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Distribution of Chironomidae (Diptera: Insecta): Bio-Indicators of Organic Pollution in the Bamenda River Basin, North West Region, Cameroon

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Abstract:
The influence of physical and chemical parameters on the abundance and diversity of chironomids has been studied in river mezam and its affluence which present a moderate to highly polluted water in Bamenda. Sampling was carried out on each of the rivers with its 13 sampling stations over a period of six months (January 2017– June 2017). Physico-chemically, we noted a relatively higher water temperature, low dissolved oxygen with a moderate organic pollutants concentration.
Eight chironomid genera were identified representing 18 species; Chironomus stigmaterus, Chironomus plumosus, Chironomus riparus, Chironomus staegeris, Chironomus crassicaudatus, Polypedilum illinoeuse, Polypedilum laetum, Polypedilum beckae, Polypedilum sp., Dicrotendipes neonodestus, Micropsectra sp., Radotanypus florens, Cantopelopia gesta, Brundiniella eumorpha, Procladius bellus, Tanypus sp. Zalutschia sp. and Eukiefferiella sp. were identified. Assessment of their relationships with several environmental variables was performed using multivariate analysis. Chironomus and Polypedilum which are generally considered resistant to organic pollution dominated in the dry season which is characterized by high accumulation of house hold waste in the rivers and other wastes from the various markets. Meanwhile, Zalutschia, Eukiefferiella, Radotanypus and Procladius which are less adopted to organic pollution dominated in the rainy season that is characterized by high water contain in dissolved oxygen compared to the dry season. Consequently, these aquatic communities were ecological disordered by organic pollution that caused a decreased in the different genus and loss of sensible species and the abundance of tolerant species. We found several significant correlations ($p<0.05$), but most of them were low ($r<0.5$). We can only highlight those that were higher ($r>0.5$). There were significant positive correlations between temperature and a number of chironomus species ($r=0.270$) and for the taxa we found a significant negative correlation between electrical conductivity, Total Dissolved Solids and Procladius bellus ($r=-0.267$), ($r=-0.267$) respectively and a significant positive correlation between nitrate concentration and Chironomus stigmaterus ($r=0.230$). The Shannon and weaver indice (2.75 bit/ind) and the Pelour (0.76) shows that all the sampling stations present a relatively high diversity.

Keywords*: Chironomid larvae, Mezam River, Bamenda; physicochemical parameters, multivariate analysis*

1. Introduction

Rivers play a key role in ecosystems and society, and they provide a range of ecosystem functions such as shelter and food source for an array of biological species, aid in flood management and ecological refuge development (Hoelzl, 2007). Socially, rivers accommodate communities by providing a medium for transport, recreation, tourism, worship, ecosystem services and a place to experience the serenity of nature. Unfortunately, many peri-urban rivers draining from extensive urban and agricultural areas have become highly degraded over the past few decades and remain a sensitive issue (Pinto and Maheshwari, 2011). This streams and rivers are amongst the most threatened ecosystems in the world (Allan & Flecker 1993, Dynesius & Nilsson 1994, Riccardi & Rasmussen 1999). The threats include climate change, alteration of catchment land cover and use alteration, degradation of instream habitat and water quality, and introduction of non-native species (Allan 1995, Sala et al., 2000). Several international agreements and policies address the conservation of biodiversity (e.g., Convention on Biological Diversity (2005)

Among the fauna of rivers that should be highlighted are macroinvertebrates. This group of high diversity and ecological importance consists of invertebrates of macroscopic size, normally more than 1mm, living permanently or during certain periods of their life cycle linked to the aquatic environment. They include insects, crustaceans, annelids, molluscs, leeches, etc. (Cesar et al., 2012). Different groups of macroinvertebrates are excellent indicators of human impacts, especially contamination. Most of them have quite narrow ecological requirements and are very useful as bioindicators in determining the characteristics of aquatic environments (Benetti & Garrido, 2010; Fernández-Díaz et al., 2008; Pérez-Bilbao & Garrido, 2009), to identify the segments of a polluted river where self-purification of organic inputs is under process (Chatzinikolaou & Lazaridou 2007). Among macroinvertebrate taxa, Chironomidae is one of the richest groups in species that are found in aquatic habitats (Cranston, 1995). Due to their ubiquity and different species preferences, Chironomids are well known as indicators of organic enrichment and heavy metal contamination in running waters (Rosenberg, 1992). The larvae of non-biting aquatic midges (Chironomidae: Diptera) are dominant in many aquatic ecosystems especially those with moderately to highly polluted environments (Al-Shami et al., 2010 a). Chironomid assemblages are recognized as reliable water-quality indicators, and they have been widely studied in impacted ecosystems (Ruse and Wilson 1984, Armitage and Blackburn 1985, Wilson 1994, Calle-Martinez and Casas 2006). In addition, their rapid population growth and high densities in enriched streams suggest that chironomid assemblages play a key role, particularly in food webs, in impacted aquatic ecosystems (Benke 1998). Thus, chironomid larvae are a link in the turnover of organic matter within the stream system. Moreover, chironomid adults affect the food webs of adjacent ecosystems at the catchment scale (e.g., through bat and bird predation). Species composition of chironomid assemblages differs qualitatively and quantitatively among microhabitats, and larvae are highly selective in their choice of a site (e.g., Franquet 1999, Vos et al., 2002).

Bamenda city has seen the progressive deterioration in its environmental quality as a result of rapid and unplanned urbanization that took off since the early 80's. The aim of this work is to determine the diversity of Chironomidae, the spatial and seasonal variations of all principal parameters and indicators of organic pollution.

2. Material and Methods

2.1. Geographical Location of the Town of Bamenda

Bamenda is located between latitudes 5°56" N and 5°58" North of the equator and longitude 10°09" and 10°11" East of the Greenwich Meridian. Bamenda lies at an altitude of 1430m above sea level with a surface area of 3125ha (Acho-Chi, 1998). The town occurs along the Cameroon Volcanic Line and exhibits two very distinct relief environments; that is, the High Lava plateau (Up Station) with an altitude of about 1400m and the Lower plateau (Down Town) with an average altitude of 1100m above sea level. Bamenda is the regional headquarters of the North West Region of Cameroon (Kometa1 & Ndi, 2012). The vegetation is the Guinea Savanna type and the temperature is moderate (Neba, 1999). The morphology of Bamenda is characterised by a gentle sloping Up-station area separated from an undulating to flat Down Town area by an escarpment which is about 7 km long with trend N370 and about 150 m high. The climate is the humid tropical highland type characterized by two seasons; the rainy and the dry season. The rainy season is generally longer and lasts for eight months (mid-March to mid-October) a short, dry season of four months (mid October to mid-march) (Tita et al., 2012)

2.2. Description of Study Sites and Sampling Points

The dendritic drainage pattern of running water in the town of Bamenda permits for the evaluation of the effects of urbanization in this town. For this study, river Mezam and its four affluent streams were chosen: two sub-urban streams; Mufueh and Furmuki streams and two urban streams which are: Mankon 1and Mankon 2 as presented on figure 1 below.

<u>2.2.1. Mezam</u>

It the area below Ngomgham Situated at the outlet of the Mezam River from Bamenda. this river drains the Municipal open waste discharge at Mile 8.

2.2.2. Mufueh (Mu)

The mufueh stream extends for 1.5 km up and downstream of the Mile 4 Bridge along the Mughoro stream. It receives water from the Bayelle flood and flows down into the river Mezam located at the outlet of the town. It has as altitude 1213m and situated between Longitude 5^0 58' 50" N and Latitude 10^0 11' 28" E For this study, three sampling stations where chosen

2.2.3. Furmuki

The MMU segment extends for 1.5 km up and downstream of the Mile 4 Bridge along the Mughoro stream. It receives water from the Bayelle flood plain, an intensive agricultural area in a semi-rural/semi-urban setting. Its shoreline presents some degree of disturbance by habitation, cultivation, pisciculture and eroded soil.

2.2.4. Mankon 2 – Stream Behind Vatican Express

The sediment type is mainly sand and some silt. The MNG segment extends for 1.5 km along the mainstem of the Mezam River from its confluence with the Ayaba stream at Musang downstream through Ngomgham

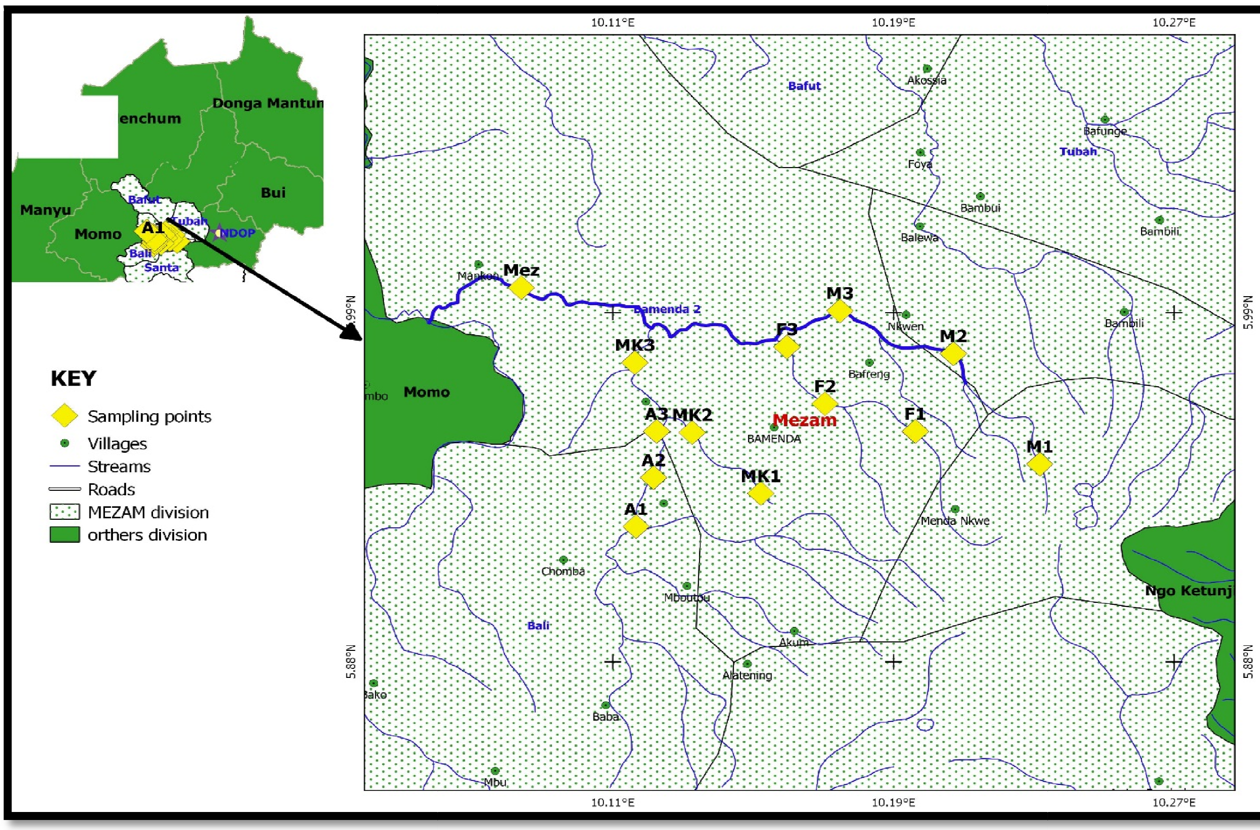

Figure 1: Map of Mezam Showing Sampling Points

2.3. Measuring of Physico-Chemical Parameters

This was achieved following the recommendation of APHA, 1998; Rodie et al. (2009). Hence, on the field, parameters like temperature (°C), pH (CU), electrical conductivity (µS/cm), turbidity (FTU) where measured using appropriate instruments. Oxygen was fixed with a Winkler reagent. Back in the laboratory, other parameters such as colour (Pt. Co), alkalinity (mg/L), oxydabelity (mg/L), nitrate (mg/L), orthophosphates (mg/L), oxygen (mg/L), Carbondioxide (mg/L) where measured.

2.4. Collection, Slide Preparation and Identification of Chironomid Larvae

On the field with the help of a hand net with very fine mesh about 300µm the aquatic vegetation of the stream was swept across upstream and to downstream. The specimens were then picked out and conserved in 100ml polythene bottle containing 10% formalin before their transportation to the laboratory (Soumi et al., 2012). In the laboratory the specimens brought from the field were washed in a 250µm mesh sieve with tap water and conserved in 70 % alcohol. The preserved larvae were transferred to a petri dish containing 10% KOH solution and left in the solution for 24 - 48 h to digest the larval muscles. Thereafter, the permanent slide mounts of the larvae were prepared following the method of Epler (2001). The slide mounted larvae were identified to genus and species level using appropriate taxonomic keys (Kikuchi et al., 1985, Hasegawa and Sasa 1987, Morse et al., 1994, Merritt and Cummins 1996, Epler 2001, Cranston 2004).

3. Results and Discussion

3.1. Physico-Chemical results

The physicochemical parameters (table 1) varied as follows: temperature varied between 16.0 °C (in February at station Mufueh 1) and 27.8 °C (in March at station Mankon 2) as in Figure 2A. Dissolved oxygen was globally high all along the stream, with values situated between 59.5 % and 71.1 % (Figure 2C). The pH values varied between 6.06 and 8.33 (Figure 2B), while oxydability values were situated between 0.19 mg/L and 15.6 mg/L (Figure 3A). No significant differences ($P > 0.05$), were observed for these four variables between the different station and from one month to another. High values (420 µS/cm) and low values (21 µS/cm) of conductivity were recorded at the stations Mufueh1 and Mankon 1 during the months of March and June respectively (Figure 2D). These variations showed a significant difference between the different stations, same as from one month to another ($P < 0.05$). The same variation trend was observed for ammonia, Nitrates and phosphates, though with relatively low values of 0.02 mg/L, 0.01 mg/L and 0 mg/L respectively (Figure 3B and C)

Parameters	Minimum	Maximum	Mean	±Std. Deviation
Temperature (ºC)	16	27.8	21.7025	0.2741
Turbidity (FTU)	1	393	44.2692	7.1472
Suspended solid (mg/L)	4	381	32.5769	6.4698
TDS (mg/L)	10	210	82.6923	6.214
Colour (Pt.Co)	9	1248	187.78	26.7519
pH (CU)	6.06	8.33	7.4696	0.0522
Electrical conductivity (µS/cm)	21	420	165.625	12.4584
Dissolved oxygen (mg/L)	0.6	4.4	1.9372	0.0978
Dissolved carbondioxide (mg/L)	1.76	94.04	25.086	2.5032
Alkalinity (mg/L)	2	60	9.6667	0.9652
Phosphate (mg/L)	0	8.7	1.8081	0.2131
Nitrate (mg/L)	0	31	2.4707	0.5733
Oxidability (mg/L)	0.19	15.6	3.0073	0.3063
Ammonia (mg/L)	0.02	2.15	0.3804	0.0466

Table 1: Summary of Physicochemical Parameters in River Mezam

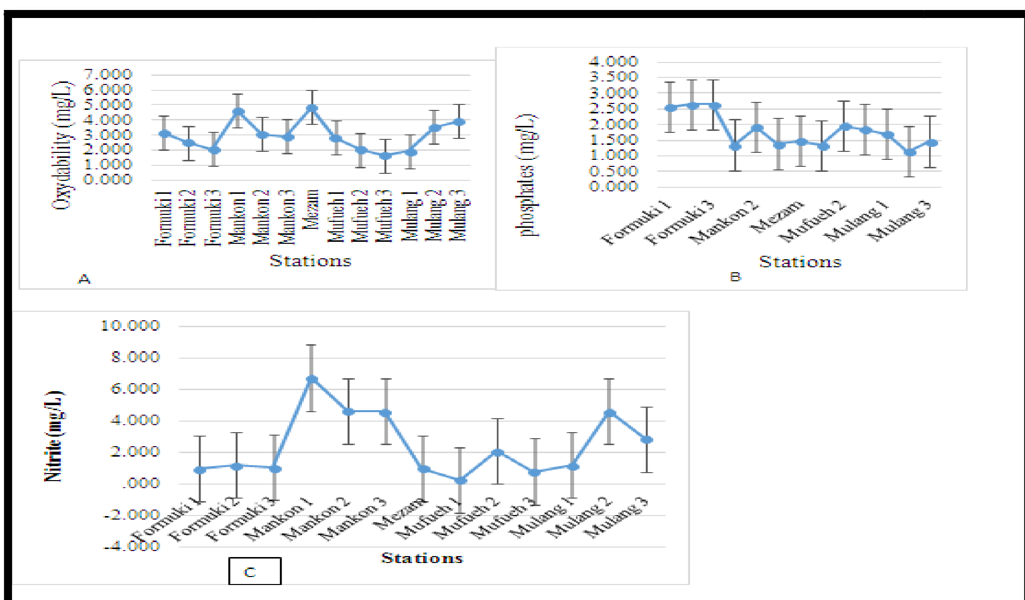

Figure 2: Spatiotemporal Variation of Physical Parameters; A) Temperature, B) Ph, C) Dissolved Oxygen, D) Electrical Conductivity

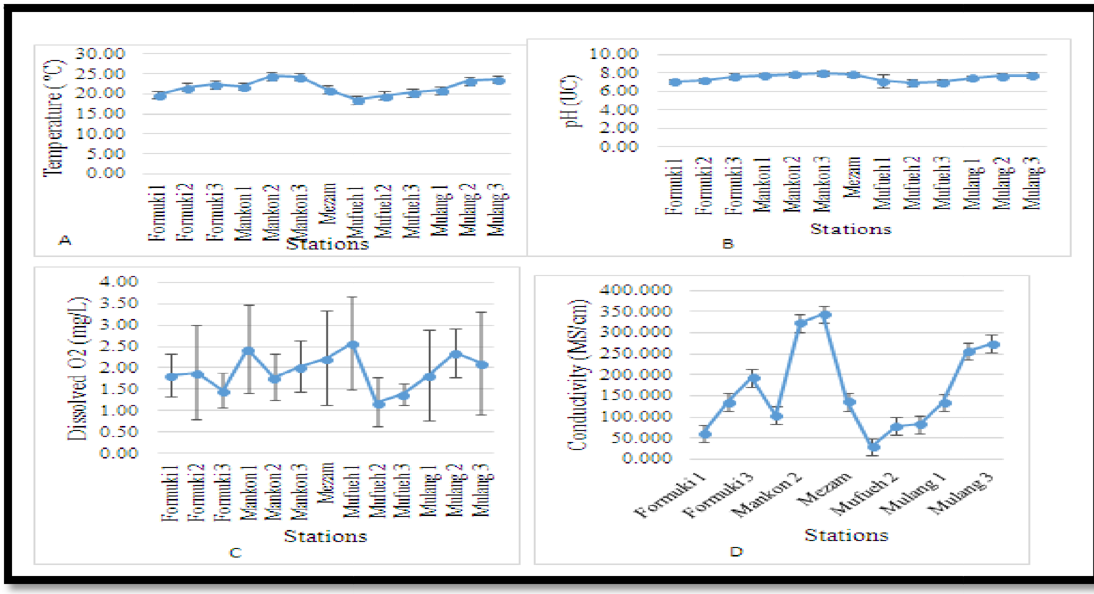

Figure 3: Spatiotemporal Variation of Chemical Parameters; A) Oxydability, B) Phosphates, C) Nitrites

3.2. Biological Results

Relative Abundance of chironomidae general a good number of campaigns were realized for 2443 chironomidae collected as summarized on table 2. These organisms belong to 8 general which are: Chironomus (78%), Radotanypus (10%), Polypedilum (5%), Brundiniella (2%), Procladius (2%), Dicrotendipes (1%), Micropsectra (1%), Cantopelopia (1%). The genus Tanypus, Zalutschia and Eukiefferiella represented approximately zero percent since the number of individuals collected was to small compared to the other groups.

Subfamily	**Genus**	**Species**	**Quantity**
Chironominea	Chironomus	Chironomus stigmatenus	305
		Chironomus plumosus	16
		Chironomus riparus	810
		Chironomus. staegeris	143
		Chironomus crassicaudatus	577
	Dicrotendipes	Dicrotendipes neonodestus	19
	Polypedilum	Polypedilum illinoeuse	68
		Polypedilum laetum	100
		Polypedilum sp.	6
		Polypedilum beckae	26
	Micropsectra	Micropsectra sp.	15
Tanypodinae	Radotanypus	Radotanypus florens	240
	Cantopelopia	Cantopelopia gesta	22
	Brundiniella	Brundiniella eumorpha	42
	Procladius	Procladius bellus	45
	Tanypus	Tanypus sp	2
Orthocladiinae	Eukiefferiella	Eukiefferiella sp.	3
	Zalutschia	Zalutschia sp.	4
Total	11	18	2443

Table: 2. Summary of the General and Species Collected During the Study

3.3. Community Structure of Chironomid Larva

A total of 18 chironomid taxa comprised 2443 individuals/m^2 were found in River mezam and its affluent during the studied period (Table 2). Although a total of thirteen different stations were investigated, many larval Chironomidae specimens were found at the Stations Formuki 1, mankon 1 and mulang 1. It was found out that the most abundant taxa were

Chironomus riparus comprising 33% abundance, followed by Chironomus crassicaudatus with 24%, and Chironomus stigmaterus and Radotanypus florens, with 12% and 10% abundances respectively in other sampling stations as seen on figure 4. It is reported that the larvae belonging to the genus Chironomus are often collected in aquatic ecosystems, which are subjected to high organic nutrient enrichment (Freimuth and Bass, 1994). In the current study, the larvae of Chironomus were also observed frequently. While low abundance and diversity of larval chironomids are reported (both species and numbers) in the Stations mufueh 3, mezam, and mufueh 1 as on table 3.

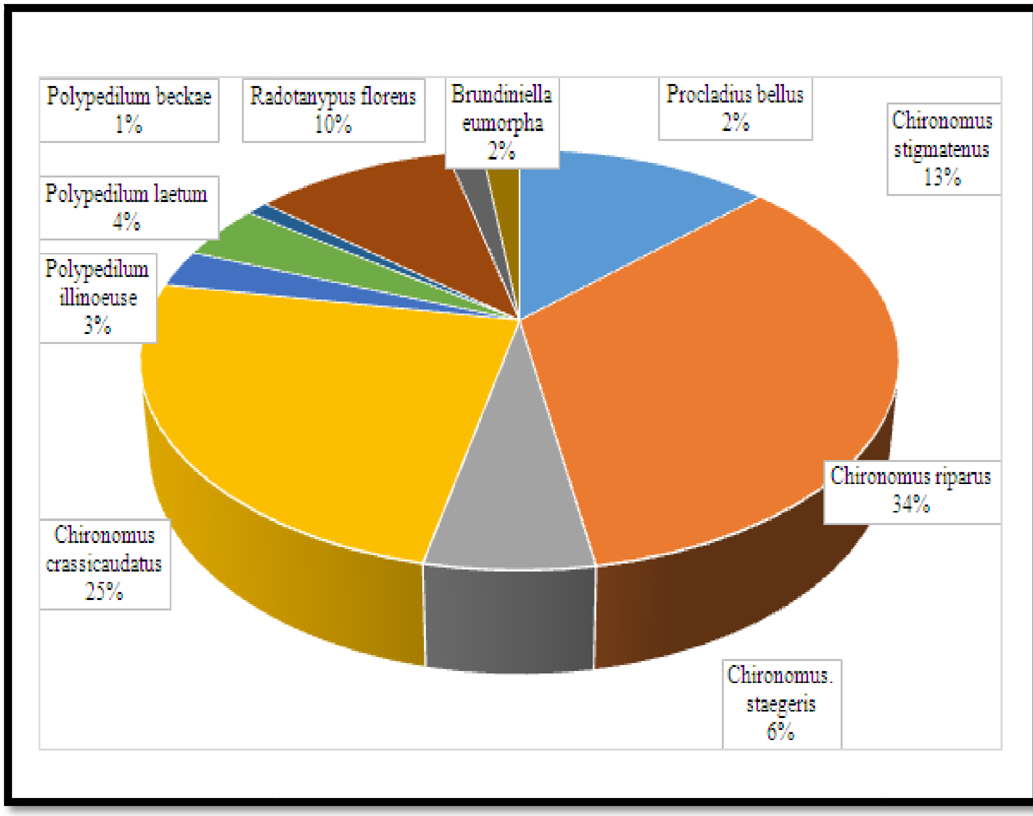

Figure 4: Percentage Representation of the Different Chironomids Species

Larvae belonging to the chironomid subfamilies Chironominae and Tanypodinae were collected at all sampling occasions. Among the Chironominae, Chironomus stigmaterus, Chironomus plumosus, Chironomus riparus, Chironomus staegeris, Chironomus crassicaudatus, Polypedilum illinoeuse, Polypedilum laetum, Polypedilum beckae, Dicrotendipes neonodestus and Micropsectra sp. were identified. Tanypodinae were represented by Radotanypus florens, Cantopelopia gesta, Brundiniella eumorpha, Procladius bellus and Tanypus sp. the sub family Orthocladiinae presented Zalutschia sp. and Eukiefferiella sp. The morphological characteristics of larvae identified based on mouth parts structure are summarized below based on the different general following the nomenclature of Epler (2001).

3.4. Taxonimic Features in Mouth Parts of Identified Species

The genus Chironomus: Larvae are distinguished by the presence of a frontoclypeal apotome and one medial labral sclerite; a single multi-toothed comb; mandible; 0-1 pairs of caudolateral tubules and 0, 1 or 2 pairs of ventral tubules figure 5 a. Larvae are usually found in sediments and can occur in highly polluted conditions. Larvae of Ch. riparius and Ch. stigmaterus are most often associated with high nutrient/low oxygen conditions. Five species were identified in this genus figure 5A. Ch. stigmatenus: Anteromedian margin of ventromental plate smooth, margin of plate may be faintly crenulate. Central tooth of mentum usually basally constricted figure 5B. Ch. plumosus: Anteromedial margin of ventromental plate with fine teeth, Mandible with 3 dark inner teeth figure 5C. Ch. riparus: Mandible with 3 dark inner teeth; 2 pairs of ventral tubules present figure 5D. Ch. staegeris: Mandible with 2 dark inner teet, Inner apex of ventromental plate directed medially figure 5E. Ch crassicaudatus: Inner apex of ventromental plate directed caudad figure 5F.

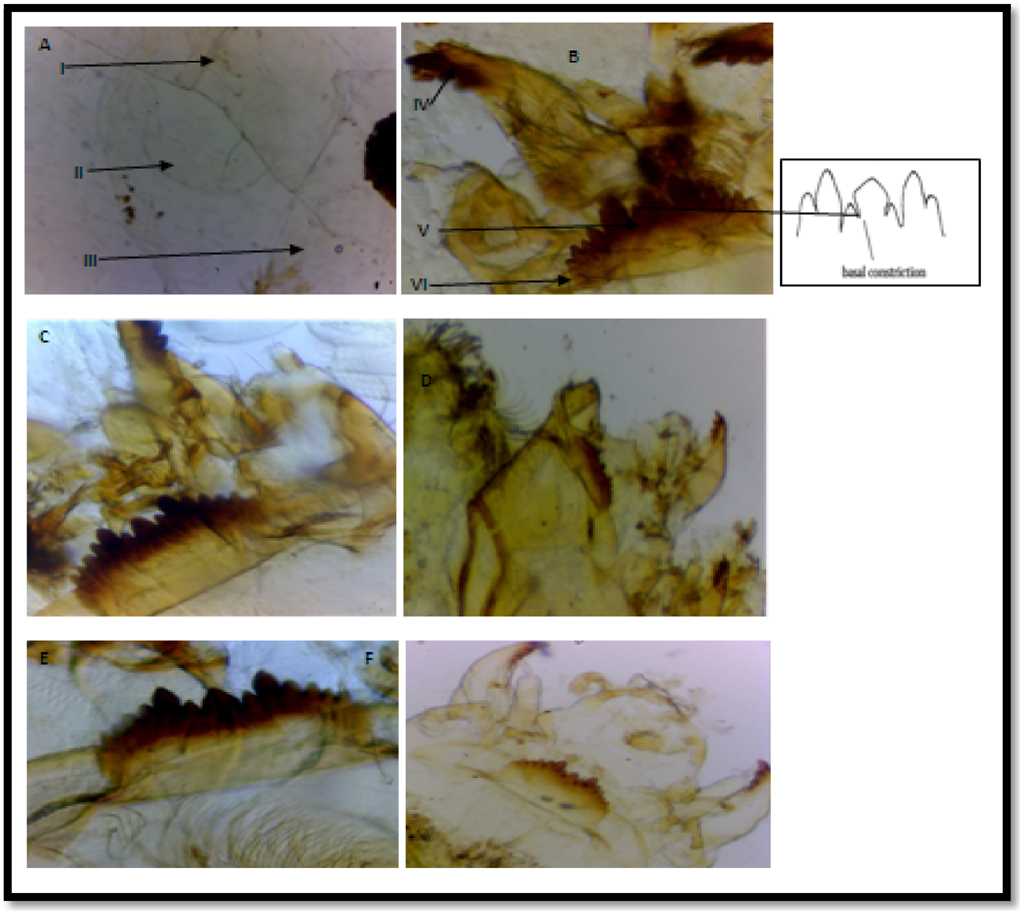

Figure 5: Taxonomic Features on the Mouth Parts and Abdomens of Chironomus; A; Posterior Segments of Chironomus, AI; 8th and 9th Abdominal Segments, AII; Ventral Tubules, AIII; Posterior Proleg, B; Mouth Parts of Ch. Stigmatenus BIV; Mandibles with a Dorsal Tooth, BV; Mentum with Teeth, BVI; Ventromental Plates C; Mouth Parts of Ch. Plumosus, D; Mouth Parts of Ch. Riparus, E; Mouth Parts of Ch. Staegeris, F; Mouth Parts of Ch Crassicaudatus

Genus Dicrotendipes: mentum convex with an odd number of teeth; ventromental plate width less than width of mentum; and mentum tooth and first lateral teeth pointed and enlarged. As for D. neomodestus, it has a postmentum length < 250 µm; mentum width < 150 µm; pect in mandibularis with 12 or fewer figure 6A.

Genus Polypedilum: The distinctive mentum, with median and second lateral teeth longer than first lateral teeth, will distinguish most members of the genus. Others have 4 median teeth of the mentum not separated from the rest of mentum by a distinct line. P. illinoeuse: Width of 1 ventromental plate 2.5X or less the distance between the plates. figure 6B. P. laetum: Mentum with central 4 teeth higher than remaining lateral teeth; mentum with 14 teeth or 16 teeth figure 6C. P. beckae: Mentum with 16 teeth, with 6 central teeth slightly higher or all teeth subequa figure 6D.

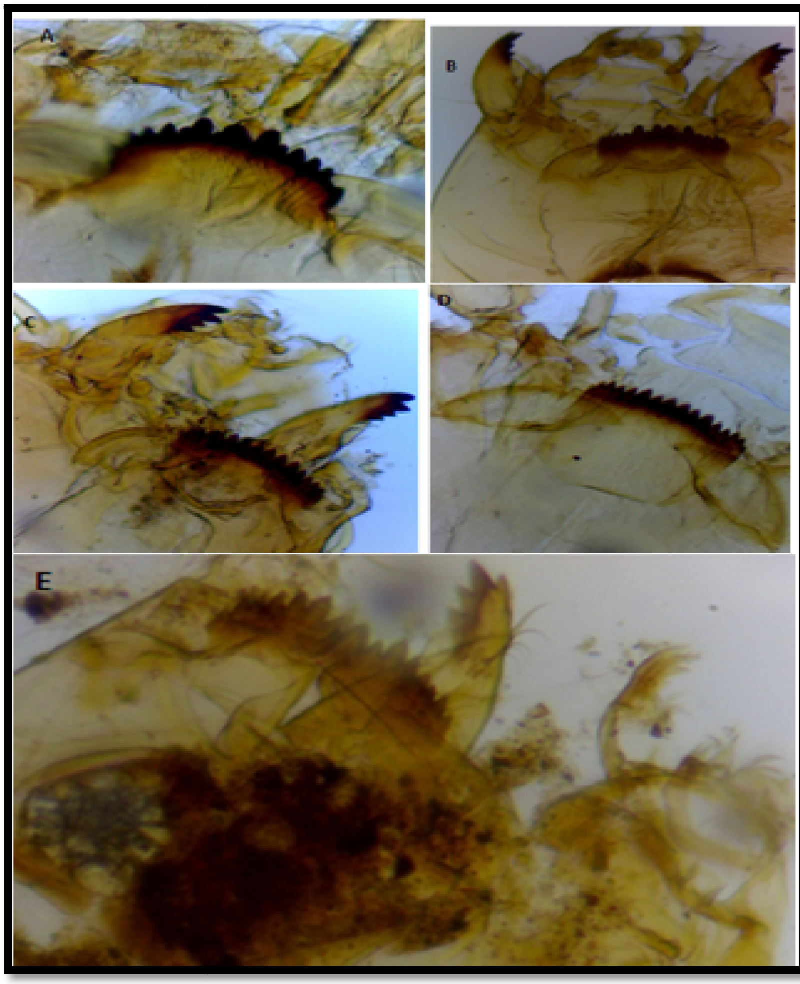

Figure 6: Teeth Disposition in Some Chironomids. 6A; D. Neomodestus 6B; P. Illinoeuse, 6C; P. Laetum, 6D; P. Beckae and 6E; P. Sp

Genus Radotanypus: Distinguished by the rotund head capsule; ring organ near middle of maxillary palp; ligula with inner teeth directed forward; dorsomental plates with 5 large teeth, a bifid innermost tooth. R. florens with a yellowish-brown head capsule, without dark marking. Ligula short and squat; paraligula with 2 or fewer lateral branches; small claw of posterior parapod with ovoid base figure 7A.

Genus Procladius: Procladius larvae are distinguished by the rotund head capsule; well-developed dorsomental tooth plates; mandible with large blunt basal tooth; black/dark brown five toothed ligula figure 7B

Genus Tanypus: Tanypus larvae may be distinguished by the stout mandible (the apical tooth appears small in relation to the remainder of the mandible); well developed, transverse dorsomental teeth figure 7C.

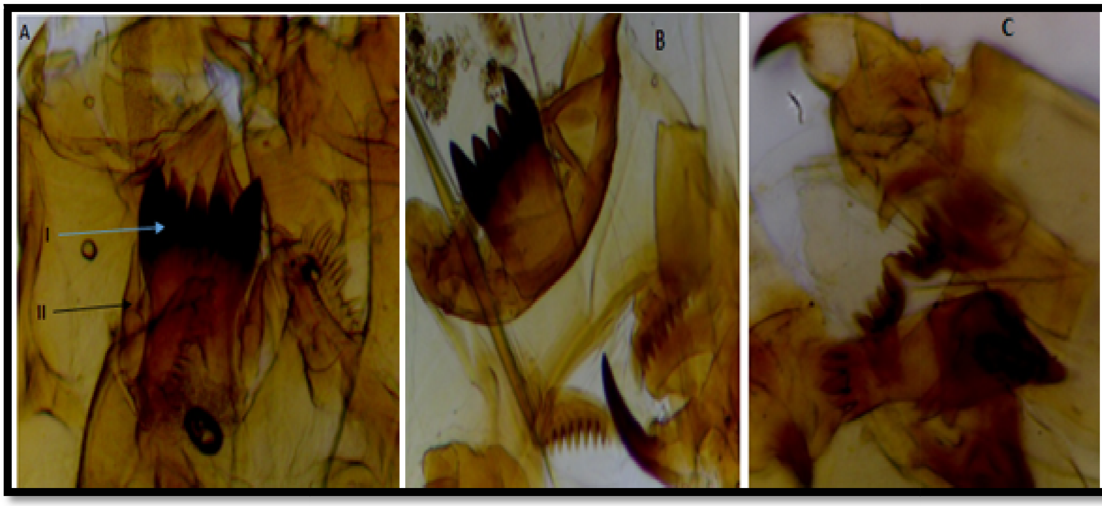

Figure 7: Chironomid Mouth Parts: 7A; R. Florens, AI; Ligula, AII; Paraligula 7B; Procladius Sp. 7C; Tanypus Sp

Genus Eukiefferiella: The simple, weak/vestigial ventromental plates; inner margin of mandible with spines/serrations; 4 or 5 segmented antennae and body with simple setae figure 8A. Genus Zalutschia: mentum with first lateral tooth reduced; well-developed ventromental plates with weak beard; and mandible with 3 inner teeth distinguish this genus figure 8B.

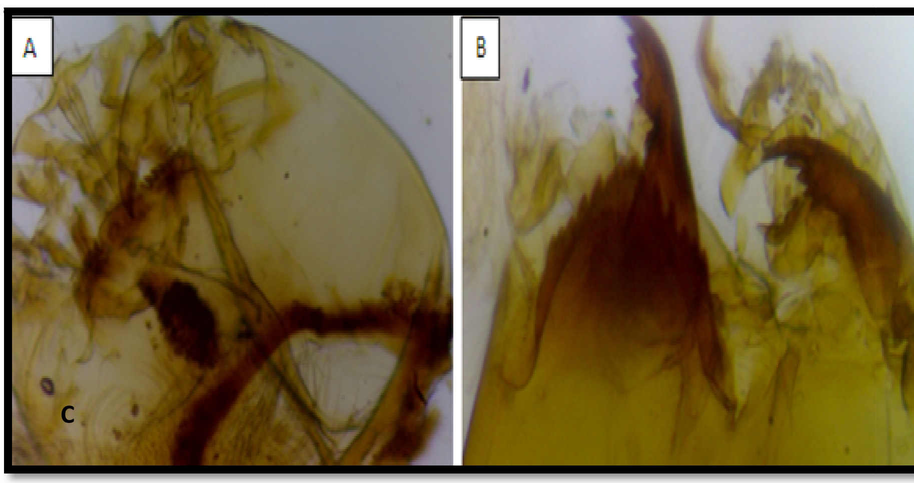

Figure 8: Head Capsules, A; Eukiefferiella and B; Zalutschia.

3.5. Influence of Environmental Variables on Macroinvertebrate Assemblages

The Pearson correlation test was performed to assess the relation between the environmental variables and the taxa and diversity indices. We found several significant correlations ($p<0.05$), but most of them were low ($r<0.5$). We only highlight those that were higher ($r>0.5$). There were significant positive correlations between temperature and a number of chironomus species ($r=0.270$) and for the taxa we found a significant negative correlation between electrical conductivity, Total dissolved solids and Procladius bellus ($r=-0.267$), ($r=-0.267$) respectively and a significant positive correlation between nitrate concentration and Chironomus stigmaterus ($r=0.230$).

3.6. Diversity of Chironomids Based on Pielou, Shannon and Weaver

The Shannon and weaver mean indice varied from 2.40 bit/ind in mankon 3 to 3.54 bit/ind in mezam with a mean of 2.75 ± 0.36. As for the indice of Pielou, which shows a minimum of 0.63 in mankon 2 to 0.92 in mezam with a mean of 0.76± 0.10 as seen on figure 9.

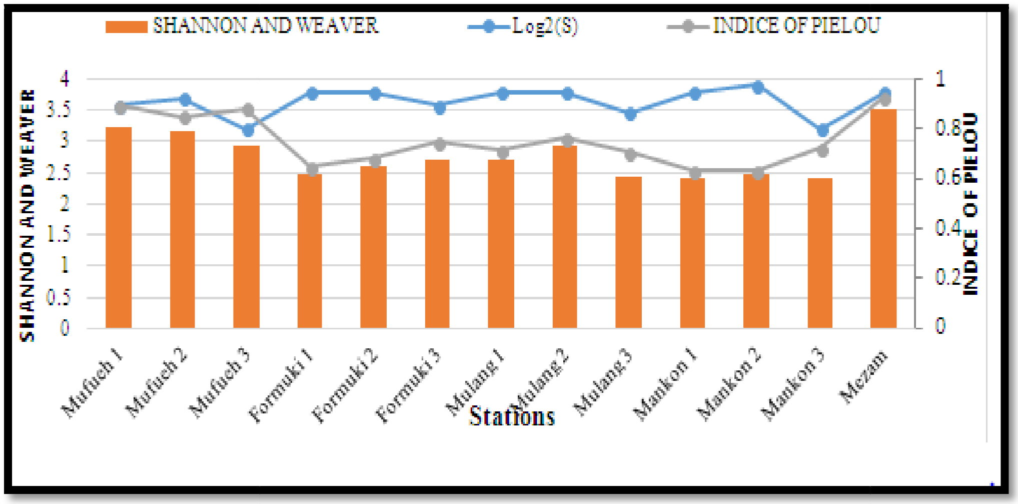

Figure 9: Variation Indices of Pielou and Shannon and Weaver

4. Discussion

Variations in temperature of river mezam and its affluent is close to that of environmental temperature with slight increase from upstream to downstream. These variations could reflect the oligotrophic character of streams in mountainous areas which are subjected to low anthropic action (Vannote et al., 1980; Lecerf, 2005). The water pH limit (7.17 – 8.24 UC) is situated at an interval which favours the development of most organism groups (AE, 1999). The positive correlation observed between temperature and pH, is in accordance with the observations of Devidal et al. (2007). These authors revealed that in forest zone, heating of water by solar rays coupled to high photosynthetic activities of river basin, natural ventilation and the presence of rapid flow rate and curved flow of water which lead to disturbance and recirculation of water, favour reoxygenation of water. This phenomenon may accelerate metabolic activities leading to an increase of water pH. However, our results are different from those observed in other urban streams of the Littoral Region of Cameroon by Tchakonté et al., 2015b who showed the hypoxic condition of water, the very high values of water temperature, conductivity, turbidity, suspended solids, diverse ions (NO3-, NH4+, PO43-), organic matter input and BOD were registered in urban stations and could have been responsible for the extinction of aquatic insect's families.

As population continue to surge in number, the challenges of urban agriculture and landscape dynamics in African cities is becoming increasingly important. Bamenda, a city known to be one of Cameroon's breadbaskets is threatened by urbanization and poor agricultural practices which pollute water ecosystems. In bamenda, where there is a widespread urbanization, most part of river ecosystems are exposed to a severe risk of damage (Suinyuy an Bongajum, 2015)

Agricultural activities couple with high urbanization, through the use of fertilizers, organic manures and domestic wastes, often lead to the nutrient enrichment of water and sediment, as does the input of both treated and untreated domestic wastes (Harding et al., 1999, Al-Shami et al., 2010a) Consequently, the river Formuki and Mulang that pass such areas, were dominated by pollution-tolerant species, such as C. riparus and C. crassicaudatu. Other than Mufueh, none of the rivers in the Mezam drainage Basin investigated in this study is clean biologically because of their location in areas of high nutrient loading from various, agricultural, and anthropogenic sources. Formuki was highly contaminated, presumably due to agricultural chemicals applied periodically by the Mundakwen people in their gardens. The highest density of Chironomus spp. was observed in this river. Therefore, a nearby river would be equally inhabited by a similar species when their females lay eggs there (Al-Shami et al., 2010b).

This economic growth and urbanization in Bamenda town which has led to environmental problems with ever-increasing land, air and water pollution (Kometa & Ndi, 2012). Consequently, many rivers in the town such as river mezam and its affluent, are listed as polluted water bodies. Organic pollution usually decreases dissolved oxygen concentrations affecting the persistence of many aquatic groups and decreasing the taxonomic richness (Bachmann 1995, Roque et al., 2003, Ferreira et al., 2009). Most Chironomidae groups are resistant to environmental disturbances due to their ability to live in conditions of low oxygen concentrations and high organic content (Sanseverino et al 1998, Roque et al 2004, de Bisthoven et al 2005, Cranston, 2007, Ajeagah et al 2016). Barbour et al (1996) claimed that Chironomus is the genera with the highest tolerance to organic pollution due to its ability to use hemoglobin for oxygen transportation, helping to sustain aerobic metabolism even under low oxygen situations. This ability has an important role in determining ecological characteristics in this group, and Lee et al (2006) considered that the expression levels of this protein in Chironomus should be used as an indicator to evaluate the health of an aquatic system. The presence of hemoglobin and the wide tolerance to environmental conditions seemed to explain the increase of Chironomus, and Polypedilum, during the dry season and other season of waste accumulation along the river bed (Day et al 2006, Helson et al 2006).

In all, the Shannon and weaver indice mean (2.75 bit/ind.) register in all the sampling stations is closer the mean of $\log_2 S$ (3.64). The results show that all the sampling stations present a relatively high diversity. AS for the mean indice of Pelour

(0.76), it is much closer to 1 showing an equal repartition of species between the sampling stations. The high diversity in species registered in this work is due to some resistance general and the sensitive groups like the Zalutschia and Eukiefferiella recorded few individuals throughout the study and this was mostly in the rainy season which is characterized by high dissolved oxygen concentration and high-water velocity.

5. Conclusion

In this study, chironomid taxa could be assigned as indicators for natural running waters and nutrient conditions. These results were obtained by chironomid mouth part and multivariate analysis based on data collected within the river Mezam and its affluent. These techniques were very useful to detect relationships between chironomid taxa and environmental variables in the river Mezam basin. From the analyses, it was noted that chironomids vary remarkably with seasons with a high species diversity. Chironomus and Polypedilum which are generally considered resistant to organic pollution dominated in the dry season which is characterized by high accumulation of house hold waste in the rivers and other wastes from the various markets. Meanwhile, Zalutschia, Eukiefferiella, Radotanypus and Procladius which are less adopted to organic pollution dominated in the rainy season that is characterized by high water contain in dissolved oxygen compared to the dry season. Consequently, these aquatic communities were ecological disordered by organic pollution that caused a decreased in the different genus and loss of sensible species and the abundance of tolerant species.

6. References

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