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Spatial evolution of the diversity of Macroinvertebrate-Odonate larva population dynamics in relation to the environmental variables of the Niete hydrosystem (South Cameroon)

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Abstract
A study was carried out in the Niété, a tributary of the Lobé, to evaluate the quality of it's water through a follow-up of the longitudinal evolution of the various abiotic (physico-chemical) and biotic (Odonate larva) parameters of this aquatic ecosystem. The results of the physico-chemical analysis of the water of the Niété, according to the grid of the water evaluation system (SEQ-Eau), show that, with the exception of aquaculture production, the rate of oxygen saturation (79.39±0.54%) electrical conductivity (42.59±, 16.52 µS/cm), sulphate (2.78±0.71 mg/L), suspended solids (10.88±0.54 mg/L), and nitrate ions (1.10±0.21mg/L) are in the very good quality range, whatever the intended use. This is not the case for orthophosphate ions (12.32±0.35 mg/L), which are rather in the range of poor quality water requiring complex treatment for drinking water production and likely to cause lethal effects on the most sensitive species, leading to a decrease in abundance. Out of 92 individuals collected, 09 genera were identified: 4 genera of Coenagrionidae (44.44%), 4 genera of Libellulidae (44.44%) and 1 genus of Corduliidae (11.12%). The genera Orthetrum (family Libellulidae), Coenagrion and Nehalennia (family Coenagrionidae) have a relative abundance of 65.22%. Sörensen's similarity coefficient reveals high dissimilarities between the populations of stations N1 and N2 (36.36%), N1 and N3 (28.57%) and N2 and N3 (25%). The diversity indices of Shannon and Weaver, Simpson and Piélou show that station N2 is the most diversified and favours the installation of polluotolerant Odonata, whereas station N1 is more balanced and favours a better development of Odonata larvae. This is confirmed by the Hilsenhoff index, which shows that station N2 has low water quality, compared to stations N1 and N3, which have very good water quality, reflecting the self-purifying action of the Niété river.

Keywords: Diversity, odonata larva, pollutant, Niété River, self-purifying

1. Introduction
Water is a natural resource essential to life in all ecosystems. Maintaining its quality should be a concern for all of the society. However, the harmony of this saving environment comes up against certain natural or artificial effects which cause its alteration and/or its dysfunction. The pressures exerted by man on the natural environment are increasingly important due to the mechanization and intensification of agriculture coupled with an ever-increasing demographic explosion (Devidal *et al*., 2007) [1]. Indeed, one of the concerns in today's world is the sustainability of a sufficient and quality water resource to meet the needs of a rapidly growing population, on a land whose climate is changing dramatically, with hydrological consequences still poorly estimated (MSTP, 2007) [2]. In the United States and in Europe, biological monitoring is recognized as an essential component of water quality monitoring programs (Barbour *et al*., 1999; WFD, 2003) [3, 4], the Odonata constitute a benthic Macroinvertebrate Order thus allowing to better understand the characterization, health and richness of our aquatic environments. In addition, the heritage aspect of odonates is essential to guide the manager in the development of the environments for which he is responsible (Cotrel, and Roullier., 2007) [5]. In Africa, the populations of Odonata are still poorly known and far from complete despite the work undertaken (Samraoui and Corbet, 2000; Tchibozo, 2004; Ndiaye,

2010; Senouci, 2013) [6-9]. Odonata is an order of flying insects that includes the dragonflies and damselflies. Members of the group first appeared during the Triassic, though members of their total group, Odonatoptera, first appeared in Carboniferous. The two common groups are distinguished with dragonflies, placed in the suborder Epiprocta, usually being larger, with eyes together and wings up or out at rest, while damselflies, suborder Zygoptera, are usually smaller with eyes placed apart and wings along body at rest. All Odonata have aquatic larvae called naiads (nymphs), and all of them, larvae and adults are carnivorous. The adults can land, but rarely walk. Their legs are specialised for catching prey. They are almost entirely insectivorous. This order is closely related to mayflies and several extinct orders in a group called the Palaeoptera, but this grouping might be paraphyletic. What they do share with mayflies is the nature of how the wings are articulated and held in rest (see insect flight for a detailed discussion). In some treatments, the Odonata are understood in an expanded sense, essentially synonymous with the superorder Odonatoptera but not including the prehistoric Protodonata. In this approach, instead of Odonatoptera, the term Odonatoidea is used. The systematics of the "Palaeoptera" are by no means resolved; what can be said however is that regardless of whether they are called "Odonatoidea" or "Odonatoptera", the Odonata and their extinct relatives do form a clade. These insects characteristically have large rounded heads covered mostly by well-developed, compound eyes, which provide good vision, legs that facilitate catching prey (other insects) in flight, two pairs of long, transparent wings that move independently, and elongated abdomens. They have three ocelli and short antennae. The mouthparts are on the underside of the head and include simple chewing mandibles in the adult. Flight in the Odonata is direct, with flight muscles attaching directly to the wings; rather than indirect, with flight muscles attaching to the thorax, as is found in the Neoptera. This allows active control of the amplitude, frequency, angle of attack, camber and twist of each of the four wings entirely independently. In most families there is a structure on the leading edge near the tip of the wing called the pterostigma. This is a thickened, hemolymph–filled and often colorful area bounded by veins. The functions of the pterostigma are not fully known, but it most probably has an aerodynamic effect and may also have a visual function. More mass at the end of the wing may also reduce the energy needed to move the wings up and down. The right combination of wing stiffness and wing mass could reduce the energy consumption of flying. A pterostigma is also found among other insects, such as bees. The nymphs have stockier, shorter, bodies than the adults. In addition to lacking wings, their eyes are smaller, their antennae longer, and their heads are less mobile than in the adult. Their mouthparts are modified, with the labium being adapted into a unique prehensile organ called a labial mask for grasping prey. Damselfly nymphs breathe through external gills on the abdomen, while dragonfly nymphs respire through an organ in their rectum. Although generally fairly similar, dragonflies differ from damselflies in several, easily recognizable traits. Dragonflies are strong fliers with fairly robust bodies and at rest hold their wings either out to the side or out and downward (or even somewhat forward). Damselflies tend to be less robust, even rather weak appearing in flight, and when at rest most species hold their wings folded back over the abdomen (see photograph below, left). Dragonfly eyes occupy much of the animal's head, touching (or nearly touching) each other across the face. In damselflies, there is typically a gap in between the eyes. The present study aims on the one hand to carry an inventory on the Odonate larvae of the Niété stream. On the other hand, it assesses the quality of its waters using five groups of descriptors: taxonomic richness, taxonomic composition, diversity indices, principal component analysis and the tolerance of the watercourse to pollution by calculation of the Hilsenhoff index.

2. Materials and Methods

2.1. Study site

The South Cameroon Region is located between 2° 30' North latitude and 11° 45' East longitude. The relief of the Region is dominated by the South Cameroonian plateau made up of vast peneplains whose altitude varies between 0 and about 1000 m (Segalen, 1967) [10]. The area is approximately 47,720 km2 with a climate that has favored over time the development of evergreen dense equatorial forest vegetation, but which has some degradation in The locality of Niété is drained by the river Niété tributary of the lobe. The commune extends over the watersheds of the Lobé and Kienké coastal rivers, it covers an area of 1003 km2 or 8.9% of the departmental territory of the Ocean, it borders four communes of this department: Lokoundjé, Akom II, Campo and Kribi I places (Figure 1).

As part of this study, 4 sampling stations were identified

- Station N1 is located in the upper part of the Niété stream, the water flow at this station relatively high. The river bed is bordered in a dominant way by species of mangrove trees bearing aerial roots. This station, although located in the rubber tree plantation, is quite far from the rubber tree farm and human habitat (Figure 2A).
- Station N2 is located in the middle part of the Niété stream, in village 2 (V2). This station is immediately adjacent to the main HEVECAM road. The river bed is quite wide covered with large stones and the water flow fluctuates greatly with the seasons. Presence of some species of mangroves and macrophytes in some places of the river bed. Presence of very few natural substrates and micro or meso-habitats (Figure 2B).
- Station N3 is located in the lower part of the Niete stream, this station is in an unexploited area within the rubber plantation. The river bed is lined with bamboo plants which reduce water lighting, especially near the river and whose dead leaves and branches act as natural substrates, creating a distinct micro climate near the river. Fast flowing river. No apparent sign of eutrophication is present (figure 2C)

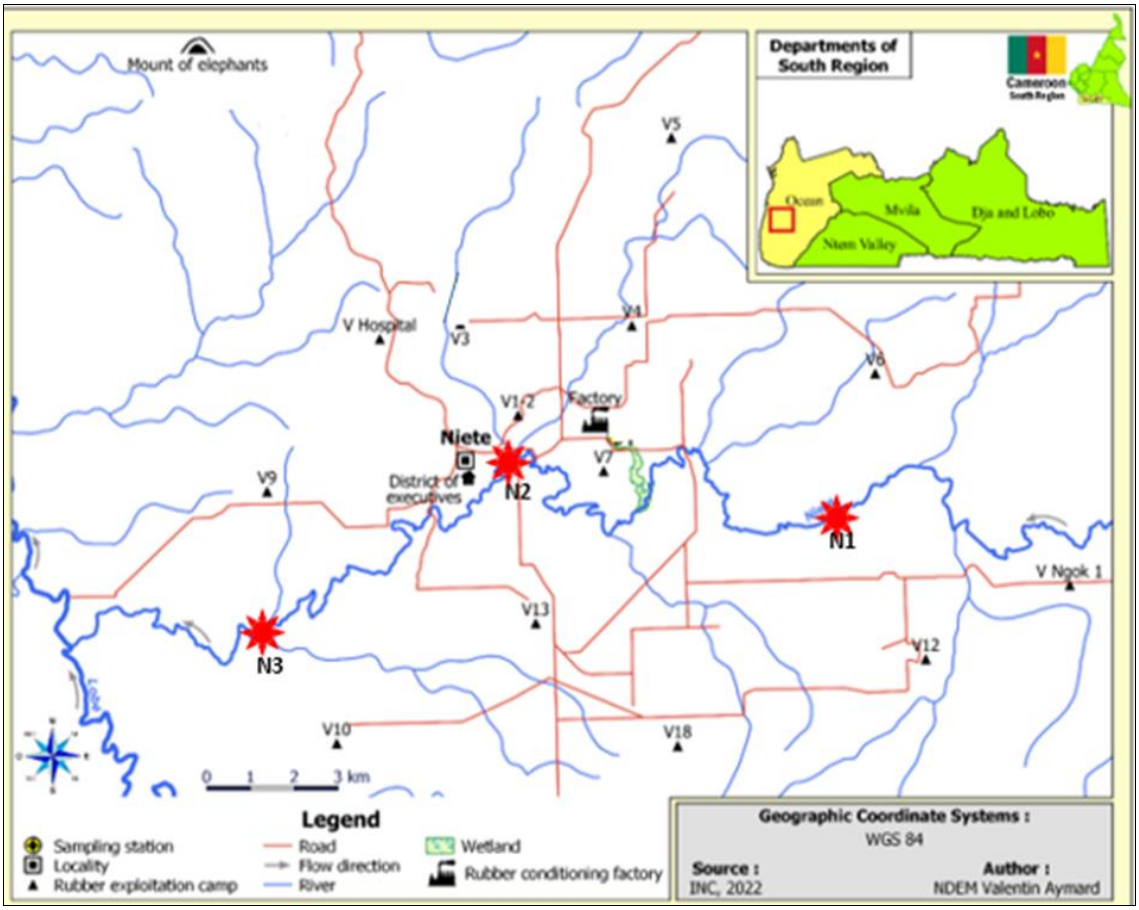

Fig 1: Geographical representation map of sampling stations

Fig 2: Partial view of the Niété stream sampling stations. (A) N1; (B) N2; (C) N3.

2.2 Study period

Our study took place from September 2019 to December 2020 following a monthly sampling frequency.

2.3 Physico-chemical analyzes

The samples were collected in sterile 1000 ml polyethylene bottles, following the recommendations of Rodier *et al.* (2009) [11] and APHA (2017) [12] and transported to the Hydrobiology and Environment Laboratory of the University of Yaoundé 1 for analysis. Thus, physico-chemical parameters such as temperature (°C), pH (U.C), dissolved oxygen (%), electrical conductivity (µS/cm) were measured in situ using a HANNA HI98130 multiparameter and a HANNA HI 9147 brand portable oximeter respectively. In the laboratory, nitrates (mg/l of NO_3^-), orthophosphates (mg/l of PO_4^{3-}), sulphates (mg/L of SO_4^{2-}), chlorides (mg/L Cl^-), suspended solids and hardness (mg/L) were determined colorimetrically using the HACH DR 2800 spectrophotometer.

2.4 Sampling of Odonata larvae

The collection of odonate larvae was carried out monthly according to the multi habitat approach of Stark *et al.* (2001) [13], Support from September 2019 to December 2020. Using a square-shaped stirrer with a side of 30 cm, fitted with a conical net of 400 µm mesh opening and 50 cm deep. For each study station, around twenty landing nets are made to collect the specimens present in the various microhabitats listed. The organisms thus collected are fixed in 10% formalin. In the laboratory, the specimens are washed in water then preserved in 70° alcohol before the identification and counting operations. All captured specimens were identified under a WILD M5 brand binocular magnifying glass with episcopic illumination, using the identification keys and works of Durand and Levêque (1991) [14], Tachet *et al.* (2006) [15], Heidemann and Seidenbusch (2002) [16], Day *et al.* (2002) [17], De Moor *et al.* (2003) [18], Stals and De Moor (2007) [19] and Moisan (2006) [20].

2.5 Data analysis
The analysis of benthic macroinvertebrate data is done using methods with single and multivariate variables. The monitoring of the spatiotemporal evolution of the demographic structure of Odonate larva populations is carried out using metrics such as taxonomic richness, taxonomic diversity, taxonomic composition. Pollution tolerance is assessed by applying the Hilsenhoff index, which takes into account the tolerance ranges attributed to each organism making up the community (Hilsenhof, 1988; Bode *et al*., 2002) [21, 22].

3. Results
3.1. Physico-chemical parameters
The objective of this part is the description of the main physical and chemical characteristics of the waters of the Niété river, the monitoring of their spatio-seasonal evolution and the understanding of the fundamental mechanisms which govern them. The results obtained are summarized in Table 1.

Table 1: Results of the physicochemical analyzes of the waters of the Niété river. Avg: Average, Sd: standard deviation.

	N1	N2	N3	Avg and Sd
Température (°C)	25, 35±0, 42	25, 26±0, 42	25, 19±0, 39	25, 27±0, 39
pH (UC)	6, 40±0, 14	6, 33±0, 11	6, 48±0, 17	6, 40±0, 14
O_2 dissous (%)	78, 94±1,52	79, 25±1, 53	79, 99±1, 03	79, 39±1, 38
Conductivité (µS/cm)	35, 36±6, 98	61, 49±44, 81	30, 93±7, 51	42, 59±28, 52
MES (mg/L)	11, 50±4, 36	10, 51±4, 48	10, 64±3, 48	10, 88±3, 91
Orthophosphate (mg/L)	12, 20±5, 54	12, 06±4, 46	12, 71±6, 50	12, 32±5, 23
Nitrate (mg/L)	0, 87±0, 20	1, 26±0, 58	1, 18±0, 14	1, 10±0, 38
Chlorure (mg/L)	0, 12±0, 02	0, 13±0, 06	0, 13±0, 03	0, 13±0, 03
Sulfate (mg/L)	2, 55±1, 01	3, 58±1, 50	2, 21±0, 71	2, 78±1, 21
Dureté totale (mg/L)	3, 06±1, 13	3, 43±1, 58	3, 86±1, 65	3, 45±1, 45

The spatial variability of the average water temperatures of the Niété river decreases from upstream to downstream and varies between 25.19±0.39 °C (station N3) and 25.35±0.42 °C (Station N1). The average values of the pH of the water measured from one station to another showed the lowest average value at station N2 (6.33±0.11 UC) and the highest at station N3 (6.48±0.17). The average levels of the percentage of oxygenation observed varied between 78.94±1.52% (station N1) and 79.99±1.03% (station N3). The average SS values obtained during the study period varied between 10.64±3.48 mg/l at station N3 and 11.50±4.36 mg/l at station N1 (Table I). With regard to electrical conductivity, the average values recorded oscillate between 30.93±7.51 µS/cm at station N3 and 61.49±44.8 µS/cm at station N2. The orthophosphate fluctuation profile shows levels that vary between 12.06±4.46 mg/L (station N2) and 12.71±6.50 mg/L (station N3). The nitrate fluctuations observed oscillate between 0.87±0.20 mg/L (station N1) and 1.26±0.58 mg.L (stations N2) (table I). Increased from upstream to downstream with a peak at stations N2 and N3 (0.13±0.06). The sulphate fluctuation profile shows average levels ranging from 2.21±0.71 mg/L at station N3 to 3.58±1.50 mg/L at station N2. Total hardness grades increased from upstream to downstream. The lowest value (3.06±1.13 mg/L) observed at station N1 and the highest value (3.86±1.65 mg/L) at station N3 (Table I).

3.2. Populations of Odonata larvae
During our study period, a total of 92 individuals were identified belonging to three (03) families, 9 genera and 9 species (Table II). Of the 9 genera identified, there are 04 genera of Libellulidae, 04 genera of Cœnagrionidae and 01 genera for Corduliidae. The profile of the total abundances of Odonates collected shows higher values at station N2 (50 ind.), followed respectively by stations N1 (24 ind.) and N3 (20 ind.) (Table 2).

Table 2: Biodiversity of Odonata species collected during the study

Order	Families	Genres/Species	Stations N1	N2	N3	Total
Odonate	Libellulidae	*Libellula* sp.	4	0	0	4
		Orthetrum caffrum	4	6	12	22
		Sympetrum proparte	0	0	8	8
		Brachythemis leucosticta	2	0	0	2
	Cœnagrionidae	*Nehalennia speciosa*	10	8	0	18
		Ishnura sp.	0	12	0	12
		Erythromma viridulum	0	2	0	2
		Cœnagrion proparte	0	20	0	20
	Corduliidae	*Oxygastra curtisii*	4	0	0	4
Total Abundance (N)			24	50	20	92

Most of the Odonate larvae collected belong to the Cœnagrionidae family (56.52%) followed by Libellulidae (39.13%) and Corduliidae (4.35%). Thus, a total of 92 individuals divided into 3 families, 9 genera, 9 species were collected, identified and counted. Of the 9 genera identified, there are 4 genera of Cœnagrionidae, 4 genera of Libellulidae and 1 genus of Corduliidae (Figure 3).

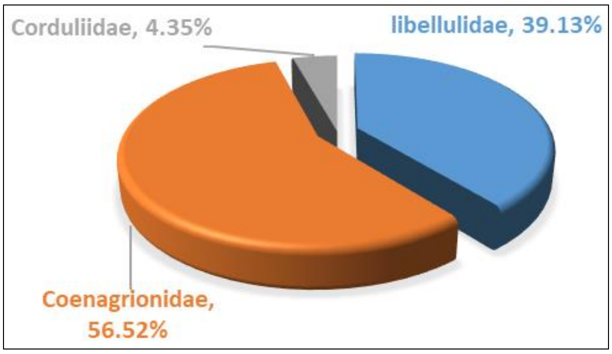

Fig 3: Quantitative distribution of the different families identified during the study period

The population was dominated by the genus *Nehalennia* at station N1 with 21.43% of the relative abundance, while the genus *Cœnagrion* (27.59%) was dominant at station N2. Station N3 would have been more favorable to the installation of only the genera *Orthetrum* and *Sympetrum* (figure 4).

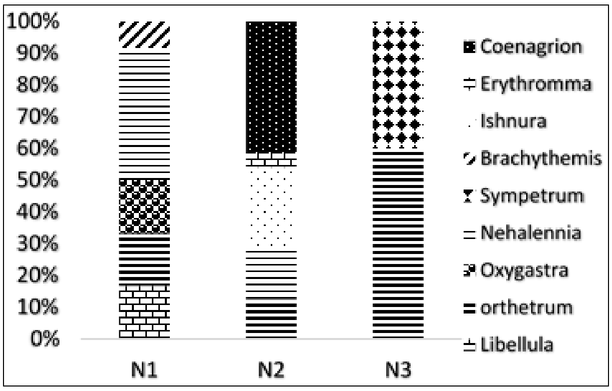

Fig 4: Spatial variation in the relative abundance of the different genera of Odonata harvested at dawn during the study period.

3.3. Spatial Variation of Taxonomic Richness, Taxonomic Abundance and Diversity Indices

During the study period, the average number of taxa recorded at the different stations ranged around 4.33±2.08 species. The standard deviation is greater than 2 taxa from one station to another and reflects a relative instability of the taxonomic richness from upstream to downstream of the river. Station N2 records the highest taxonomic richness (6 species) while the lowest is found in N3 (02 species) (Table II). The average abundance of the specimens collected at the different stations is 31.33±16.29 individuals, the value of the standard error observed here is essentially due to the low value of the numbers obtained at stations N1 AND N3 which move considerably away from station N2 (table II).

The Shannon & Weaver index (H') fluctuates from one station to another. The lowest value (0.67 bits/ind.) was observed at station N3 and the highest (1.51 bits/ind.) at station N2. Similarly, Simpson's diversity index (1-D) varied by 0.48 bits/ind. (station N3) at 0.74 bits/ind (station N1 and N2). Regarding the Piélou (J) equitability index, it varied very slightly from 0.86 bits/ind (N2 station) to 0.96 bits/ind (N1 stations) (Table 3).

Table 3: Spatial variation of taxonomic richness, taxonomic abundance and diversity indices during the study period

Description	Stations			Average and standard deviation
	N1	N2	N3	
Specific richness (S)	5	6	2	4,33±2,08
Total abundance (N)	24	50	20	31,33±16,29
Indice de diversity index of Simpson (1-D)	0,74	0,74	0,48	0,65±0,15
Diversity index of Shannon and Weaver (H')	1,45	1,51	0,67	1,22±0,47
Equitability index of pielou (J)	0,96	0,86	0,91	0,91±0,06

3.4. Variation of the Similarity Coefficient

The Sörensen similarity coefficient calculated consecutively between stations N1, N2 and N3 reveals a dissimilarity between the populations of the different stations. the similarity coefficient variation profile is as follows N1 and N2 (36.36%) > N1 and N3 (28.57%) > N2 and N3 (25%).

3.5. Spatial Variation of the Hilsenhoff Index

The values of the Hilsenhoff index vary between 3 and 7.50, showing that the waters of the Niété are between the quality ranges called "very poor" to "excellent" during the period of this study (Figure 5). We can thus see along the watercourse sections of different quality levels as follows: the lower section represented by station N3 (3.00) with so-called "excellent" quality water without organic pollution; the upper section represented by station N1 (4.26) with so-called "good" quality water exposed to probable organic pollution;the middle section represented by station N2 (7.50) where the water is of so-called "very poor" quality, characterized by serious organic pollution.

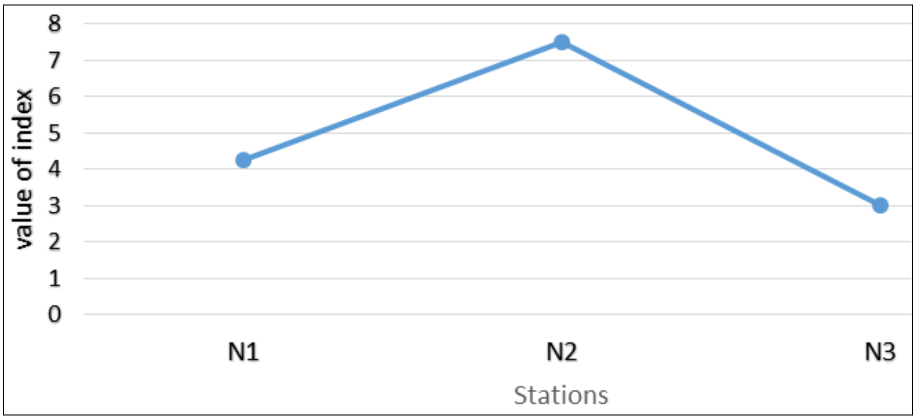

Fig 5: Variatio of hilsenhoff index on the Niete during the study

3.6. Morphological characteristics of some predominant species obtained

Odonates are aquatic or semi-aquatic as juveniles. Thus, adults are most often seen near bodies of water and are frequently described as aquatic insects. However, many species range far from water. They are carnivorous (or more specifically insectivorous) throughout their life, mostly feeding on smaller insects. Male Odonata have complex genitalia, different from those found in other insects. These include grasping cerci at the tip of the abdomen for holding the female, and a secondary set of copulatory organs located between the second and third abdominal segment in which the spermatozoa are stored after being produced by the primary genitals- whose external opening is known as the genital pore, on the ninth abdominal segment. This process is called intra-male sperm translocation (ST). Because the male copulatory organ has evolved independently from that in other insects, it has been suggested the stem-group dragonflies had external sperm transfer. To mate, the male claspers grasps the female by the thorax (Zygoptera) or head (Anisoptera) while the female bends her abdomen so that her own genitalia can be grasped by the copulatory organ holding the sperm. This is known as the "wheel" position. Eggs are laid in water or on vegetation near water or wet places, and hatch to produce pronymphs which live off the nutrients that were in the egg. They then develop into instars with approximately 9–14 molts that are (in most species) voracious predators on other aquatic organisms, including small fishes. The nymphs grow and molt, usually in dusk or dawn, into the flying teneral immature adults, whose color is not yet developed. These insects later transform into reproductive adults. Odonates can act as bioindicators of water quality in rivers because they rely on high quality water for proper development in early life. Since their diet consists entirely of insects, odonate density is directly proportional to the population of prey, and their abundance indicates the abundance of prey in the examined ecosystem.Species richness of vascular plants has also been positively correlated with the species richness of dragonflies in a given habitat. This means that in a location such as a lake, if one finds a wide variety of odonates, then a similarly wide variety of plants should also be present. This correlation is not common to all bioindicators, as some may act as indicators for a different environmental factor, such as the pool frog acting as a bioindicator of water quality due to its high quantity of time spent in and around water. In addition, odonates are very sensitive to changes to average temperature. Many species have moved to higher elevations and latitudes as global temperature rises and habitats dry out. Changes to the life cycle have been recorded with increased development of the instar stages and smaller adult body size as the average temperature increases. As the territory of many species starts to overlap, the rate hybridization of species that normally do not come in contact is increasing. If global climate change continues many members of Odonata will start to disappear. Because odonates are such an old order and have such a complete fossil record they are an ideal species to study insect evolution and adaptation. For example, they are one of the first insects to develop flight and it is likely that this trait only evolved once in insects, looking at how flight works in odonates, the rest of flight can be mapped out. The description below ties to the odonate species identified in our study.

Description *Orthetrum caffrum*

The specimens studied have small eyes, an abdomen densely covered with fine setae, no lateral spines on segments 8 and 9. The femur of the forelegs shorter (Figure 6A).

Description *Nehalennia speciosa* (Charpentier, 1840)

Identified specimens have chiaroscuro mottled antennae. Each item has a dark part and a light part. Dorsal side of occiput with light dots. The proctes end in small points. The series of teeth resemble each other in length and development. The back part of the head, seen from above, does not have the angular appearance. The comb of the labial palp is distinctly serrated, and the mentum bears no setae, but only one seta on each side. The border spines at the last 3 or 4 segments (Figure 6B)

Description *Coenagrion proparte* (Tachet *et al*., 2006) [15]

Identified individuals have six antennal segments. The first abdominal sternites lacking the rows of short spines. Caudal lamellae varied in shape. Series of setae on the mentum including at least 2 large setae per set. The width of the comb of the labial palp reaches at least half the length of the mobile hook. Femurs has at least 4 dark rings (Figure 6C).

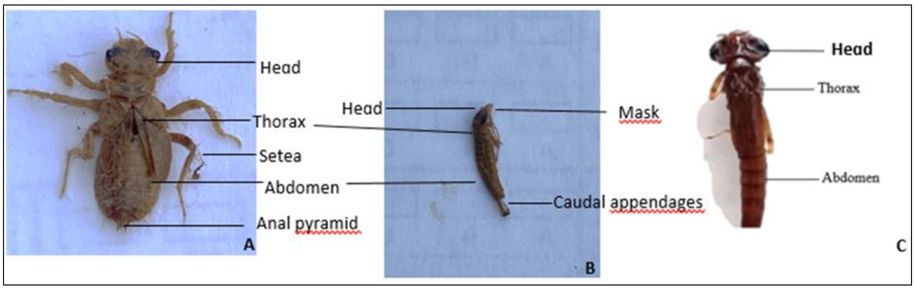

Fig 6: Photography of the larva of Odonata identified: A) *Orthetrum caffrum*, B) *Nehalennia speciosa* et C) *Cœnagrion proparte*

4. Discussion

4.1 Physicochemical variable

The average water temperature (25.27±0.39 °C) recorded throughout this study would result from the synergy between the ambient temperature, the time of sampling and other factors such as the immediate environment of the stations (riparian vegetation, shade). According to Liechti *et al*. (2004) [23], the thermal variations of lotic ecosystems match those of the air. This temperature range is similar to that obtained by Moussima (2022) [24] for some surface water bodies in the city of Yaoundé as well as by Tchakonté (2016) [25] for the urban and peri-urban waters of Douala. The average water content in percentage of oxygen saturation (79.39±1.38%) corresponds to good quality water (MEDD and Water Agency, 2003) [26]. Although sensitive to hydrological and hydrodynamic fluctuations specific to each of the study stations, no significant variation is perceptible from one site to another. This value is similar to that obtained by Biram A Ngon (2019) [43] in the Mefou watershed. The average pH value (6.40±0.14 UC) recorded reveals a slight acidity of the Niété waters studied and would be, according to Ajeagah *et al*. (2016) [28] due to the dissolution of atmospheric carbon dioxide, coupled with the metabolic activity of biological organisms present in watercourses, contributing to the conversion of carbonates into bicarbonates, promoting acidification of the environment. Our results are similar to those obtained by Moanono (2021) [29] in some mangroves on the Cameroonian coast. The recorded pH values nevertheless remain favorable for aquatic life (SEEE, 2007) [44] as well as for agricultural irrigation (FAO, 2003).

The spatial variation of chlorides and sulphate in Niété waters fluctuates around an average of 0.13±0.03 mg/L and 2.78±1.21 mg/L respectively and is due to low anthropization of the watershed. According to the SEQ–Water grid The average chloride and sulphate values recorded are still favorable for agricultural irrigation and the production of drinking water. The average total water hardness in the region (3.45±1.45mg/L) recorded reveals slightly hard waters and remains within the range of those generally found in unpolluted forest streams or at springs. some urban watercourses (Keitan and Lowe, 1985; Bellinger *et al*., 2006; Moreno *et al*., 2006; O'driscoll *et al*., 2012) [32, 33, 34, 35]. The low hardness value would be favorable to potential uses such as the production of drinking water, watering) and aquaculture (MEDD and Water Agency, 2003) [26]. No significant difference was observed from one site to another, reaffirming the homogeneity of the substrate on which the waters flow in this region.

4.2. Biotic characterization of study stations

The faunal inventory summarized (Table 2) shows the quantitative distribution of populations in the different stations sampled. In total, the samples collected during the study period at all the Niete stations contain 92 specimens belonging to 3 families and 9 species. The distribution of these organisms per station varies between 20 and 50 specimens. These spatial variations could be attributed to the characteristics of the biotope. Indeed, these taxonomic categories, which reflect diversity, appear to be good indicators of the capacity of the environment to support a variety of taxa (Resh *et al*., 1995) [36]. Note, however, the relative abundance of Coenagrionidae and Libellulidae during this study. Indeed, these two families of aquatic odonates are mostly made up of pollutant-tolerant species (Foto Menbohan *et al*. 2023) [37]. Thus, they also associate them with the organic pollution of water. This would explain their almost absolute dominance at the polluted station (N2).

At station N2, we note the emergence of two families, the Libellulidae and the Cœnagrionidae, with a tolerance rating of 9 (Barbour *et al*., 1999; Bode *et al*., 2002; Mandaville, 2002) [3, 22, 38]. The unique presence of the Libellulidae and Cœnagrionidae families at this station would be an ecological consequence of the significant organic pollution of this station due to the discharge of agricultural and domestic wastewater. Indeed, this station presented the worst values for almost all the physico-chemical parameters measured, suggesting that the type of stress to which it is subject would have greater consequences on the integrity of the assemblages of Odonata larvae in the waters. surface in this area.

The omnipresence of *Orthetrum* in all the stations except (Table 2) would be linked to the presence of vegetation and sunshine in the waters, hence their. To this end, Grand (1990) [39] and Schmidt (1993) [40] associated the presence of Orthetrum with that of vegetation, stagnant or slightly running water, shallow and in full sun. The low sampling frequencies of the genus *Oxygastra* in the sampling stations (Table 2) could be explained by the fact that the sampling at these stations was only carried out in the meadow at the level of the banks. excluding bottom sediments.

The highest values of the Shannon-Weaver and Simpson diversity indices were obtained at station N2 and the highest Piélou evenness index at station N1. This would reflect the fact that station N2 is the most diversified, but with a population slightly dominated by *Coenagrion proparte* (40%), whereas station N1 is more balanced. Dajoz (1985) [41] stipulate in this regard that the diversity index is all the higher when the environmental conditions favor the establishment and maintenance of a balanced, integrated community capable of adapting to change. Conversely, the low values recorded at station N3 would reflect an unstable environment dominated by the species Orthetrum caffrum which represents 60% of abundance. To this end, Grall and Coïc (2005) [42] point out in this regard that the diversity index of Shannon and Weaver and of equitability of Piélou decrease when the population is largely dominated by a taxon.

In addition, all the descriptors used in this study place station N2 as the most affected by the degradation process and yet the most subject to stress. The arrival of untreated agricultural and domestic effluents would affect the quality of the water in this place and would favor the proliferation of polluting-tolerant odonate larvae. However, the Hilsenhoff Biotic Index (HBI) was applied to estimate the biological quality of Niété water and revealed serious organic pollution (N2) to excellent quality (N1 and N3). This reflects a change in the composition of Odonate communities in the face of changes in water quality.

5. Conclusion

It appears from this work that the waters of the Niété river studied have a moderate tropical temperature, a slightly acidic pH, good oxygenation, these waters are weakly mineralized and have low nitrogen levels. It should also be noted that good water oxygenation, low mineralization, low oxidability and nitrogen compound concentrations are ecological factors favorable to the distribution of Odonates. This study identified 09 genera of Odonate including 04 genera of Cœnagrionidae, 04 genera of Libellulidae and 1 genus of Corduliidae. Of the 92 individuals collected, most belong to the Cœnagrionidae family (56.52%) followed by Libellulidae (39.13%) and Corduliidae (4.35%). The diversity of populations of Odonata larvae is generally decreasing from upstream to downstream of the river. Its maximum value obtained at station N2 indicates that this section offers better conditions for the development of Odonata larval communities. However, the Hilsenhoff biotic index (HBI) applied to estimate the biological quality of surface water and reveal that the sections represented by stations N1 and N3 have good quality water compared to N2 where organic pollution looks serious. The water quality is very good on the lower section represented by station N3, thus confirming the self-purifying action of the Niété river. In view of these findings, we recommend strengthening the monitoring of aquatic environments, in particular in environments with agricultural activities and ensuring compliance with standards for the treatment of industrial effluents before their discharge into the environment.

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