC station Akosombo) where they were identified morphologically using the descriptions of Rutherford, (1971) and Powell, (1982). They were then preserved in 10% formaldehyde solution for further studies.

**Water Quality Parameters and Chemistry**

Analysis of some water quality parameters at sampling sites were carried out in-situ using Hydro lab water quality meter (Electronic Probe Type Hanna H198106 model). These measurements were performed in triplicates at each sampling station. The parameters measured are: Temperature ($^0$C), pH, Conductivity (mΩ/cm), Dissolved Oxygen (ppm), Salinity (%) and Total Dissolved Solid (ppm). Colorimetric Test kit methods (Pond Lab NT200) were also in-situ engaged to determine water chemistry values for Total water Hardness (ppm), Alkalinity (ppm), Ammonia level (ppm), Nitrates and Nitrite levels (ppm). Water samples were also collected in transparent labeled bottles and transported in ice-chest containers to Water Research Institute laboratory (ARDEC station Akosombo). The titrimetric method was used to analyze for Sulphates (ppm), Carbonates (ppm) and Phosphates (ppm). Other ionic constituents of the river systems like $Na^+$, $K^+$, and $Ca^+$ were determined using a flame photometric method using a PG Flame Photometer Equipment with Model Number FP902. Also, the presence of Chloride ions

($Cl^-$) was determined by Argentometric method. Heavy metals such as Magnesium, Iron, Barium, Manganese, Copper, Cadmium, Nickel, Zinc and Lead were determined by AOAC, (1997) analytical procedure using a metal detector Atomic Absorption Spectrophotometer (Bulk Scientific AAS with Model Number 210 VGP).

**River Sediment Texture and Chemistry**

Textural and chemical analyses of river sediments across the sampling stations were analyzed on a seasonal basis. Samples were collected and analyzed according to the methods described in International Institute of Tropical Agriculture Laboratory Manual on Soil and Plant Analysis (IITA, 1979). Sediment samples were collected in triplicates at each sampling stations. After routing laboratory sample treatments, Sediments Bulk Density were evaluated by the formula:

A. **Bulk density ($D_b$)** = $\frac{\text{Weight of oven-dry soil}}{\text{Volume of oven-dry soil}} = \frac{w3 - w1}{V}$

B. **Particle–size analysis** was used to determine the textural classifications of the river sediments. The Hydrometer method was employed to flocculate the river sediment while the United States Department of Agriculture Classification Technique (USDA) was used to fractionalize the sediment into their respective textural classes.

C. **The sediment pH** was determined by the use of Hanna 211 microprocessor electronic pH meter with model number T106018. The microprocessor unit was first inserted into a calibration buffer to set the scale reading to neutral pH (7.0) after which the microprocessor was inserted into the sediment to determine the actual reading through the electronic meter attachment.

D. **Sediments organic matter compositions** were determined using the Walkley-Black Wet Oxidation Method which utilizes the redox potentials of potassium dichromate (vi) ions ($K_2\ cr_2\ 0_7$) to determine the percentage (%) organic carbon in the sediment. Thus the percentage organic matter in the sediment was calculated with the following formula:

**% Organic Matter = % organic carbon x 1.724 (Correction co-efficient)** (IITA, 1979 and Ibitoye, 2006).

**Measurement of Water Depth**

Water depth measurements at the study locations were taken with a calibrated string tape with a lead weight attached to the zero end of the string to allow easy sink through the water column. Measurements were made at three different points at each study location to ensure the accuracy of measurement. Cognizance was given to depth variations as a result of possible land elevation, depression or other secondary features like rock intrusion at different points of measurement

**Percentage Sex Abundance Record**

Percentage abundance record for sex was based on catch statistics of male and female specimens of *M. vollenhovenii* from the three sampling stations. It was expressed with the formula:

$$\%\ S.A = \frac{AU+AM+AD}{Y} \times 100 : \frac{BU+BM+BD}{Y} \times 100$$

Where: $Y = A' + B'$

Y is the gross seasonal catch of both specimens for the three study stations

A' is the total seasonal catch of male specimen for the three sampling stations and is expressed as: $A' = AU + AM + AD$

B' is the total seasonal catch of female specimen for the three sampling stations and is also expressed as: B' = BU + BM + BD

**Identification of Associated Fauna and Flora at Study Locations**

Photographs of fish species found as by-catch in the prawn basket traps used for sampling and other associated flora diversities of the study locations were taken by the use of Digital camera camp-coder AIPTEK with model number AHD 200. Identification of these fish fauna was done by the use of Freshwater Fishes and Fisheries of Nigeria Identification Guide (Adesulu and Sydenham, 2007). Identification of flora compositions was done by the use of identification manual for West African Weeds by Akobundu and Agyakwa, (1987).

## Results

The results of physico-chemical parameters taken at designated sampling stations revealed that the mean seasonal values for most parameters do not vary concerning seasons (Table 1) as obtained values for pH, salinity, temperature, ammonia and phosphates are not significantly different ($p>0.05$) based seasonality. Also, observations from obtained physico-chemical parameters results when compared with water quality standards for fresh water aquaculture revealed that the observed values are within the normal range (Table 2). Summary statistics for annual average values for the ionic constituents of water and heavy metal pollution indices revealed that $K^+$, $Ca^{2+}$, $Cu^{2+}$, $Zn^{2+}$ and $Pb^{2+}$ ions have values above the recommended thresholds (Table 3).

Annual average values for river sediments' chemistry revealed that the pH obtained was weakly acidic. A pH value of 5.12±1.13 was obtained at Kotoku upstream section near the Volta river dam around ARDEC station, while a value of 5.33±0.95 was obtained at Atimpoku (midstream section) and 4.96±1.33 was obtained downstream Akuse dam. The observed organic matter constituent of the river sediment was low with the highest percentage of 1.62% around Atimpoku (Table 4). The textural class of the river sediment was observed not to vary with seasons as sediment texture around this study location is basically sandy loam (Table 5). Average water depths across the sampling sites ranged between 5.13±2.6 (ft) to 15.80±4.92 (ft).

Results obtained from the percentage sex abundance records of samplings for the entire study period revealed that male population out-numbered female population in all catches at rainy and dry seasons (Table7).

Two species of fin fish and a prawn species known as African giant filter shrimp (*Atya gabonensis*) were the fish fauna collected and identified together with *M. vollenhoveni* in the prawn basket traps used for sampling. Also, four species of surface macrophyte were identified as water flora providing hiding spots for the prawns around the study location.

Table 1. Summary for Seasonal Average of Water Quality Parameters for Habitat Study of *M. vollenhovenii* on Designated Sections of Volta River Basin Channel for the Two Years of Study

| Water Quality Parameters | Volta River Basin Channel, Ghana | | | |
|---|---|---|---|---|
| | Sampling Year 1 Mean±S.D | | Sampling Year 2 Mean±S.D | |
| | Dry Season 1 | Rainy Season 1 | Dry Season 2 | Rainy Season 2 |
| Temp ( $^0$C ) | 28.23±0.44$^a$ | 28.01±0.78$^a$ | 31.59±2.51$^b$ | 28.21±0.91$^c$ |
| pH | 6.37±0.24$^a$ | 6.37±0.45$^a$ | 6.11±0.44$^a$ | 6.24±0.30$^a$ |
| Conductivity (Mμ-Cm) | 0.0134±0.00$^a$ | 0.0187±0.00$^a$ | 0.0182±0.00$^a$ | 0.0203±0.00$^b$ |
| D.$O_2$ (ppm) | 2.91±0.51$^b$ | 2.31±1.70$^b$ | 1.92±0.13$^a$ | 3.78±3.00$^c$ |
| Salinity (ppm) | 0.02±0.00$^a$ | 0.02±0.00$^a$ | 0.02±0.00$^a$ | 0.02±0.00$^a$ |
| Tds (ppm) | 26.82±3.78$^b$ | 27.62±3.47$^c$ | 27.95±2.07$^c$ | 24.94±2.05$^a$ |
| Hardness (ppm) | 31.64±6.85$^b$ | 29.66±10.27$^a$ | 35.60±0.00$^c$ | 35.60±0.00$^c$ |
| Alkalinity (ppm) | 26.50±8.07$^d$ | 22.94±8.90$^b$ | 17.80±0.00$^a$ | 23.73±10.27$^c$ |
| Ammonia (ppm) | 0.00±0.00$^a$ | 0.00±0.00$^a$ | 0.33±0.28$^b$ | 0.00±0.00$^a$ |
| Nitrates (ppm) | 0.00±0.00$^a$ | 0.83±1.44$^c$ | 0.55±0.95$^b$ | 1.11±1.27$^d$ |
| Nitrites (ppm) | 0.083±0.14$^b$ | 0.00±0.00$^a$ | 0.10±0.04$^c$ | 0.08±0.08$^b$ |
| Sulphates (ppm) | 67.56±2.42$^b$ | 40.80±1.62$^a$ | 70.43±1.95$^c$ | 68.20±1.79$^b$ |
| Carbonates (ppm) | 31.39±24.89$^a$ | 39.19±26.26$^b$ | 59.14±18.92$^c$ | 68.97±7.63$^d$ |
| Phosphates (ppm) | 0.08±0.08$^a$ | 0.15±0.09$^b$ | 0.07±0.04$^a$ | 0.07±0.02$^a$ |

- Duncan Multiple Range Test (P = 0.05)
- Means with different superscripts are significantly different across rows at P≤0.05.
- Mean value equal to 0.00 connotes undetected parameter
- S.D. = Standard Deviation of the Mean

Table 2. Summary for Annual Average of Water Quality Parameters for Habitat Study of *M. vollenhovenii* on Designated Sections of Volta River Basin Channels for the Two Years of Study as it compare with recommended benchmarks for Aquaculture

| Water Quality Parameters | Volta River Basin Channel, Ghana | | Water Parameter Standards For Fresh Water Fish/Prawn Aquaculture As Captured In F.A.O.,1987; F.E.P.A., (1991); World Bank, (1999) | References |
|---|---|---|---|---|
| | Sampling Year 1 Mean±S.D | SamplingYear 2 Mean±S.D | | |
| Temp ( $^0$C ) | 28.14±0.18 | 29.90±0.23 | 26-30$^0$C | Romaire, 1985; Boyd, 1990 |
| pH | 6.37±0.13 | 6.11±0.28 | 6.5-9.0 | Lawson, 1995 |
| Conductivity (Mμ$^-$Cm) | 0.0186±.00 | 0.0194±0.00 | | |
| D.$O_2$ (ppm) | 2.61±0.34 | 2.84±0.34 | ≥1.0 or 0.7-1.4mg/l | Marioghae, 1987; Boyd, 1990 |
| Salinity (ppm) | 0.02±0.00 | 0.02±0.00 | 0.10-0.27mg/l | Marioghae, 1987 |
| Tds (ppm) | 27.22±0.58 | 26.44±1.77 | | |
| Hardness (ppm) | 30.98±1.51 | 35.60±0.00 | 25-80mg/l | Boyd, 1990 |
| Alkalinity (ppm) | 25.05±0.41 | 20.76±0.00 | >50mg/l | Boyd, 1990 |
| Ammonia (ppm) | 0.00±0.00 | 0.16±0.00 | ≥ 100 or 150mg/l | Turker and Robinson, 1990 |
| Nitrates (ppm) | 0.41±0.00 | 0.83±0.00 | 0.1 – 1.0mg/l | Boyd, 1990 |
| Nitrites (ppm) | 0.04±0.00 | 0.09±0.02 | < 3.0mg/l | Piper *et.al*., 1982 |
| Sulphates (ppm) | 31.20±0.55 | 69.33±2.67 | < 0.5mg/l | Swan, 1993 |
| Carbonates (ppm) | 39.10±7.92 | 68.30±14.40 | 500mg/l | F.E.P.A., 1991 |
| Phosphates (ppm) | 0.11±0.05 | 0.07±0.01 | 5.0 mg/l | F.E.P.A., 1991 |

- S.D. = Standard Deviation of the Mean
- 1ppm ≡ 1mg/l

Table 3. Summary for Annual Average of Ionic Constituents of Water and Heavy Metal Pollution Indices for Habitat Study of *M. vollenhovenii* on Designated Sections of Volta River Basin Channels as it compare with recommended benchmarks for Aquaculture

| Water Quality Parameters | Volta River Basin Channel, Ghana | | Water Parameters Benchmarks For Fresh Water Fish/Prawn Aquaculture As Reported In Literatures | References |
|---|---|---|---|---|
| | Sampling Year 1 Mean±S.D | Sampling Year 2 Mean±S.D | | |
| $Na^{+}$(ppm) | 9.49±2.52 | 29.17±7.24 | 50mg/l | UNESCO/WHO/UNEP, 1996 |
| $K^{+}$(ppm) | 13.05±11.05 | 23.40±7.15 | 10mg/l | UNESCO/WHO/UNEP, 1996 |
| $Ca^{2+}$ (ppm) | 107.78±8.57 | 145.91±11.13 | <15mg/l | C.F.F., 1993 |
| $Cl^{-}$ (ppm) | 212.40±12.11 | 307.20±38.29 | 300mg/l | UNESCO/WHO/UNEP, 1996 |
| $Mg^{2+}$ (ppm) | 0.95±0.17 | 2.63±0.44 | 200mg/l | F.E.P.A., 1991 |
| $Fe^{2+}$ (ppm) | 0.33±0.05 | 0.51±0.12 | 1.0mg/l | F.E.P.A., 1991 |
| $Mn^{2+}$ (ppm) | 0.04±0.01 | 0.18±0.06 | 5mg/l | F.E.P.A., 1991 |
| $Cu^{2+}$ (ppm) | 0.06±0.02 | 0.12±0.05 | 0.010mg/l or 1-10ppb | World Bank, 1999 |
| $Zn^{2+}$ (ppm) | 0.10±0.06 | 0.24±0.06 | 0.075mg/l or 75ppb<br>0.05mg/l or 50mg/l | E.U., 1979<br>U.S.E.P.A., 1993 |
| $Pb^{2+}$ (ppm) | 0.04±0.00 | 0.12±0.05 | 0.0032mg/l or 3.2ppb | U.S.E.PA., 1986 |
| $Ba^{2+}$ (ppm) | 0.00±0.00 | 0.00±0.00 | 5mg/l | F.E.P.A., 1991 |
| $Cd^{2+}$ (ppm) | 0.00±0.00 | 0.01±0.01 | <1.1mg/l<br><2.0mg/l | U.S.E.P.A., 1986<br>U.N.E.P., 1985 |
| $Ni^{2+}$ (ppm) | 0.00±0.00 | 0.01±0.01 | 0.01mg/l or 10ppb<br>0.05mg/l | World Bank, 1999<br>F.E.P.A., 1991 |

- S.D. = Standard Deviation of the Mean
- 1ppm ≡ 1mg/l

Table 4. Average Values for River Sediments Chemistry and its Physical Properties for Habitat Study of *M. vollenhovenii* at Selected Locations on Volta River Basin, Ghana based on Sampling Stations

| River Sediments Chemistry And Its Physical Properties | Sampling Stations | | |
|---|---|---|---|
| | Upstream Kotokukope: $N06^{0}31.775^{1}$ $E000^{0}3.388^{1}$ (Mean±S.D) | Midstream Atimpoku: $N06^{0}13.596^{1}$ $E000^{0}05.547^{1}$ (Mean±S.D) | Downstream Akuse: $N06^{0}10.965^{1}$ $E000^{0}06.287^{1}$ (Mean±S.D) |
| Moisture (%) | $13.43±3.84^{a}$ | $13.45±3.92^{a}$ | $14.69±4.02^{a}$ |
| Bulk Density ($G/Cm^{3}$) | $0.92±0.05^{a}$ | $0.97±0.11^{a}$ | $0.97±0.08^{a}$ |
| Ph | $5.12±1.13^{a}$ | $5.33±0.95^{a}$ | $4.96±1.33^{a}$ |
| Organic Matter (%) | $1.50±1.10^{a}$ | $1.62±1.95^{a}$ | $1.18±0.77^{a}$ |

- Duncan Multiple Range Test (P = 0.05)
- Means with different superscripts are significantly different across rows at P≤0.05.
- Mean value equal to 0.00 connotes undetected parameter
- S.D. = Standard Deviation of the Mean

Table 5. Seasonal Variations in River Sediments Textural Properties on the Eastern Region of Volta River Basin Channel, Ghana.

| Sampling Locations | Dry Season | | | | Textural Class | Rainy Season | | | Textural Class |
|---|---|---|---|---|---|---|---|---|---|
| | | Textural Properties (Mean±S.E) | | | | Textural Properties (Mean±S.E) | | | |
| | Sampling Year | Sand (%) | Silt (%) | Clay (%) | | Sand (%) | Silt (%) | Clay (%) | |
| Volta River Basin Channel, Eastern Region, Ghana | 1 | 55.53±.53 | 23.58±3.35 | 20.66±2.66 | Sandy clay loam | 63.33±10.00 | 20.55±6.11 | 16.11±3.89 | Sandy loam |
| | 2 | 45.57±2.44 | 38.88±4.07 | 15.55±1.63 | Sandy loam | 70.00±0.92 | 15.55±0.55 | 14.44±0.55 | Sandy loam |

- Results are presented as a measure of percentage mean composition

S.E = standard error of mean

Table 6. Average Water Depth Analysis of Study Stations for the *Macrobrachium Prawns* Habitat Study at Volta River Basin Channel, Ghana.

| Study Rivers | Water Depths (Fts) (Mean+S.E) | | |
|---|---|---|---|
| | Upstream | Midstream | Downstream |
| Volta River Basin Channel, Ghana | 5.13±2.16 | 15.80±4.92 | 7.60±1.77 |

- S.E = Standard Error of Mean
- Volta River Basin Channel, Ghana - Upstream (Kotukukope) $N06^{0}31.775^{1}$ $E000^{0}03.338^{1}$; Midstream (Atimpoku) $N06^{0}13.596^{1}$ $E000^{0}05.547^{1}$; Downstream (Akuse) $N06^{0}10.965^{1}$ $E000^{0}06.287^{1}$

Table 7. Percentage Sex Abundance Record of *M. vollenhovenii* collected from Eastern Section of Volta River Basin Channel, Ghana based on Seasonality of Sampling

| Sampling Seasons | Percentage Sex Abundance Record *Macrobrachium vollenhovenii* | | | |
|---|---|---|---|---|
| | Sampling Year 1 | | Sampling Year 2 | |
| | Males (%) | Females (%) | Males (%) | Females (%) |
| Dry season | 59.91 | 40.08 | 65.23 | 34.77 |
| Rainy season | 74.53 | 25.46 | 76.83 | 23.17 |

## Discussion

The habitat ecology of *M. vollenhovenii* was studied around the Eastern Section of Lower Volta River Basin Channel, Ghana between June, 2015 and May, 2017. The study section of this river is an exclusively fresh water ecosystem bounded at various distances between Kotokukope village (Upstream), Atimpoku (Midstream), and Akuse (Downstream) by the construction of two units of hydro-electric power generation reservoirs as the river flow from the North through the

Eastern region of the country. The ecological sampling of physico-chemical parameters of this river at designated sampling stations revealed that seasonality is not the dominant factor affecting the water quality parameters but rather anthropogenic activities. Inferences drawn from analytical results of annual average for water quality parameters such as temperature ($^0$C), pH, salinity, ammonia, nitrites and phosphates revealed no significant variation ($p>0.05$) between seasons for the first and second year of sampling. Most of these water quality parameters (Table 2) were observed to be within the recommended threshold, suitable for aquaculture of fresh water fin or shell fishes (F.A.O., 1987; F.E.P.A., 1991; World Bank, 1999). Ionic constituents of water were examined to determine the level of heavy metal pollution across sampling locations because of likely discharges of metal ions and effluents that may occur due to the presence of hydro-electric power stations and Akosombo Textile Company near the river channel. Results revealed that values for $Na^+$, $Cl^-$, $Mg^{2+}$, $Fe^{2+}$, $Mn^{2+}$, $Ba^{2+}$, $Cd^{2+}$ and $Ni^{2+}$ were lower than the recommended thresholds for surface water and fish aquaculture (UNEP, 1985; USEPA,1986; World Bank, 1999; UNESCO/WHO/UNEP, 1996). However, metal ions like $K^+$, $Ca^{2+}$, $Cu^{2+}$, $Zn^{2+}$ and $Pb^{2+}$ were observed to be present in quantities above recommended thresholds (E.U., 1979; USEPA, 1986; C.F.F., 1993). The average pH and organic matter contents of the river sediments also ranged between 4.96±1.33-to-5.33±0.95 and 1.18±0.77-to-1.62±1.95. This result affirms that the river sediment is weakly acidic with low percentages of decomposed organic materials around the sampling stations (Table 4). In practical terms, *Macrobrachium* prawns are known to forage on the river substrates and use the roots of water macrophytes as hiding spots (Eniade and Bello-Olusoji, 2011). The health of this animal is thus partly influenced by the chemical and physical compositions of the river substrates on which they forage. River sediments' texture around this section of Volta River was also observed to be sandy-loam (Table 5). This observation is in agreement with (Powel, 1982) on the preferences of Macrobrachium species for a particular type of habitat substrate. He observed that *M. macrobrachion* showed a preference for the muddy and quiet environment while *M. vollenhovenii* prefer sandy substratum. Inferences obtained from water depth measurements across sampling stations revealed that *M. vollenhovenii* do not inhabit great depths and that maximum water depth obtained around this study location was 15.80fts (Table 6). This result supports the observation of Eniade and Bello-Olusoji, (2011) that Macrobrachium prawns are sub-lithoral in nature and do not inhabit great depths.

Furthermore, percentage sex abundance statistics showed that male populations of *M. vollenhovenii* outnumbered the females at both dry and rainy seasons for the two years of study with variable percentages of males-to-females (Table 7). This phenomenon whereby male population outnumbers female population has been reported by Deekae and Abowei, (2010a). They pointed at the fact that female populations in prawns naturally outnumber the male population but may not be so in some exceptional situation as observed in this study. They further explained that sex ratios in Macrobrachium species may vary according to sampling months and seasons. Motoh, (1981) also reported that for shrimps, variable male to female sex ratios could be obtained at any sampling period irrespective of months or seasons. However, this interpret to the fact that variability in sex ratio or percentage relative abundance within a prawn population may be subjective to more selective forces other than sampling months and seasonality. These selective forces could be type and number of predators within the population, fishing pattern, gear types and other chemical or physical parameters which may aid spatial re-distribution or separation of sex or age classes within the population.

Furthermore, this population of *M. vollenhovenii* was observed foraging with other fin-fish species like *Chana obscura and Oreochromis niloticus* around the upstream and midstream stations. However, at the downstream portion of Akuse hydro-electric power generation reservoir, a mixed population of *Atya gaboniensis* and *M. vollenhovenii* were collected together in prawn basket traps throughout the 24 months of study. Results on morphological features for identification of *M. vollenhovenii* revealed that the spine arrangement pattern on the dorsal part of rostrum remained the most useful parameter for easy identification during field sampling. Rutherford, (1971) observed that the major morphological delineation between *M. vollenhovenii* and other prawn species collected from the area of Cape Coast, Ghana was the continuous pattern of spines arrangement on the dorsal part of rostrum lacking toothless portion and that the number of spines on the dorsal and ventral part of rostrum ranged from 11-to-14 and 4-to-5 teeth on adult specimen. *Eichhornia crassipes, Ipomoea aquatica, Diplazium sammatii and Leptochloa caerulescens* were flora species observed to provide hiding spots and foraging ground for *M. vollenhovenii* across sampling stations designated for this study.

## Conclusion

Observations from the results of this ecological study suggest that this prawn population lives in an exclusively fresh water body (completes its entire life cycle in fresh water) and the stock could easily be developed to promote prawns' aquaculture in West Africa region. It is therefore recommended that fisheries scientists and aquaculture experts should conduct more researches to promote commercial production of this prawn.

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## Conflict of Interest

The author confirms that this article content has no conflicts of interest.

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