International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

E-ISSN: 2347-2677
P-ISSN: 2394-0522
IJFBS 2018; 5(1): 165-170
Received: 29-11-2017
Accepted: 30-12-2017

Djene Kouakou Roland
Laboratory of Environment and Aquatic Biology, University Jean Lorougnon Guédé, Daloa, CI

Allouko Jean Renaud
Departement of Environment, Laboratory of Environment and Aquatic Biology, University Jean Lorougnon Guédé, BP 150 Daloa, Côte d'Ivoire CI

Bony Kotchi Yves
Departement of Environment, Laboratory of Environment and Aquatic Biology, University Jean Lorougnon Guédé, BP 150 Daloa, Côte d'Ivoire, CI

N'DO Bi Boly Valerie
Laboratory of Environment and Aquatic Biology, University Jean Lorougnon Guédé, Daloa, CI

Kamagate El Hadj Issouf
Laboratory of Environment and Aquatic Biology, University Jean Lorougnon Guédé, Daloa, CI

Correspondence
Djene Kouakou Roland
Laboratory of Environment and Aquatic Biology, University Jean Lorougnon Guédé, Daloa, CI

Spatial distribution pattern of Hemiptera community (Heteroptera) in the urban water bodies of Daloa (Côte d'Ivoire, West Africa)

Djene Kouakou Roland, Allouko Jean Renaud, Bony Kotchi Yves, N'DO Bi Boly Valerie and Kamagate El Hadj Issouf

Abstract
The diversity of aquatic Hemiptera and their spatial dynamics has been investigated in Daloa's urban water bodies during two seasons between June and august 2015. Samplings were performed by using grab and kicknet on twelve stations. A total of 1105 individuals from 21 taxa belonging to 10 families were identidfied. The largest taxonomic richness were recorded in ponds, lakes and channels. Hemiptera taxonomic richness variation was not depended of the season, but corolated with the type of aquatic environment. These insects were distributed in the various water according to their particular ecological requirements like pH and temperature. So while some were strongly associated with pH, others were positively corrolated with temperature. The *Diplonychus* sp. of Belostomatidae family and *Micronecta* sp. of Corixidae family which are the vectors and potential hosts of *Mycobacterium ulcerans*, the causative agent of burili ulcers, are more prevalent in Daloa different urban water.

Keywords: Dynamic, aquatic Hemiptera, urban water, Daloa

1. Introduction
The distribution of aquatic organisms relative to their habitat is of central importance to ecology [1]. Moreover, stream-dwelling macroinvertebrates are generally thought to be distributed according to environmental factors [2]. These organisms have many interests that are shared ecologically, medical and food and are even of major importance in fish farming. From an ecological view, aquatic Hemiptera have developed adaptations to respiration in the aquatic environment (presence of respiratory siphon in Nepidae) and are therefore moderately resistant to environmental degradation [3, 4]. Despite its importance, few studies have been published on the distribution of benthic macroinvertebrates among stream habitats for tropical systems. Hemiptera deserve to be better known in Côte d'Ivoire in general and more particularly in Daloa where there was a great diversity of both lotic and lentic aquatic environments located in urban areas [5]. Unfortunately, few studies have been published on insects of Hemiptera order of the Daloa's urban waters. The objective of this study is to contribute to the knowledge of aquatic Hemiptera in Daloa's urban waters.

2. Materials and Methods
2.1 Study site
Sampling was carried out in 12 water bodies (called sampling stations) located in the city of Daloa (Figure 1) in central-western Côte d'Ivoire, at 6 ° 53 'north latitude and 6 ° 27 'west longitude. These stations were chosen taking into account human activities and their accessibility. The study area is consisting of marsh, pond, artificial lake and stream. These sampling point are shown in Figure 1.

2.2 Sampling procedure
Samples were collected in triplicates per site (by checking all type of substrates) seasonally from June to August 2015 in the different sampling stations. The temperature, pH, conductivity and turbidity of the water were measured *in situ* between 06 and 08 am using a *HANNA* multiparameter. Aquatic macroinvertebrates were sampled with a pelagic kick net and a Van Veen grab sediment for benthic species. At each site, three (03) sediment samples corresponding to a total area of 0.15 m^2 were taken at several depths. At the exit of water, the

contents net were washed on a sieve of 0.5 mm. All samples were fixed in 70% alcohol. The six samples (3 by Kick net and 3 by Van Veen grab) at each site and each campaign were pooled for analysis. In the laboratory, all samples were sorted using a binocular microscope, counted and identified at the lowest taxonomic level by combining the appropriate key [6, 7, 8, 9].

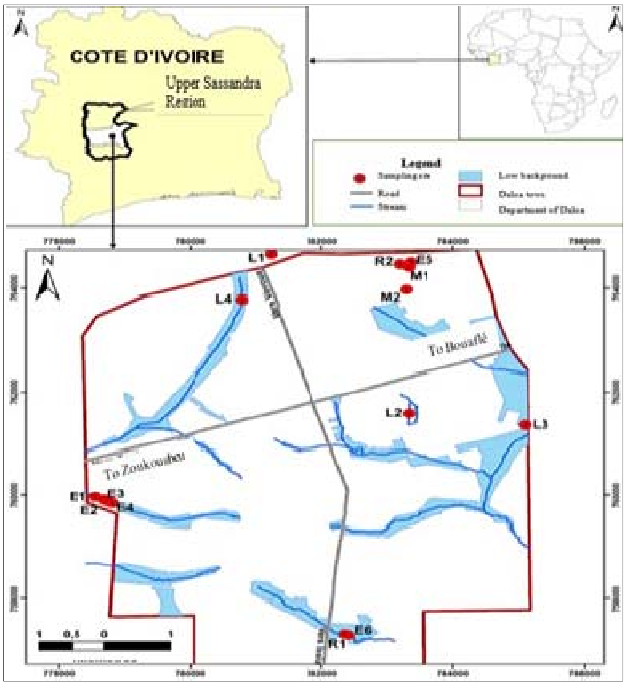

Fig 1

2.3 Data analysis

The Shapiro-Wilk normality test was made to evaluate the normality of the different parameters. The Kruskal-Wallis (multiple comparisons) and Mann-Whitney (two-sample comparison) tests were performed for the different comparisons. The taxa spatial distribution was performed with a Factorial Correspondence Analysis on the station-taxon matrix using PAleotological STatistic (PAST) software (Version 2.17c). In order to characterize the distribution of insects populations according to physicochemical parameters, a Canonical Correspondence Analysis was carried out using the CANOCO program (Canonical Community Ordination, Version 4.5) [10]. A redundancy analysis (RDA) was carried out between four physicochemical parameters and the abundances of 21 taxa of aquatic Hemiptera sampled in the urban water area of Daloa

3. Results

3.1 Water physico-chemical parameters

The spatio-seasonal variations of the physicochemical parameters are indicated in Table 1. The pH values oscillating around 9 have very small variations according to the stations and the seasons. Temperature was varied between 25 and 30 ºC. However, seasonal variations were very small. The highest values were recorded during the long rainy season at all stations except stations 3 and 4 where they were observed in the short dry season. Conductivity and turbidity were varied significantly according to seasons and stations. The highest values of these parameters were obtained during the high season in the majority of the studies stations.

Table 1: Water physico-chemical parameters of sampling stations. LWS: Long wet season (April - July), SDS: Short dry Season (August - September)

Parameters					
Stations	**Seasons**	**Temperature (ºC)**	**pH**	**Conductivity (µs/cm)**	**Turbidity (ppm)**
S1	LWS	29.1	8.8	78.3	37
	SDS	28.6	9.6	69.3	33
S2	LWS	28.9	8.6	74.6	37
	SDS	27.3	9.2	57.6	27
S3	LWS	27.3	9.5	172	85
	SDS	27.5	9.6	165.3	81.6
S4	LWS	27.4	9.5	138.3	69.3
	SDS	29.6	9.2	130.6	64.6
S5	LWS	25.8	9.0	74	36.3
	SDS	25	8.1	106.3	52.3
S6	LWS	26.6	8.4	72.3	34.6
	SDS	26.3	8.7	62.3	30.3
S7	LWS	26.1	8.9	185.6	92.6
	SDS	25.5	8.6	313	144.6
S8	LWS	26.3	8.6	167.6	83.3
	SDS	25.2	8.6	135	63
S9	LWS	27.2	8.9	158	76.6
	SDS	26.7	8.4	138.6	70.3
S10	LWS	27.6	9.1	143.3	69.6
	SDS	26.6	8.8	141.3	69.6
S11	LWS	26.5	9.3	243	120
	SDS	25.4	8.8	260	128.6
S12	LWS	28.2	9.4	146.6	72.3
	SDS	25.9	9.3	172	86

3.2 Taxonomic composition and variation of Hemiptera:

A total of 1105 individuals distributed in 21 taxa divided into 17 genera, 10 families and 2 infra-orders were inventoried in all 12 stations (Table 2). In the Nepomorpha infraorder, Belostomatidae and Corixidae contain the largest number of taxa. These two families each have three taxa. In Gerromorpha, families with more taxa are those of Gerridae and Veliidae with three taxa each. Spatio-seasonal variations in taxonomic richness indicate that during the two studies seasons, fish pond stations 8 and 10 were the most abundant and diversified with 8 taxa and 10 taxa respectively. The pond stations (7 and 6) are the least re-diversified (1 taxon). No taxon was collected at Station 5 (Rice Pond). Globally, seasonal variations of taxonomic richness indicated more taxa had been collected during the short dry season (20 taxa) than in the long rainy season (18 taxa). However, there was no significant difference in Hemiptera taxonomic richness seasonal variation (Mann-Whitney test, *p*>0.05).

Table 2: Variations spatial and-seasonal variation of aquatic Hemiptera abundances. LWS: Long wet season (April - July), SDS: Short dry Season (August - September).

			Stations and sampling seasons																								
			S1		**S2**		**S3**		**S4**		**S5**		**S6**		**S7**		**S8**		**S9**		**S10**		**S11**		**S12**		**Total**
Infraorder	**Famillies**	**TAXA**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	**LWS**	**SDS**	
	Notonectidae	*Enithares* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	2
Nepomorpha		*Anisops* sp.	20	42	1	3	5	5	5	4	0	0	0	0	0	2	34	0	0	0	136	10	0	2	3	10	282
	Nepidae	*Ranatra* sp.	4	1	1	0	0	1	2	0	0	0	0	0	0	0	2	3	8	7	4	10	0	2	0	0	45
		Laccotrephes sp.	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2	0	2	4	0	0	11
	Pleidae	*Plea* sp.	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	4	0	0	2	0	0	0	0	0	10
	Naucoridae	*Naucoris* sp.	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	1	1	4	0	0	0	0	9
	Corixidae	*Micronecta* sp.	0	2	1	0	0	0	0	1	0	2	0	0	0	4	9	2	0	5	0	7	0	0	3	0	36
		Micronecta scutellaris	0	0	0	0	0	0	0	0	0	0	0	0	3	14	11	0	0	0	22	0	11	0	0	0	61
		Stenocorisea protrusa	0	0	0	0	0	0	0	1	0	0	0	0	0	0	103	58	17	12	0	43	0	10	0	0	244
	Belostomatidae	*Diplonychus* sp.	2	2	6	14	3	1	8	0	0	1	0	0	0	0	0	5	0	0	79	147	0	6	1	3	278
		Limnogeton fieberi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
		Appasus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
Gerromorpha	Veliidae	*Microvelia* sp.	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	6	3	0	10	7	0	0	0	2	30
		Rhagovelia infernalis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	6
		Microvelia bourbonensis	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	8
	Hydrometridae	*Hydrometra* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	1	4
	Gerridae	*Eurymetra* sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	0	0	8
		Limnogonus	0	0	0	0	0	0	0	0	0	0	2	0	0	2	0	1	0	0	0	0	0	0	0	0	5
		Gerrisella sp.	1	1	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0	1	0	11
	Mesoveliidae	*Mesovelia vittigera*	0	0	2	0	0	0	2	0	0	0	0	0	0	0	9	0	0	0	0	1	0	0	0	0	14
		Mesovelia sp.	0	0	0	3	1	1	0	0	0	2	0	0	0	0	0	0	6	0	24	0	0	2	0	0	39
Total	10	21	27	49	11	21	11	9	22	7	0	6	4	1	3	23	174	83	36	25	281	229	29	29	8	17	1105
			Abund 76		32		20		29		6		5		26		257		61		510		58		25		

3.3 Relative Abundances of Hemiptera taxa

The seasonal distribution of hemptera taxa was indicated in Figure 2. The occurrences of the different Hemiptera taxa indicated the constant presence of *Anisops* sp., *Ranatra* sp., *Micronecta* sp. et *Diplonychus* sp. in all studies stations. In contrast, *Limnogeton fieberi*, *Rhagovelia infernalis*, *Enithares* sp., *Microvelia bourbonensis*, *Eurymetra* sp., *Limnogonus* sp., *Hydrometra* sp. et *Appasus* sp. were appeared accidentally.

The taxon *Anisops* sp. was best represented (33 66%°) of the Hemiptera collected during this period. Then come *Stenocorisea protrusa* and *Diplonychus sp*. The least represented taxa were *Enithares* sp., *Limnogonus* sp. and *Naucoris* sp. They each have two individuals (0.33%). During the short dry season *Diplonychus* sp., *Stenocorisea protrusa* and *Anisops* sp. were the most abundant taxa while less abundant taxa are *Appasus* sp., *Limnogeton fieberi*, *Hydrometra* sp., *Mesovelia vittigera* et *Microvelia bourbonensis*. Globally, during both studies seasons, *Anisops* sp., *Diplonychus* sp and *Stenocorisea protrusa* were more abundants in the fish ponds (stations 10 and 8). Seasonal variation of abundance indicated that more individuals were collected in the long wet season (606 individuals) than in the short dry season (499 individuals)..

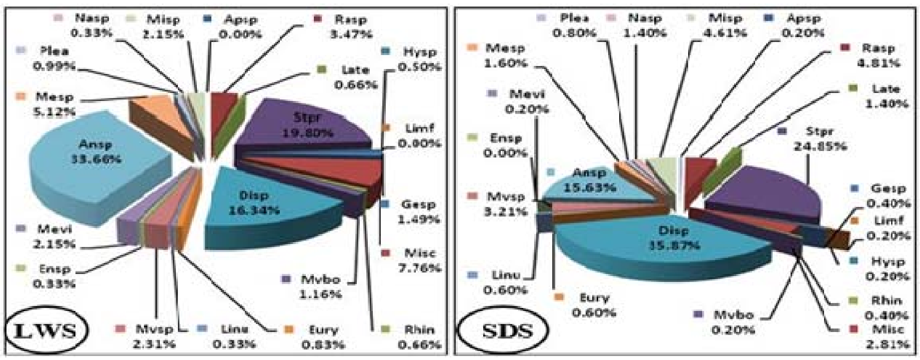

Fig 2: Relative Abundances of Hemiptera taxa collected in sampling stations

Ansp = *Anisops* sp. ; **Rasp** = *Ranatra* sp. ; **Late** = *Laccotrephes* sp. ; **Plea sp** = *Plea* sp.; **Nasp** = *Naucoris* sp. ; **Misp** = *Micronecta* sp. ; **Misc** = *Micronecta scutellaris* ; **Stpr** = *Stenocorisea protrusa* ; **Disp** =*Diplonychus* sp. ; **Limf** = *Limnogeton fieberi* ; **Apsp** = *Appasus* sp. ; **Mvsp** = *Microvelia* sp. ; **Rhin**= *Rhagovelia infernalis* ; **Mvbo** = *Microvelia bourbonensis* ; **Hysp** = *Hydrometra* sp. ; **Eury** = *Eurymetra* sp. ; **Linu** = *Limnogonus* sp. ; **Gesp** = *Gerrisella* sp. ; **Ensp** = *Enithares* sp. ; **Mevi** = *Mesovelia vittigera* ; **Mesp** = *Mesovelia* sp. ; LWS: Long wet season, **SDS**: Short dry Season.

3.4 Spatial distribution of Hemiptera:

The results of Correspondence Factor Analysis (CFA) performed on the basis of a presence / absence matrix made up of the 12 sampling stations and 21 taxa of Hemiptera are presented by the factorial box (Figure 3A). The first two axes (Axis 1 and Axis 2) expressed respectively 24.86% and 16.66% so 41.52% of the information contained in the data matrix. The hierarchical classification analysis (Figure 3B) reveals that taxa are distributed in three groups of stations. The first group formed by station 4 (lake) and stations 8 and 10 (fish ponds) is characterized by taxa such as *Enithares* sp., *Plea* sp., *Eurymetra* sp., *Naucoris* sp., *Stenocorisea protrusa*, *Micronecta scutellaris* and *Mesovelia vittigera*. The second group consists of stations 6 and 12 (ponds), station 9 (fish pond) and station 12 (stream). It is associated with *Anisops* sp., *Micronecta* sp., *Limnogeton fieberi*, *Microvelia* sp., *Hydrometra* sp., *Limnogonus* sp. and *Gerrisella* sp. The third group includes stations 1, 2 and 3 (lakes), station 5 (pond) and station 11 (canal), with as characteristic taxa *Diplonychus* sp., *Appasus* sp., *Rhagovelia infernalis*, *Microvelia bourbonensis*, *Mesovelia* sp. and Nepidae.

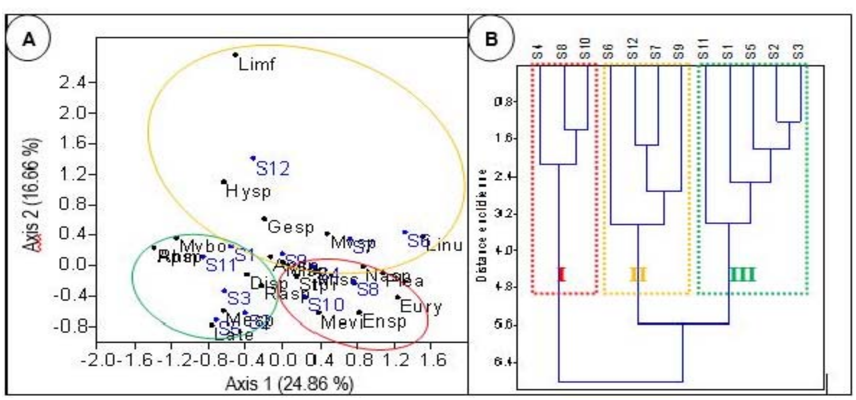

Fig 3: Correspondence Factor Analysis (CFA) showing the spatial distribution of sampled Hemiptera taxa (A: factorial map, B: hierarchical classification).

Ansp = *Anisops* sp. ; **Rasp =** *Ranatra* sp. ; **Late** = *Laccotrephes* sp. ; **Plea sp =** *Plea* sp.; **Nasp =** *Naucoris* sp. ; **Misp =** *Micronecta* sp. ; **Misc =** *Micronecta scutellaris* ; **Stpr =** *Stenocorisea protrusa* ; **Disp** =*Diplonychus* sp. ; **Limf =** *Limnogeton fieberi* ; **Apsp =** *Appasus* sp. ; **Mvsp =** *Microvelia* sp. ; **Rhin=** *Rhagovelia infernalis* ; **Mvbo =** *Microvelia bourbonensis* ; **Hysp =** *Hydrometra* sp. ; **Eury =** *Eurymetra* sp. ; **Linu =** *Limnogonus* sp. ; **Gesp =** *Gerrisella* sp. ; **Ensp =** *Enithares* sp. ; **Mevi =** *Mesovelia vittigera* ; **Mesp =** *Mesovelia* sp.

3.5 Influence of water physico-chemical parameters on Hemiptera spatial distribution

A redundancy analysis (RDA) result was presented on Figure 4. The representativity of all the axes is very significant (P-value = 0.002, F-ratio = 6.710). Axis I is significant (P-value = 0.009, F-ratio = 8.447) and expresses 44% of the information, Axis II 31%, for a total of 75% for both axes. The analysis of the graph shows that the pH and the temperature influence most the variation of the abundances of Hemiptera. Axis I reveals a positive association of pH with *Limnogeton fieberi* and a negative association with *Limnogonus* sp. and *Stenocorisea protrusa*. On axis II, *Anisops* sp. and *Plea* sp. are influenced by high temperatures. Moreover, *Infernalis*,

Laccotrephes sp., *Appasus* sp., *Rhagovelia Microvelia bourbonensis* and *Hydrometra* sp. are influenced not only by high conductivities and turbidities, but also by low temperatures. However, taxa such as Diplonychus sp. and Micronecta sp. are almost unaffected by the measured physicochemical parameters.

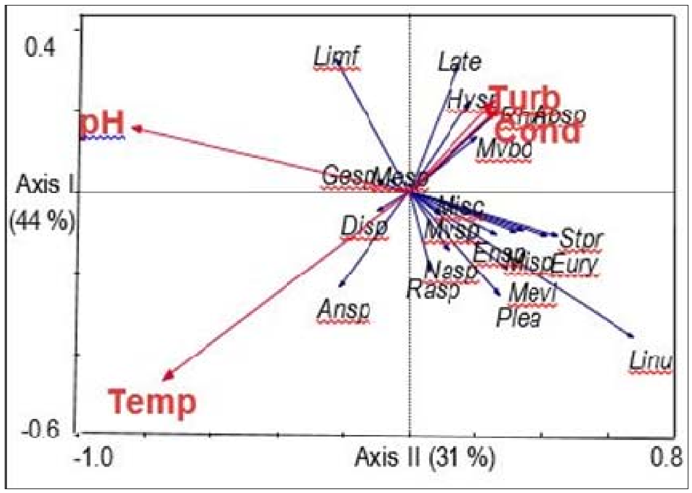

Fig 4: Redundancy analysis (RDA) plot showing environmental parameters and Hemiptera taxa collected from Daloa urban water.
Ansp = *Anisops* sp. ; **Rasp =** *Ranatra* sp. ; **Late =** *Laccotrephes* sp. ; **Plea sp =** *Plea* sp.; **Nasp =** *Naucoris* sp. ; **Misp =** *Micronecta* sp. ; **Misc =** *Micronecta scutellaris* ; **Stpr =** *Stenocorisea protrusa* ; **Disp =***Diplonychus* sp. ; **Limf =** *Limnogeton fieberi* ; **Apsp =** *Appasus* sp. ; **Mvsp =** *Microvelia* sp. ; **Rhin=** *Rhagovelia infernalis* ; **Mvbo =** *Microvelia bourbonensis* ; **Hysp =** *Hydrometra* sp. ; **Eury =** *Eurymetra* sp. ; **Linu =** *Limnogonus* sp. ; **Gesp =** *Gerrisella* sp. ; **Ensp =** *Enithares* sp. ; **Mevi =** *Mesovelia vittigera* ; **Mesp =** *Mesovelia* sp. **Cond =** Conductivity ; **pH** = Hydrogen potential; **Temp =** Temperature ; **Turb =** Turbidity.

4. Discussion

The analysis of abiotic variables values observed during the two seasons shows that the water studied in the urban area of Daloa have approximately the same physico-chemical characteristics, in spite of some variations observed from one station to another and from one season to another.

Aquatic Hemiptera are cosmopolitan or ubiquitous; because they are found in all the urban hydrosystems of Daloa. These insects are more abundant in ponds, lakes and the canal than in ponds and streams. This strong representation of Hemiptera in these environments could be due to the presence of aquatic plants (Nympheaceae) and prey such as fry [11]. Points out that these insects are mainly subservient to aquatic and semi-aquatic vegetation. And this vegetation is an indispensable support in the life traits of macroinvertebrates [12]. On the other hand, the heavily anthropised ponds and streams are the poorest in Hemiptera. Indeed, [1] noted that the diversity of benthic communities is modified by the various pressures they experience. Aquatic Hemiptera do not affect heavily polluted waters. These insects testify, by their great diversity in an aquatic environment, of an average degradation of this biotope. However, overall, the diversity of these insects is greater in lentic than lotic environments. Our results corroborate those of [13, 14]. These authors pointed out that aquatic Hemiptera are more common in stagnant or calm water than in running waters. The taxonomic richness of aquatic Hemiptera does not vary according to the season, but rather according to the nature of the environments studied. They meet as well in the rainy season as in the dry season, as pointed out by [15] in a study carried out on the macroinvertebrates of Kabylie Rivers in Algeria. According to this author, these organisms are distributed in different aquatic environments according to their ecological requirements. Thus taxa such as *Limnogeton fieberi, Limnogonus* sp. and *Stenocorisea protrusa* are strongly associated with pH while taxa such *as Anisops* sp. and *Plea* sp. are positively correlated with temperature. The taxon *Diplonychus* sp. of the family Belostomatidae and Micronecta sp. of the family Corixidae are the most widespread in the different urban water bodies of Daloa. This situation is due to the fact that these two taxa are hardly influenced by physicochemical characteristics in aquatic environments. These two insects are recognized as potential vectors and / or hosts of the prokaryotic Micobacterium ulcerans, the causative agent for burili ulcer [16]. The water bodies in which these two taxa are found are very popular with the riparian populations for agriculture, fishing, bathing and many other activities [17]; which would explain the high prevalence of *Burili ulcer* in Daloa.

5. Conclusion

All of Daloa's urban water contain a great diversity of Hemiptera because of their physicochemical characteristics which are favorable to the development of these insects. However, these organisms were found more in lentic than lotic media. They presented taxonomic wealth depended on the nature of the water. These organisms were distributed in hydrosystems according to their ecological preferences. Thus taxa like *Limnogeton fieberi*, *Limnogonus* sp. and *Stenocorisea protrusa* are strongly associated with low pH and taxa like *Anisops* sp. and *Plea* sp. are influenced by high temperatures. Taxa *Diplonychus* sp. of the family Belostomatidae and Micronecta sp. of the family Corixidae which are the vectors and / or potential hosts of Micobacterium ulcerans, the causative agent of *Burili ulcer*, are widespread in the different urban water of Daloa; which represents a potential risk for public health.

6. Acknowledgement

The authors gratefully acknowledge the University Jean Lorougnon Guédé, Daloa, Ivory Coast, for extending all facilities and words of encouragement from the principal while working on this research.

7. References

1. Bony KY, Konan KF, Edia OE, Kouassi NC. Diomandé D. & Ouattara A. Anatomie et stratégies de reproduction de *Indoplanorbis exustus* (Deshayes, 1834), un mollusque invasif d'eau douce en Côte d'Ivoire (Afrique de l'Ouest). Journal of Applied Biosciences. 2013 : 71: 5742-5752.
2. Cadot E, Fournet F, N'Guessan N, Salem G. Des bas-fonds dans la ville, l'impact sanitaire des aménagements agricoles à Daloa (Côte d'lvoire). Cahiers Agriculture. 2000; 5:7-14.
3. De Moor IJ, Day JA, De Moor FC. Freshwater invertebrates of southern Africa. Hemiptera, Megaloptera, Neuroptera, Trichoptera and Lepidoptera. WRC Report No. TT 214/03. 2003 ; 8(2):209.
4. Dejoux C, Elouard JM, Forge P, Maslin JL. Catalogue iconographique des insectes aquatiques de Côte d'Ivoire. ORSTOM. 1981 ; 42, 178.
5. Dejoux C. Les insectes aquatiques du lac Tchad - Aperçu systématique et bio-écologique. Verhandlungen des Internationalen Verein Limnologie. 1969, 900-906.
6. Déthier M. Introduction pratique à la systématique des organismes des eaux continentales françaices. Insectes. Hétéroptères aquatiques et ripicoles (genres et principales espèces). Association française de limnologie. 1986, 40.
7. Doannio JMC, Konan KL, Dosso FN, Koné AB, Konan YL, Sankaré Y *et al. Micronecta* sp. (Corixidae) et *Diplonychus* sp. (Belostomatidae), deux hémiptères aquatiques hôtes et/ou vecteurs potentiels de *Mycobacterium ulcerans* agent pathogène de l'ulcère de Buruli en Côte d'Ivoire. Médecine Tropicale. 2011; 71:53-57.
8. Forcellini M, Mathieu C, Merigoux S. Atlas des macro-invertébrés des eaux douces de l'Île de la Réunion. Conception d'indices de bio-évaluation de la qualité écologique des rivières de l'Île de la Réunion à partir des poissons et macrocrustacés et des invertébrés benthiques. Office de l'Eau de la Réunion – CNRS. 2011, 137.
9. Fournet F, N'Guessan NA, Cadot E, Gestion de. l'espace et schistosomose urinaire à Daloa (Côte d'Ivoire). Bulletin de la Societé de Pathologie Exotique. 2002; 97(1):33-36.
10. Haouchine S. Recherches sur la faunistique et l'écologie des macroinvertébrés des cours d'eau de Kabylie. Mémoire de Magister. Option : Ecologie et biodiversité animale des écosystèmes continentaux. Faculté des Sciences Biologiques et Sciences Agronomiques. Université Mouloud Mammeri de Tizi ouzou. 2011, 157.
11. Hessé AS, Imbert E, Karabaghli C, Mangot S, Saadat S. Les macro-invertébrés benthiques : Bioindicateurs de la qualité de nos rivières. Ministère de l'Écologie, du Développement durable et de l'Énergie. 2014, 6.
12. Kiblut K. Les communautés ichtyologiques et mesures de l'intégrité biotique du bassin versant de la rivière Kamouraska. Diplôme d'Etudes Supérieures Spécialisées « Ingéniérie des Hydrosystèmes Continentaux en Europe ». 2002, 64.
13. Mary N. Guide pratique d'identification des Macroinvertébrés benthiques des cours d'eau. 2000, 100.
14. Moisan J. Guide d'identification des principaux macroinvertébrés benthiques d'eau douce du Québec, 2010 – Surveillance volontaire des cours d'eau peu profonds, Direction du suivi de l'état de l'environnement, Ministère du Développement Durable, de l'Environnement et des Parcs. 2010, 82.
15. Palmer MW. Putting things in even better order: the advantages of Canonical Correspondence Analysis. Ecology. 1993 ; 74: 2215-2230.
16. Pointier JP, Théron A. La Schistosomose intestinale dans les forêts marécageuses à *Pterocarpus* de Guadeloupe (*Antilles françaises*). Ecologie du mollusque vecteur, *B. glabrata* et de son parasite *S. mansoni*. *Annales de. Parasitologie*, Paris. 1979; 54(1):43-56.
17. Poisson R. Hétéroptères aquatiques. In : P. Lechevalier (Ed.), Faune de France, C.N.R.S. Paris. 1957; 61:264