World Journal of Advanced Research and Reviews, 2020, 05(01), 001–015

World Journal of Advanced Research and Reviews

e-ISSN: 2581-9615, Cross Ref DOI: 10.30574/wjarr

Journal homepage: https://www.wjarr.com

(RESEARCH ARTICLE)

Diversity and abundance of macrophytes of streams under different anthropogenic influences in the Buea municipality, southwestern Cameroon

Anyinkeng Neculina [1,*], Mih Mathias Afui [1] and Tening Aaron Suh [2]

[1] *Department of Botany and Plant Physiology, Faculty of Science, University of Buea, P. O Box 63, Buea, Cameroon.*
[2] *Department of Agronomic and Applied Molecular Sciences, Faculty of Agriculture and Veterinary Medicine, University of Buea, P. O Box 63, Buea, Cameroon.*

Publication history**:** Received on 30 December 2019; revised on 08 January 2020; accepted on 09 January 2020

Article DOI: https://doi.org/10.30574/wjarr.2020.5.1.0112

Abstract

Macrophytes can occur as submerged, floating or emergent. They provide not only important structural supports in streams and river habitats, but also absorb and sequester pollutants, provide primary food production, nutrients and habitats to a wide range of macro and micro-organisms living in and around lotic sites. Their existence is however threatened by both anthropogenic and natural stresses. This study aimed to document macrophyte diversity and abundance in streams under different anthropogenic influences in Buea, southwestern Cameroon. Floristic surveys were carried out using 500 m long transects laid along the different streams. Plants encountered were identified and confirmed at the Limbe Botanic Garden Herbarium. One hundred and ten species belonging to 38 families and 83 genera were recorded. There were no floating species and only one stream had submerged species (*Vallisneria spiralis* L and *Crinum calamistratum* Bogner & Heine). The highest number of families (26), genera (58) and species (70) were obtained in Ndongo while the least of these taxa were obtained in Bulu (16, 35 and 39, respectively). Overall, Asteraceae and Poaceae were the most abundant, suggesting anemophilic dispersals. However, individual species abundances varied with streams. The highest diversity index (0.945) was in Wongangjio while the least (0.760) was in Nange, suggesting that waste discharge from car wash might influence species diversity negatively. The macrophyte composition was made up of obligate and non-obligate species as a consequence of anthropogenic influences. These results constitute baseline data for the area that can be exploited for further research and monitoring.

Keywords: Macrophyte; Streams; Anthropogenic influence; Buea Municipality

1. Introduction

Aquatic ecosystems usually contain macrophytes which may be submerged, floating or emergent. The plants are very important in the structure and function of the aquatic system in that they absorb and sequester pollutants, reduce erosion by damping wave action and stabilize shorelines and river bottoms [1, 2, 3]. Additionally, macrophytes provide primary food production, nutrients and habitat for a wide range of macro and micro-organisms living in and around lotic sites [4]. The effectiveness of their functioning depends, amongst other factors, on their diversity and abundance [5].

Studies on macrophyte abundance and diversity in Cameroon are rare [1, 6, 7]. Other studies involving macrophytes in other areas of the country, focus on their use in wastewater treatment [8, 9, 10]. Little or no such data exist for the Southwest Region and Buea in particular.

Buea lies between $3^0$57'N – $4^0$27'N and $8^0$58' – $9^0$25'E on the eastern flank of mount Cameroon. The mean annual precipitation and temperature stand at 3000 mm and 28 °C, respectively. The mean relative humidity is 86% and

* Corresponding author
E-mail address: anyinkengnicoline@yahoo.com

sunshine ranges from 900 to 1200 hrs per annum [11]. The climate is equatorial, with two seasons: a dry season from November to February and a rainy season from March to October. The municipality has a rich hydrological network. The absence of conscious efforts to protect water catchments, haphazard waste disposal especially in water ways, deforestation motivated by agriculture, timber for local consumption, fuel wood and bush fires (natural and hunting fires) have all contributed to degrade the aquatic ecosystem within the municipality.

This work had as objective to assess the diversity and abundance of macrophytes from five streams with different anthropogenic influences in the Buea municipality. This baseline data will complement data from other areas which can be exploited for further research and by aquatic ecosystem protection services of the municipality.

2. Material and methods

2.1. Sampled streams and their characteristics

Five streams subjected to different anthropogenic influences were selected. Farming as an activity cuts across the different streams.

Nange water: This is a stream located far from habitation but with characteristic that cars are driven into it and washed. In this stream, there are two car wash points.

2) Stream at Mile 17 Hill (M17): The catchment area of this stream was used as dumping ground for municipal waste before the arrival of the waste collection company in 2010. In this stream, cars are washed by the banks, with effluents discharged into it. It also receives storm drainage from Molyko, a residential neighbourhood with dense population.

3) Ndongo: It is exposed to waste from various anthropogenic (waste disposal, bathing and laundry) activities as it flows from lower Bokoko to Mile 16, passing through Molyko, with dense population. Despite the presence of the waste collection company, municipal waste are deposited at various points along the course of the stream. Bathing and laundry, in addition to farming, are other activities along the stream course.

4) Bulu water: It originates from Lower Bunduma and flows down to Bulu Native, with storm drainage as well as municipal wastes from Upper Bunduma and Great Soppo getting into it at various points along the course.

5) Wongangjio: It is a stream located far from habitation with no waste dump and no washing of cars`.

2.2. Data collection

Floristic inventory was carried out along 500 m long transects laid along the different streams (Figure 1). The transect for Nange originated 10 m before the first car wash point and extended downstream beyond the second car wash point. In the stream at Mile 17 Hill, the transect originated from the catchment and extended downstream beyond the car wash area. The transects for Ndongo and Wonganjio originated 10 m from the catchment. For Bulu, the transect was laid 10 m after the observed point of water emergence along the course.

Ten plots were laid per transect. The plots began 10 m from transect origin and were interspaced by a distance of 42 m. Within each plot, sampling units of 1mx1m were mapped out by dividing it into strips of (1 x 1) m and numbering. Ballots were then drawn to select sampling units such that 1/3 of them were on each of the right and left bank and within the stream. A total of twelve sampling units were randomly selected within each plot. A frame measuring (1 x 1 m, in-to-in) was placed at the selected number of the strip and the vegetation within it censured.

Plants were identified in the field. Unidentified species were photographed, voucher specimens collected and identified using illustrations and photographs in manuals and later confirmed at the Limbe Botanic Garden Herbarium (SCA).

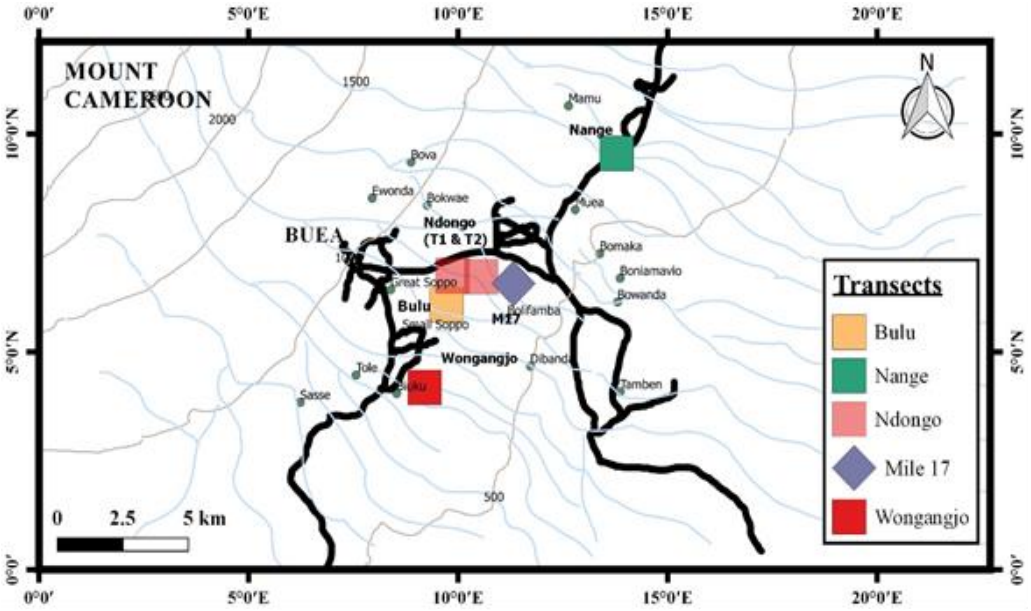

Figure 1 Location of transects for macrophyte assessment in different streams in Buea municipality

The frequency of occurrence and abundance of each species were recorded. Creeping species were evaluated by percent cover and later converted to count using Braun Blanquet scale index [12].

2.3. Data analysis

Species composition for the streams were determined through Simpson's diversity indices. Simpson's diversity index = 1 – D

Where;

$$D = \sum \left(\frac{n_i}{N} \right)^2$$

n_i = number of individuals of species i

N = Total number of individuals of all species

Species richness was determined using the Menhinicks index (D)

$$D = \frac{S}{\sqrt{N}}$$

Where

S = number of different species in the sample

N = total number of individual organisms in the sample

Species similarity between steams was determined using Sörensen similarity coefficient (Ss).

$$S_S = \frac{2a}{2a + b + c}$$

Where S_s = Sorenson similarity coefficient

a = number of species common to all sites/category

b = number of species unique to first site/category

c = number of species unique to second site/category

3. Results and discussion

The study revealed a total of 108 emergent and two submerged (*Vallisneria spiralis* L. and *Crinum calamistratum* Bogner & Heine, unique to Nange) species from the five streams. These species belong to 83 genera in 38 families (Table 1; Plates 1, A-F). No floating species was found in any of the streams. The absence of floating species is due to the sloppy nature of the streams since such species are characteristic of stagnant and slow-flowing waters. However, the peculiarity of Nange with regard to submerged species is probably due to the fact that it is the only stream in the list with gentle slope and wide area (40 m stream breadth). These characteristics give it the ability to accumulate sediments and nutrients thus allowing shallow pools of water which favour the establishment of submerged species.

The occurrence and abundance of the different taxa varied among streams (Fig 2). In Nange, there were a total of forty eight species. Asteraceae and Poaceae had the highest number of genera with six each while those with one genus included; Amaryllidaceae, Arecaceae, Brassicaceae, Commelinaceae, Crassulaceae, Lamiaceae and Tiliaceae. *Vallisneria spiralis* had the highest (40.98) relative abundance while species with the least (0.01) were; *Asystasia gangetica*, *Raphia farinifera*, *Conyza boriensis*, *Vernonia amydalina* and *Plectranthus monostachyus.*

In the stream at M17 hill with forty eight species, the Asteraceae had the highest number of genera (6) while Commelinaceae, Costaceae, Cyperaceae, Heliconiaceae, Malvaceae, Mimosaceae and Piperaceae were among the list of families represented by single genus. The species with the highest (31.06) relative abundance was *Echinochloa pyramidalis* while the least (0.04) included *Anubias barteri*, *V. amydalina* and *Abelmoschus esculentus*

Ndongo had seventy species. Poaceae had the highest genera (11) while families with single genus were many and included Asparagaceae, Cannaceae, Costaceae and Sellaginellaceae. *Pennesetum purpureum* had the highest (17.24) relative abundance while the least (0.03) were species such as *Axonopus compressus*, *Colocasia esculenta* and *Diplocyclos palmatus*

In Bulu, there were a total of thirty nine species and the families with the highest genera (6) were Poaceae and Asteraceae while those with the least (1) included Costaceae, Dryopteridaceae, Fabaceae, Oxalidaceae, Piperaceae and Solanaceae. *P. purpureum* had the highest (10.66) relative abundance while the least (0.08) was *Oxalis simplex*

In Wongangjio with a total of forty six species, Asteraceae had the highest (7) genera while the least were families such as Araceae, Brassicaceae, Blechnaceae, Costaceae, Lamiaceae and Tiliaceae with one genus each. *A. barteri* had the highest (12.89) relative abundance while the least (0.05) were *Vernonia hyminolepis, Luffa aegyptiaca* and *Dryopteris felixmas.*

Table 1 Macrophtes of different streams in Buea

Species*	Nange		Mile 17		Ndongo		Bulu		Wongangjio	
	Freq	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**
Acanthaceae										
Asystasia gangetica (L.) T. Anderson	1.00	0.01	12.00	0.66	19.00	2.27	34.00	6.65	39.00	3.32
Asystasia intrusa Nees	12.00	4.48	19.00	10.45	2.00	0.05	0.00	0.00	0.00	0.00
Brillantaisia nitens Lindau	0.00	0.00	0.00	0.00	17.00	2.62	2.00	0.16	3.00	0.28
Eremomastax speciosa (Hochst.) Cufod	0.00	0.00	4.00	0.35	1.00	0.27	0.00	0.00	4.00	0.75
Justicia carnea Lindl.	0.00	0.00	0.00	0.00	1.00	0.70	0.00	0.00	0.00	0.00
Ruellia strepens L.	0.00	0.00	0.00	0.00	5.00	0.27	6.00	3.37	9.00	2.99
Ruellia prostrata Poir.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	2.99
Strobilanthes heyneanus Nees	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	3.50
Amaranthaceae										
Achyranthes aspera L.	2.00	0.72	1.00	0.14	9.00	0.72	0.00	0.00	7.00	0.98
Alternanthera sessilis (L.) R.Br. ex DC	0.00	0.00	0.00	0.00	20.00	3.82	6.00	2.16	0.00	0.00
Amaranthus blitum L.	0.00	0.00	2.00	0.24	7.00	0.96	12.00	4.81	2.00	0.31
Amaranthus hybridus L.	0.00	0.00	1.00	0.04	1.00	0.03	0.00	0.00	0.00	0.00
Amaranthus spinosa L.	0.00	0.00	0.00	0.00	2.00	0.05	0.00	0.00	0.00	0.00
Amaryllidaceae										
Crinum calamistratum Bogner & Heine	2.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Araceae										
Alocasia cucullata (Lour.) Schott	0.00	0.00	0.00	0.00	1.00	0.03	0.00	0.00	0.00	0.00
Alocasia macrorrhizos (L.) G.Don	0.00	0.00	2.00	0.69	2.00	0.11	4.00	0.48	0.00	0.00
Anubias barteri Schott.	9.00	6.96	1.00	0.04	0.00	0.00	0.00	0.00	13.00	12.89
Colocasia esculenta (L.) Schott	3.00	0.06	5.00	0.45	1.00	0.03	2.00	0.56	0.00	0.00

Species*	Nange		Mile 17		Ndongo		Bulu		Wongangjio	
	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun
Dieffenbachia picta Schott	0.00	0.00	1.00	0.04	1.00	0.08	0.00	0.00	0.00	0.00
Xanthosoma sagittifolium (L.) Schott	0.00	0.00	3.00	0.28	6.00	0.67	9.00	0.72	0.00	0.00
Arecaceae										
*Raphia farinifera (*Gaertn.) Hyl.	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Asparagaceae										
Dracaena sp	0.00	0.00	0.00	0.00	1.00	0.03	0.00	0.00	0.00	0.00
Asteraceae										
Ageratina adenophora (Spreng.) King & H.Rob.	8.00	2.47	13.00	1.90	0.00	0.00	0.00	0.00	0.00	0.00
Ageratum conyzoides L.	9.00	2.31	34.00	10.41	17.00	5.29	11.00	5.13	18.00	9.48
Bidens pilosa L.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.19
Chromolaena odorata (L.) King & H.E. Robins	11.00	0.48	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.09
Conyza boriensis (L.) Cronq.	1.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Crassocephalum crepidioides (Benth.) S.Moore	0.00	0.00	2.00	0.48	4.00	0.37	1.00	0.16	4.00	0.19
Emilia coccinea (Sims) G. Don	1.00	0.10	5.00	0.17	1.00	0.11	2.00	0.40	2.00	0.09
Galingsoga quadriradiata Ruiz & Pav	0.00	0.00	0.00	0.00	3.00	0.40	5.00	2.08	0.00	0.00
Synedrella nodiflora (L.) Gaertn	0.00	0.00	2.00	0.24	15.00	2.97	8.00	4.09	2.00	0.09
Tithonia diversifolia (Hemsl.) A.Gray	0.00	0.00	0.00	0.00	0.00	0.00	22.00	10.34	0.00	0.00
Vernonia amygdalina Delile	1.00	0.01	1.00	0.04	1.00	0.03	0.00	0.00	0.00	0.00
Vernonia hyminolepis A. Rich.	0.00	0.00	1.00	0.04	3.00	0.13	0.00	0.00	1.00	0.05
Athyriaceae										
Diplazium proliferum (Lam) Thouars.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.09
Blechnaceae										
Woodwardia fimbriata Sm.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.09

Species*	Nange		Mile 17		Ndongo		Bulu		Wongangjio	
	Freq	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**
Brassicaceae										
Rorippa nasturtium- aquaticum R.Br.	13.00	24.05	0.00	0.00	0.00	0.00	0.00	0.00	5.00	5.37
Cannaceae										
Canna. indica L.	0.00	0.00	0.00	0.00	1.00	0.53	0.00	0.00	0.00	0.00
Commelinaceae										
Aneilema umbrosum (Vahl) Kunth	0.00	0.00	0.00	0.00	11.00	2.86	1.00	0.16	5.00	0.42
Commelina benghalensis L.	43.00	1.06	42.00	2.15	45.00	5.13	41.00	8.57	39.00	3.36
Convolvulaceae										
Ipomoea alba L.	0.00	0.00	0.00	0.00	0.00	0.00	8.00	1.76	0.00	0.00
Ipomoea batatas (L.) Lam.	0.00	0.00	17.00	0.93	21.00	2.06	23.00	4.09	0.00	0.00
Ipomoea muricata (L.) Jacq.	0.00	0.00	0.00	0.00	13.00	1.76	26.00	7.13	36.00	6.02
Ipomoea purpurea (L.) Roth	10.00	0.30	0.00	0.00	11.00	0.67	0.00	0.00	21.00	6.16
Ipomoea tiliacea (Willd.) Choisy	0.00	0.00	54.00	2.80	3.00	0.32	0.00	0.00	0.00	0.00
Costaceae										
Costus scaber Ruiz & Pav.	6.00	1.20	2.00	0.62	14.00	2.54	4.00	0.72	8.00	2.05
Crassulaceae										
Bryophyllum pinnatum (Lam.) Oken	1.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cucurbitaceae										
Diplocyclos palmatus (L.) C.Jeffrey	7.00	0.15	1.00	0.04	1.00	0.03	8.00	0.96	8.00	0.79
Coccinea grandis (L.) Voigt	0.00	0.00	0.00	0.00	2.00	0.45	0.00	0.00	0.00	0.00
Luffa acutangula (L.) Roxb.	0.00	0.00	0.00	0.00	4.00	0.32	0.00	0.00	10.00	0.98
Luffa aegyptiaca Mill.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.05
Momordica dioica Roxb. ex Willd	0.00	0.00	0.00	0.00	15.00	1.26	0.00	0.00	13.00	1.82

Species*	Nange		Mile 17		Ndongo		Bulu		Wongangjio	
	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun
Momordica foetida Schumach.	5.00	0.16	26	1.49	18.00	1.12	12.00	3.00	14.00	1.82
Sicyos angulatus L.	0.00	0.00	13.00	0.66	8.00	0.35	0.00	0.00	0.00	0.00
Cyperaceae										
Cyperus erythrorhizos Muhl.	5.00	0.46	7.00	3.84	1.00	0.05	0.00	0.00	2.00	0.37
Cyperus oxylepis Nees ex Steud	1.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Kyllinga gracillima Miq.	1.00	0.07	0.00	0.00	2.00	0.21	0.00	0.00	1.00	0.47
Dryopteridaceae										
Dryopteris cochleata (D. Don) C. Chr.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	1.17
Dryopteris cycadina (Franch. & Sav.) C. Chr.	3.00	0.12	0.00	0.00	0.00	0.00	3.00	0.64	12.00	1.20
Dryopteris felixmas (L.) Schott	2.00	0.04	0.00	0.00	1.00	0.11	0.00	0.00	1.00	0.05
Euphorbiaceae										
Euphorbia dentata Michx	0.00	0.00	0.00	0.00	2.00	0.05	0.00	0.00	0.00	0.00
Fabaceae										
Puereria phaseoloides (Roxb.) Benth.	6.00	0.20	14.00	0.90	8.00	0.40	4.00	0.64	0.00	0.00
Vigna radiata (L.) R. Wilczek	5.00	0.12	2.00	0.07	4.00	0.96	0.00	0.00	0.00	0.00
Heliconiaceae										
Heliconia marginata (Greigg) Pittier	0.00	0.00	1.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Hydrocharitaceae										
Vallisneria spiralis L.	18.00	40.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Lamiaceae										
Plectranthus aboinicus (Lour.) Spreng	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	1.54
Plectranthus monostachyus (P.Beauv.) B.J.Pollard	1.00	0.02	1.00	0.14	1.00	0.03	0.00	0.00	0.00	0.00
Malvaceae										
Abelmoschus esculentus (L).Moench	0.00	0.00	1.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00

Species*	Nange		Mile 17		Ndongo		Bulu		Wongangjio	
	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun
Melastomataceae										
Tristemma mauritianum J.F. Gmel.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.19
Mimosaceae										
Mimosa pudica L.	0.00	0.00	4.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Musaceae										
Ensete ventricosum (Welw.) Cheesman	0.00	0.00	0.00	0.00	1.00	0.19	0.00	0.00	0.00	0.00
Musa paradisiaca L	0.00	0.00	1.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00
Nephrolepidaceae										
Nephrolepis biserrata (Sw.) Schott	8.00	0.74	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.09
Nephrolepis cordifolia (L.) K. Presl	1.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Onagraceae										
Ludwigia adscendens (L.) H.Hara	2.00	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ludwigia alternifolia L.	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.24	0.00	0.00
Ludwigia longifolia (DC.) H. Hara	1.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ludwigia peruviana (L.) H. Hara	10.00	0.41	17.00	1.83	2.00	1.26	1.00	0.32	0.00	0.00
Ludwigia stolonifera (Guillemin & al.) P. H. Raven	11.00	0.59	3.00	0.623	2.00	0.48	1.00	0.24	0.00	0.00
Oxalidaceae										
Oxalis simplex Salter	0.00	0.00	0.00	0.00	2.00	0.08	1.00	0.08	0.00	0.00
Piperaceae										
Peperomia pellucida Kunth	0.00	0.00	1.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
Piper umbellatum L.	0.00	0.00	0.00	0.00	2.00	0.83	1.00	0.41	26.00	3.74
Poaceae										
Axonopus compressus (Sw.) P.Beauv	0.00	0.00	0.00	0.00	1.00	0.027	0.00	0.00	0.00	0.00

Species*	Nange		Mile 17		Ndongo		Bulu		Wongangjio	
	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun	Freq	Rel Abun
Coix lacryma-jobi L.	0.00	0.00	0.00	0.00	1.00	0.08	0.00	0.00	0.00	0.00
Dactyoctenium aegyptium (L.) Beauv.	11.00	0.38	0.00	0.00	4.00	0.51	0.00	0.00	0.00	0.00
Echinochloa cruss-galli (L.) Beauv	0.00	0.00	0.00	0.00	4.00	0.67	0.00	0.00	0.00	0.00
Echinochloa pyramidalis (Lam.) Hitchc. & Chase	1.00	0.12	52.00	31.06	3.00	13.20	0.00	0.00	0.00	0.00
Eleusine indica (L.) Gaertn	0.00	0.00	0.00	0.00	1.00	0.21	1.00	0.08	0.00	0.00
Microstegium vinineum (Trin.) A. Camus	0.00	0.00	0.00	0.00	3.00	0.29	4.00	0.72	0.00	0.00
Panicum maximum Jacq.	0.00	0.00	0.00	0.00	4.00	0.86	1.00	0.16	0.00	0.00
Panicum sellowii Nees	2.00	0.07	0.00	0.00	1.00	0.03	0.00	0.00	13.00	1.31
Paspalum fimbriatum Kunth	2.00	0.10	1.00	0.24	6.00	0.96	4.00	5.13	9.00	3.74
Pennesetum purpureum Schumach	15.00	1.36	45.00	17.12	22.00	17.24	14.00	10.66	6.00	1.59
Sacharrum officinalis L.	0.00	0.00	1.00	0.04	0.00	0.00	3.00	0.64	0.00	0.00
Zea mays L.	0.00	0.00	3.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00
Polygonaceae										
Polygonum hydropiper L.	0.00	0.00	0.00	0.00	4.00	0.96	0.00	0.00	0.00	0.00
Polygonum hydropiperiodes Michx.	7.00	0.38	1.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00
Polygonum persicaria L.	22.00	7.46	1.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00
Portulacaceae										
Talinum triangulare (Jacq.) Willd	0.00	0.00	2.00	0.83	1.00	0.24	0.00	0.00	0.00	0.00
Sellaginellaceae										
Sellaginella kraussiana (Kunze) A. Braun	0.00	0.00	0.00	0.00	2.00	0.08	0.00	0.00	0.00	0.00
Solanaceae										
Brugmansia arbora (L.) Sweet	4.00	0.29	1.00	0.07	19.00	2.97	11.00	2.72	15.00	3.27
Solanum carolinense L.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.05
Solanum nigrum L.	0.00	0.00	5.00	3.22	2.00	0.11	0.00	0.00	0.00	0.00

Species*	Nange		Mile 17		Ndongo		Bulu		Wongangjio	
	Freq	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**	**Freq**	**Rel Abun**
Tiliaceae										
Triumfetta cordifolia A. Rich.	1.00	0.04	4.00	0.73	3.00	1.23	0.00	0.00	26.00	5.79
Urticaceae										
Boehmeria cylindrica (L.) Swartz	6.00	0.30	0.00	0.00	0.00	0.00	2.00	0.24	2.00	6.68
Fleurya aestuans (L.) Gaudich	5.00	0.39	22.00	3.18	32.00	11.57	19.00	8.01	30.00	0.28
Parietaria officinalis L.	0.00	0.00	0.00	0.00	5.00	0.35	3.00	1.60	0.00	0.00
Pilea pumila (L.) A. Gray	0.00	0.00	0.00	0.00	5.00	2.38	0.00	0.00	0.00	0.00
Urera hypselodendron (Hochst. ex A. Rich.) Wedd.	6.00	0.22	0.00	0.00	0.00	0.00	0.00	0.00	10.00	1.26

Note: *Frequency of occurrence (Freq) was calculated as the number of times a species was encountered in the stream. Relative abundance (Rel Abun) was calculated as the percentage of individuals of a particular species over the total number of individuals of all species.

Overall, Poaceae and Asteraceae were the most abundant in the different streams. Plants in these families have tiny feathery/light seeds which are easily dispersed by wind and insects. The variability in the relative abundances of the different macrophytes for the different streams could be associated to the fact that some species such as *P. purpureum* are able to survive under both wetland and dry land conditions.

The highest number of families (26), genera (58) and species (70) were obtained in Ndongo while the least of these taxa were obtained in Bulu (16, 35 and 39, respectively) (Figure 2).

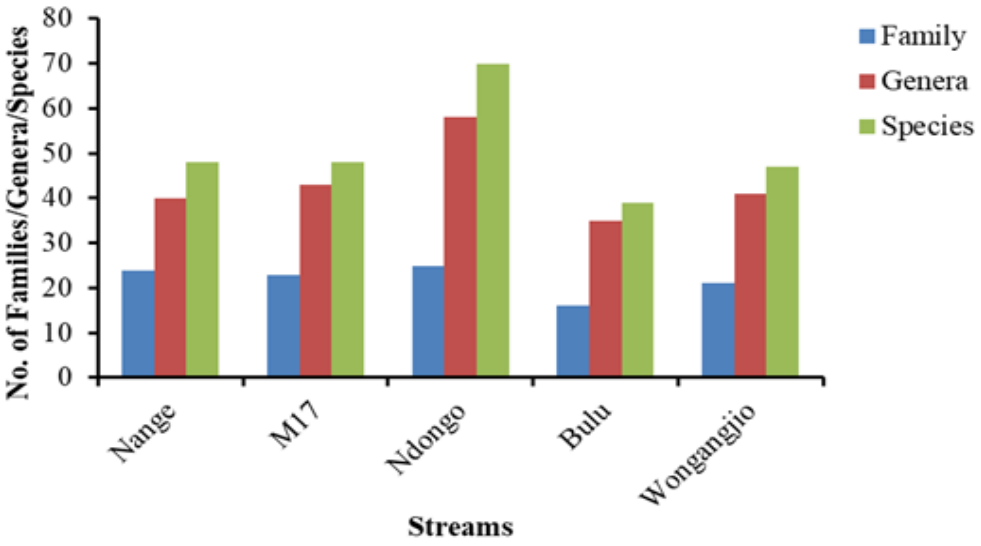

Figure 2 Macrophyte occurrence in different streams in Buea

Fourteen families, 28 genera and 44 species were specific to particular streams (Figure 3). Nange and Ndongo had the highest number (4) of unique families while Bulu had none. Across the unique genera and species, Ndongo had the highest number (10 and 13 respectively) while the least were in Bulu (1 and 3 respectively).The high number of unique species in Ndongo is accounted for by the presence of species which are not obligate macrophytes, brought about by anthropogenic impacts, in line with the findings of Fonkou *et al.* [6] in Yaounde and Tita [13] in Foumbot, other areas in Cameroon**.**

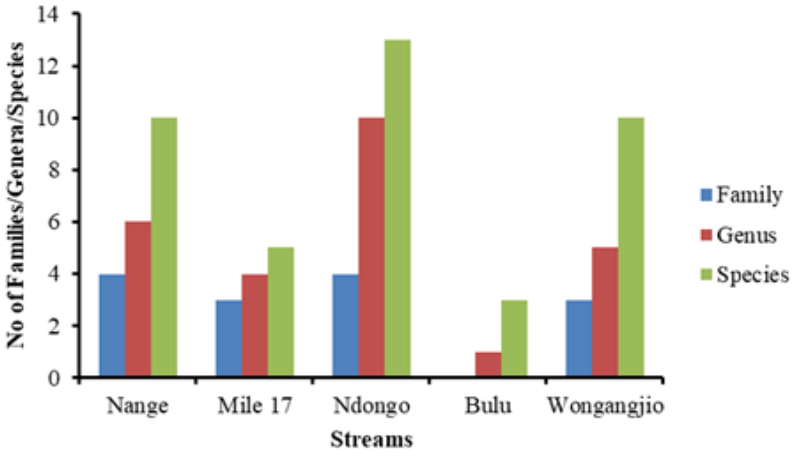

Figure 3 Unique macrophytes in different streams in Buea

The highest diversity index (0.945) was in Wongangjio while the least (0.760) was in Nange (Table 2), suggesting that waste discharge from car wash might influence species diversity negatively. The highest species richness index (1.144) was in Ndongo while the least (0.577) was in Nange.

Table 2 Diversity and species richness indices of macrophytes in different streams in Buea

Stream	Simpson's diversity index	Species richness index (D)
Nange	0.760	0.577
M17	0.846	0.893
Ndongo	0.925	1.144
Bulu	0.939	1.104
Wongangjio	0.945	1.016

The highest Sorensen similarity index (0.606) was between Ndongo and Bulu while the least (0.391) was between Nange and Bulu (Table 3) possible because the two streams Ndongo and Bulu have similar anthropogenic influence.

Table 3 Macrophyte Sorensen similarity indices of different streams in Buea

	Nange	M17	Ndongo	Bulu	Wongangjio
M17	0.563	1.000			
Ndongo	0.458	0.593	1.000		
Bulu	0.391	0.506	0.606	1.000	
Wongangjio	0.532	0.426	0.5	0.471	1.000

The impact of agricultural activities on the natural environment includes the creation of new habitats, which is brought about by clearing and cultivation of plant species at the expense of others [14, 15, 16]. This is probably the reason for the high diversity indices encountered in the different streams except Nange. The presence of edible species such as *Vernonia hyminolepis*, *Abelmoschus esculentus* and *Colocasia esculenta* among the list further constitutes anthropogenic impact on vegetation structure along stream courses.

The spatial differences in species composition, diversity and richness of macrophytes observed are in conformity with the findings of Bini *et al*. [17], Thomaz *et al* [18] and Ruto *et al.* [19], and could also be accounted for by differences in physico-chemical properties [20] of both water and sediments of the streams.

4. Conclusion

Macrophyte diversity and abundance in Buea is high, composed of both submerged (unique to Nange) and emergent plants. The composition is made up of both obligate and non-obligate species as a consequence of anthropogenic impact along the stream belts. The abundance of the macrophytes varied with streams. Overall, Poaceae and Asteraceae were the most abundant due to anemophilic dispersal mechanisms. These results constitute baseline data for the area that can be exploited for further research and monitoring.

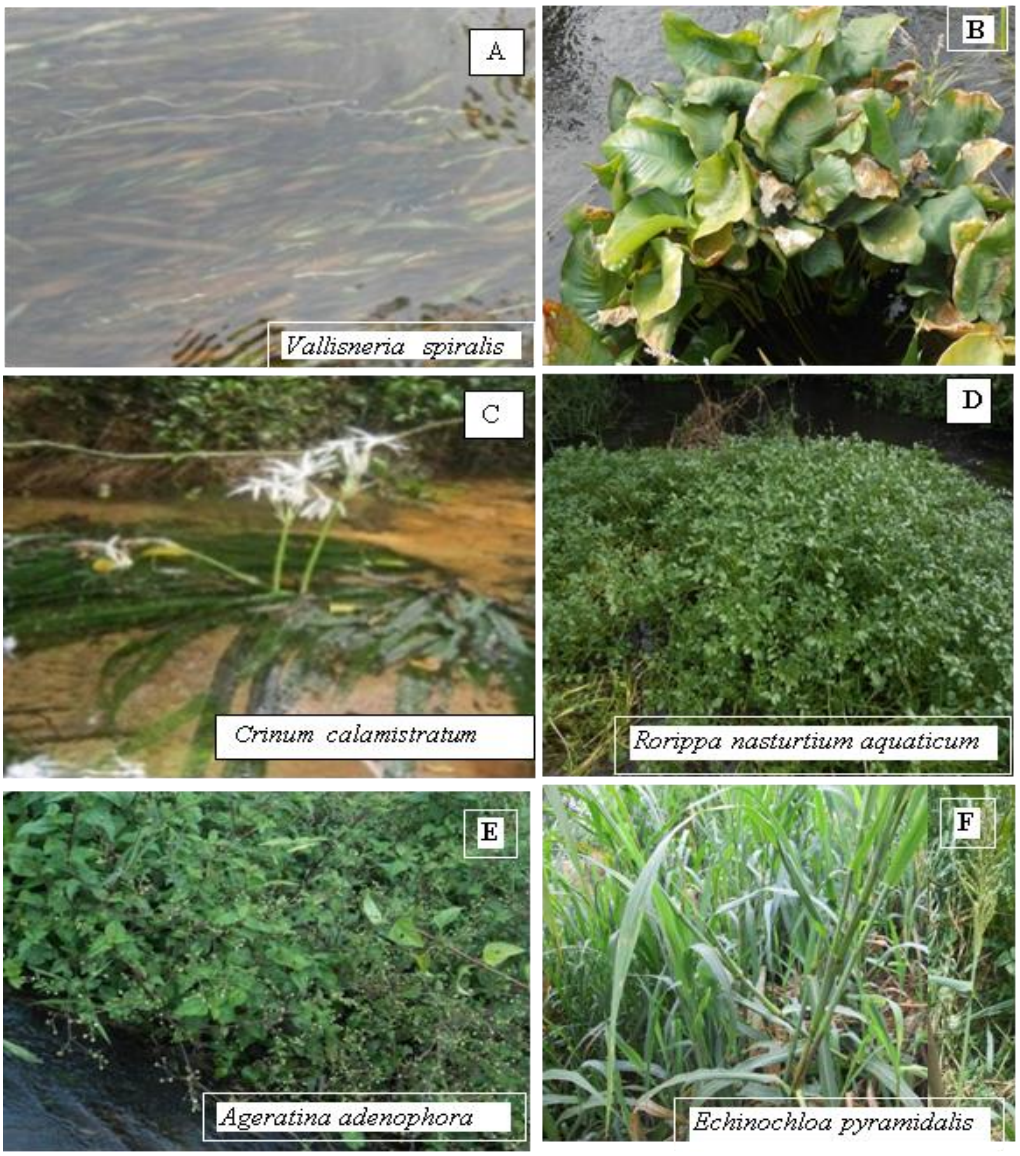

Plate 1 Submerged and Emergent macrophytes of streams in Buea Municipality, Cameroon

Compliance with ethical standards

Acknowledgments

The authors are thankful to the authority of the Limbe Botanic Garden Herbarium unit for plant identification.

Disclosure of conflict of interest

The authors do not disclose any conflict of interest.

References

[1] Tita MA, Kuitcha D, Magha A, Ndjama J and Kamgang KBV. (2012). Occurrence of macrophytes in the Mezam river system in Bamenda (Cameroon) and their role in nutrient retention. Syllabus Review, Science Series 3, 1-10.

[2] Kamel KA. (2013). Phytoremediation Potentiality of Aquatic Macrophytes in Heavy Metal Contaminated Water of EL-Temsah Lake, Ismailia, Egypt. Middle-East Journal of Scientific Research, 14, 1555-1568.

[3] Deshmukh UB, Shende MB and Rather OS. (2016). Aquatic macrophytes biodiversity assessment from Asolamendha reservoir of Chandrapur district, Maharashtra State (India). International Journal of Applied Research, 2, 293-298.

[4] Balanson S, Walton BM, Wolin GA and Mal TK. (2005). Aquatic Macrophyte Diversity and Habitat Characterisation of the Cuyahoga River Watershed in North-eastern Ohio. The Ohio Journal of Science, 105, 88-96.

[5] Dar NA, Pandit AK and Ganai BA. (2014). Factors affecting the distribution patterns of aquatic macrophytes. Limnological Reviews, 14, 75 -81.

[6] Fonkou T, Nguetsop VF, Pinta JY, Dekoum VMA and Lekeufack M and Amougou A. (2005). Macrophyte diversity in polluted and non-polluted wetlands in Cameroon. Cameroon Journal of Experimental Biology, 1, 26-33.

[7] Fonge BA, Egbe EA, Fongod AN, Tening AS, Achu RM, Yinda GS and Mvondo- Ze A. (2012). Effects of Land Use on Macrophyte Communities and Water Quality in the Ndop Wetland Plain, Cameroon. Journal of Agriculture and Social Sciences, 12, 41 – 49.

[8] Agendia P, Charbonnel Y and Valet G. (1988). Preliminary trials of several aquatic plants to treat Biyeme - Assi (Yaounde) domestic sewage. Journal of Biochemical Science, 1, 9 – 16.

[9] Kengne IM, Dodane PH, Amougou A and Kone D. (2009). Vertical - flow constructed wetlands as sustainable sanitation approach for faecal sludge dewatering in developing countries. Desalination, 248, 291 – 29.

[10] Fonkou T, Fonteh MF, Kanouo MD and Akoa A. (2010). Performances of vegetated beds with Echinochloa pyramidalis in the purification of wastewater from distillery in sub - Saharan Africa. Tropicultura, 28, 69 – 76.

[11] Folifac F, Lifongo L, Nkeng G and Gaskin S. (2009). Municipal drinking water source protection in low income countries: Case of Buea municipality-Cameroon. Journal of Ecology and Natural Environment, 1, 73-84.

[12] Pirini CB, Karagiannakidou V and Charitonidis S. (2011). Abundance, diversity and distribution of macrophytes communities in neighbouring lakes of different trophic states and morphology in North-Central Greece. Archives of Biological Science, 63, 763-774.

[13] Tita MA. (2008). Water Pollution of the Nkoup River System and its environmental impact in Foumbot, An Agricultural Town in Western Cameroon. Ph.D. thesis, University of Yaounde I, Cameroon, 145- 209.

[14] Alvarez-Yepiz JC, Martinez- Yrizar A, Burguez A and Lindquist C. (2008). Variation in vegetation structure and soil properties related to land use history of old-growth and secondary tropical dry forests in northwestern Mexico. Forest Ecology and Management, 256, 355-366.

[15] Baudry J, Burel F, Thenail C and Le Coeur D. (2000). A holistic landscape ecological study of the interactions between farming activities and ecological patterns in Brittany, France. Landscape and Urban Planning, 50, 19-28.

[16] Aguiar FC and Ferreira MT. (2006). Riparian and aquatic vegetation in Mediterranean type streams (western Iberia). Limnetica, 25, 411 - 424.

[17] Bini LM, Thomaz SM and Souza DC. (2001). Species richness and beta-diversity of aquatic macrophytes in the Upper Parana River floodpain. Archiv fur Hydrobiology, 151, 511-525.

[18] Thomaz SM, Carvalho P, Padial AA and Kobayashi JT. (2009). Temporal and spatial patterns of aquatic macrophyte diversity in the Upper Paraná River floodplain. Brazilian Journal of Biology, 69, 617-625.

[19] Ruto WKS, Kinyamario JI, Ng'etich NK, Akunda E and Mworia JK. (2012). Plant Species Diversity and Composition of Two Wetlands in the Nairobi National Park, Kenya. Journal of Wetlands Ecology, 6, 7-15.

[20] Thomaz SM, Pagioro TA, Bini LM, Roberto MC and Rocha RRA. (2004). Limnological characterization of the aquatic environments and the influence of hydrometric levels. In: Thomaz SM, Agostinho AA and Hahn NS (Eds). The upper Parana River and its floodplain: physical aspects, ecology and conservation. Leiden, The Netherlands, Backhuy publishers, 75-102.

How to cite this article

Anyinkeng N, Mih MA and Tening AS. (2020). Diversity and abundance of macrophytes of streams under different anthropogenic influences in the Buea municipality, southwestern Cameroon. World Journal of Advanced Research and Reviews, 5(1), 01-15.