

Preliminary data on the odonatofauna in Pelefero Gon Coulibaly University's forest reserve perimeter (Northern of Côte d'Ivoire)

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World Journal of Advanced Research and Reviews, 2024, 21(01), 641–649

Publication history: Received on 18 November 2023; revised on 01 January 2024; accepted on 04 January 2024

Article DOI: <https://doi.org/10.30574/wjarr.2024.21.1.2671>

Abstract

The ecological importance and diversity of Odonata are most often underestimated. However, their sensitivity to environmental conditions makes them excellent biological indicators of environmental conditions. The aim of this study is to explore the diversity of Odonata within and around Pelefero Gon Coulibaly University forest reserve, with a view to providing valuable data to guide conservation efforts. The Odonata were collected using a sweep net from May to August 2023. This study revealed a preliminary list of 28 species of Odonata including 26 species of Anisoptera and 2 species of Zygoptera belonging to 3 families (Libellulidae, Aeshnidae and Coenagrionidae). The Libellulidae family was the most diversify, comprising 25 species alone (or 98.66%). The Shannon-Weaver index and rarefied richness revealed that site S2 had significantly higher diversity values compared to other sites due to the different crops that provide favorable conditions for Odonata to survive. Site S1 proved to be the least inhospitable for the Odonata, because it was poor in vegetation. This result was also confirmed by the distribution profile of Odonata from the Self-Organising Map (SOM).

Keywords: Pelefero Gon Coulibaly University; Korhogo; Odonata; Forest reserve; Diversity; Self Organising Map

1. Introduction

Odonata, also known as Dragonflies and Damselflies, are a fascinating group of winged insects whose ecological importance and diversity are often underestimated. They represent an important element in the ecosystem of aquatic environments [1]. Their sensitivity to environmental conditions makes Odonata excellent biological indicators of environmental conditions [2]. As a result, they serve as indicators of changes in water quality and surrounding vegetation. Their assemblages can also be used as surrogates to determine which aquatic areas should be prioritized for conservation [3]. The preservation of these species is therefore crucial in the context of biodiversity conservation.

This study focuses on exploring the diversity of Odonata within and around a specific forest reserve, aiming to unveil their ecology and provide valuable data to guide conservation efforts. Odonata, although often overlooked, play a crucial role in food webs as efficient predators of various insects [4], thereby contributing to population control and maintaining ecological balance. Furthermore, due to their complex life cycle between aquatic and terrestrial environments, Odonata offer the opportunity to explore the interconnections between these two environmental components within the forest reserve.

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In Africa, odonatological studies have been carried out [5, 6] particularly in West Africa [7, 8], in Ghana and [9,10], in Nigeria, in Benin [11,12]. In Côte d'Ivoire, studies on Odonata are rare and very old [13,14]. Odonata of the north of the country were only known from inventories previously carried out in Korhogo [13]. Some recent studies have been carried out in the north of the Côte d'Ivoire [15,16].

In summary, this study fits into the broader framework of biodiversity conservation, focusing on a group of insects that are often underestimated, but whose role in terrestrial and aquatic ecosystems is crucial. The results of this first study are likely to contribute to a better understanding of the dynamics of odonatan populations in the forest reserve of Peleforo Gon Coulibaly University and will make it possible to better manage and preserve this studied forest reserve.

2. Material and methods

2.1. Study area

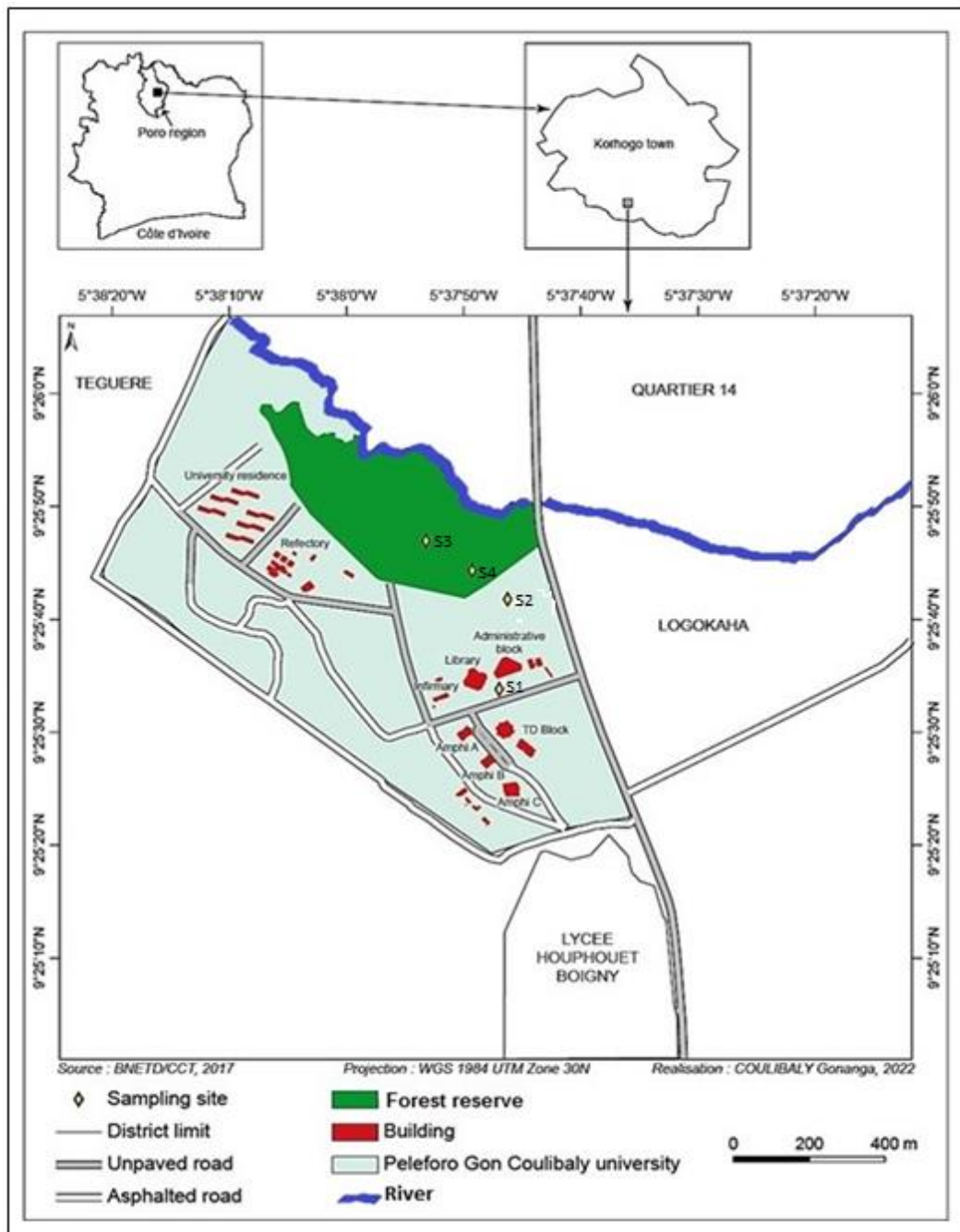


Figure 1 Location of the Sampling sites

The city of Korhogo is located in the north of Côte d'Ivoire, capital of the Poro region: This region is characterized by a transitional tropical climate with two seasons, with average annual rainfall between 1000 and 1700 mm of rain. The rainy season runs from May to October and the dry season runs from November to April. The area belongs to the Sudanian region whose climatic formations are open grass-carpet formations. They are characterized by the typical Sudanian savannah containing forest islands [17]. This study was conducted in Pelefero Gon Coulibaly University's forest reserve perimeter (Figure 1) located south of the city of Korhogo (9°25'38"N and 5°37'58"W), on the Korhogo-Abidjan highway. This site has a very heterogeneous physiognomy, with built-up areas consisting of administrative buildings, amphitheatres and other classrooms, as well as university cities with their play areas; Bushy areas represented by the undeveloped areas of the campus; a very densely forested area comprising a teak patch and a dry forest relic. The site S1 (9°25'34"N; 5°37'47"W) is very urbanized, it is located on the green garden surrounding the administration buildings of Pelefero Gon University. This site is home to some shrubs. Site S2 (9°25'42.10"N; 5°37'47.61"W) is an agricultural environment where some vegetable crops such as lettuce, cabbage are practiced. The Site S3 (9°25'47"N; 5°37'55"W) and S4 (9°25'45"N; 5°37'50"W) are located in the forest reserve is located within the Botanical Garden of the University Pelefero Gon Coulibaly with small contracted units of plant formations clear forest, riparian forest, savannah trees. The soils are mainly ferruginous and ferralitic [18]. The forest reserve is bordered by a permanent urban river.

2.2. Sampling procedure

The Odonata were captured during four campaigns in May, June, July and August 2023 at all sites. We sampled adult individuals of Odonata species with a sampling protocol of 2 researchers per hour per sampling site [19]. Field investigations consisted of walking the perimeter of each site as well as its immediate vicinity where imagoes hunt and mature as recommended by Grand and Boudot [20]. All visits and collection were conducted between 9:00 am to 02:00 pm. Sweep net technique was followed in the sampling. At the different sites, adult Odonata were captured using a swath net. Specimens collected were identified using the field guide of Dijkstra and Clausnitzer [21] and the African Dragonflies and Damselflies Online (ADDO) [22].

2.3. Data analysis

The species diversity was calculated using the Shannon-Weaver diversity index and Pielou's evenness index. Taxonomic richness was rarefied in each site per sampling period. Precisely, rarefied richness was used to avoid any bias related to differences in abundances between samples [23]. Before performing comparison analyses, data normality was checked using Shapiro test. As the biotic and environment data distribution follow non-normal distribution ($P < 0.05$), the non-parametric test of Kruskal-Wallis was performed to compare data variability between the four sampling sites. When Kruskal-Wallis test is significant, Mann-Whitney test was used for pairwise comparison. The significance threshold was $p = 0.05$. Analyses were conducted using the R package. The occurrence percentage (FO) was calculated using the following formula: $FO = (Ni/Nts) \times 100$; with Ni = number of samples containing a given species i , and Nts = total number of samples collected. The FO was used to classify species following [24] $FO > 50$: very frequent species; $25 < FO \leq 50$: frequent species; $FO \leq 25$: rare species. The presence-absence database for Odonata of Pelefero Gon Coulibaly University's forest reserve perimeter was analysed using Self-Organising Maps (SOM) or Kohonen maps [25]. This method was used to order the samples according to species assemblages. Once the map had been obtained, a hierarchical classification analysis (HCA) algorithm based on the Ward method as an aggregation criterion and Euclidean distance was used to highlight the real assemblages of objects on the map [26]. Clusters are created on the basis of the similarities between the samples projected into the cells of the SOM map. The analysis was carried out using MATLAB 6.1 software.

3. Results

3.1. Composition of Odonata

Anisoptera (Dragonflies) showed the highest percentage of Odonata composition and diversity with 26 species belonging to the Libellulidae, the Aeshnidae 1 only family. Zygoptera (Damselflies) with 2 species belonging to 1 single family (Coenagrionidae) (Table 1). Libellulidae (98.66%), Aeshnidae and Coenagrionidae are taken back by a percentage less than 1% (Figure 2). At site S1 (09) nine species belonging to a family (Libellulidae) were recorded. Libellulidae is the most represented family with 88 % of the species. It is followed by the Coenagrionidae with 8% of the species. At site S2, two families were collected. The Libellulidae was the highest (98.76%) and the Coenagrionidae (1.23 %). Taxonomy dominated by Libellulidae 76.19% followed by Aeshnidae (19.04%) and Coenagrionidae (4.76%) at site S3; at site S4, the only family found is Libellulidae.

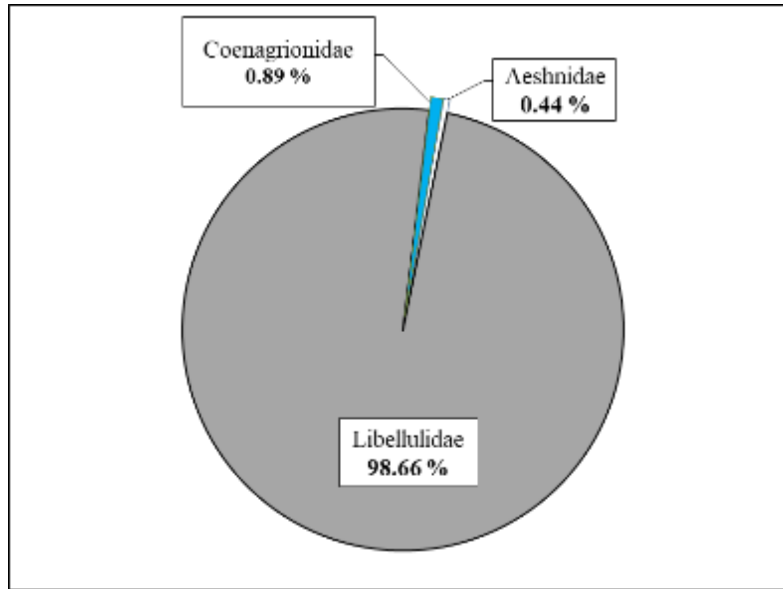


Figure 2 Composition of the families of Odonata collected in the perimeter of Pelefero Gon Coulibaly University's forest reserve

Table 1 List of the Odonata taxa found in the four sites of Pelefero Gon Coulibaly University's forest reserve

Suborders	Families	species	Sampling sites			
			S1	S2	S3	S4
Anisoptera	Aeshnidae	<i>Gynacantha manderica</i> (Grünberg, 1902)			++	
	Libellulidae	<i>Acisoma inflatum</i> (Selys, 1882)	+	++	+	+
		<i>Aethiothemis solitaria</i> (Ris in Martin, 1908)	+	+	+	++
		<i>Chalcostephia flavifrons</i> (Kirby, 1889)			+	
		<i>Crocothemis erythraea</i> (Brullé, 1832)	++	+	+	+
		<i>Crocothemis sanguinolenta</i> (Burmeister, 1839)				+
		<i>Diplacodes lefebvrii</i> (Rambur, 1842)		++		
		<i>Diplacodes luminans</i> (Karsch, 1893)		+		
		<i>Hadrothemis camarensis</i> (Kirby, 1889)	+			
		<i>Hadrothemis infesta</i> (Karsch, 1891)		++		
		<i>Hadrothemis scabrifrons</i> (Ris, 1910)	++			
		<i>Hemistigma albipunctum</i> (Rambur, 1842)	+	++		
		<i>Macrodiplax cora</i> (Brauer, 1867)	+	+		
		<i>Malgassophlebia bispina</i> (Fraser, 1958)		+		
		<i>Orthetrum chrysostigma</i> (Burmeister, 1839)		+		
		<i>Orthetrum guineense</i> (Ris, 1910)		+		
		<i>Orthetrum icteromelas</i> (Ris, 1910)		+++		++
		<i>Orthetrum julia</i> (Kirby, 1900)				+
		<i>Orthetrum stemmale</i> (Burmeister, 1839)			++	
		<i>Palpopleura albifrons</i> (Legrand, 1979)		+	+	

		<i>Palpopleura jucunda</i> (Rambur, 1842)		+		
		<i>Palpopleura lucia</i> (Drury, 1773)	+++	++++	+	+++
		<i>Palpopleura portia</i> (Drury, 1773)	+++	++++		++++
		<i>Pantala flavescens</i> (Fabricius, 1798)	+	+		++
		<i>Trithemis annulata</i> (Palisot de Beauvois, 1807)		+		
		<i>Urothemis assignata</i> (Selys, 1872)	+			
Zygoptera	Coenagrionidae	<i>Ceriagrion glabrum</i> (Burmeister, 1839)		+++		
		<i>Pseudagrion kersteni</i> (Gerstäcker, 1869)			+	
2	3	28	11	19	9	9

+++Very frequent (% OF > 50); ++frequent (25 < % OF ≤ 50); +rare (% OF ≤ 25)

3.2. Diversity indices

Variations of Shannon-Weaver diversity index, Pielou’s evenness index and rarefied taxonomic richness are shown on figure 3.

Shannon-Weaver diversity index and rarefied taxonomic richness are significantly higher at site 2 (P < 0.05; Mann-Whitney) (Figure 3 A and C). Pielou’s evenness index lower at the same site (P < 0.05; Mann-Whitney) (Figure 3 B).

3.3. Frequency of occurrence

Table 2 shows the percentages of the very common, frequent and rare taxa at the four sites. The percentages of very frequent taxa vary between 0 % (S 3) to 22.96% (S 4). Those of frequent taxa varied between 18.18 % (S1) to 33.33 % (S4). Regarding rare taxa, they are the most numerous at all sites with percentages ranging from 44.44% (S4) to 77.77% (S3).

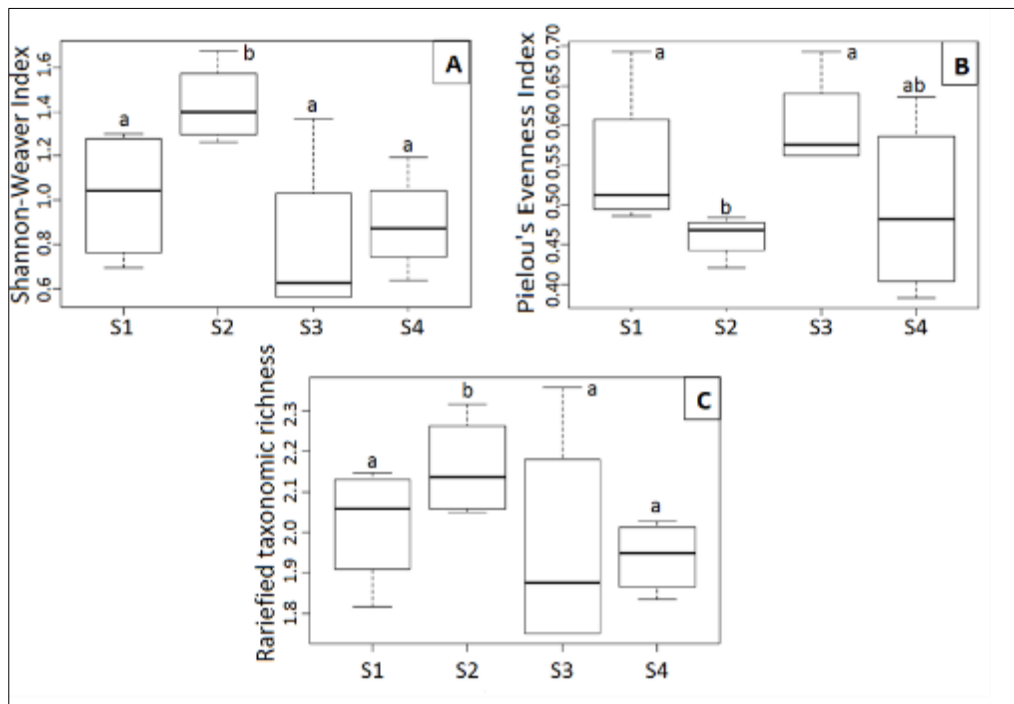


Figure 3 Box-plots showing variation of Shannon-Weaver index (A), Pielou’s Evenness index (B) and Rarefied taxonomic richness (C) of four sites (S1 - S4). Different letters (a and b) on box-plots denote significant differences between them (Mann-Whitney, P < 0.05)

Table 2 Proportions of Odonata very frequent, frequent and rare at the different sampling sites

Sites	Very frequent (%)	Frequent (%)	Rare (%)
S1	18.18	18.18	63
S2	20	20	60
S3	0	22.22	77.77
S4	22.22	33.33	44.44

3.4. Odonata distribution profile

The SOM (Self Organising Map) used to project the 16 samples (four sites X four campaigns) is 25 cells (five rows X five columns), with quantization error (1.11) and topography error (0.00). The hierarchical classification (Figure 4) carried out on the data collected made it possible to obtain three groups (G1, G2, G3) (Figure 5). Groups G1 and G3, richer in taxa, contain samples from sites S2 (agricultural), S3 (forest fragment) and S4 (bush). These two groups are isolated from the G2 group poor in taxa composed only of samples from site 1 (urbanized).

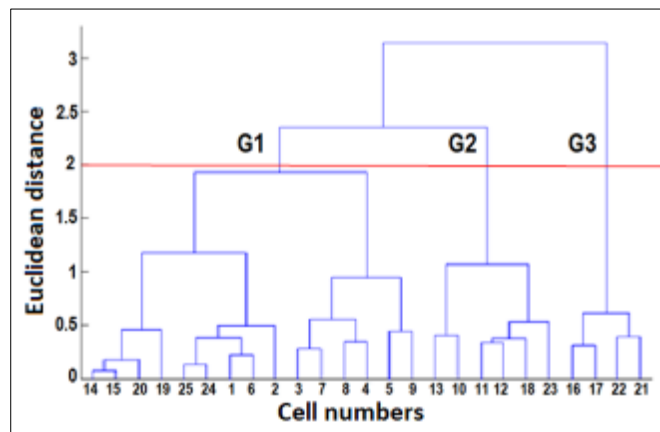


Figure 4 Hierarchical classification of SOM cells using Ward's method; G1 to G3= identified groups, the numbers 1 to 25 correspond to the cell numbers of the SOM map

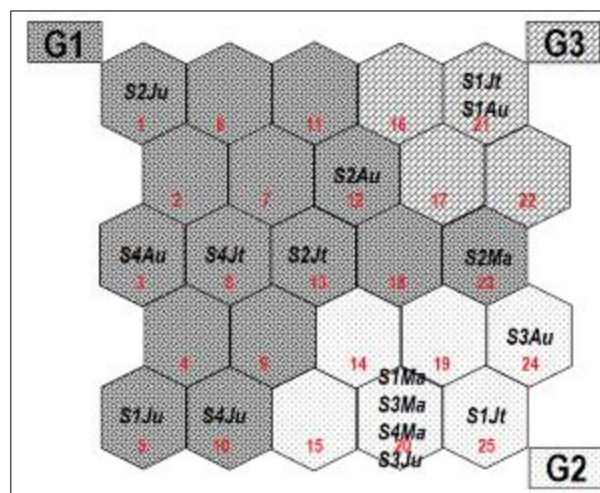


Figure 5 Distribution of samples on the SOM card. Analysis carried out using Odonata presence/absence data at different sites; G1 to G3: defined groups, S1 to S4: site numbers, Ma = Month of May, Ju = Month of June, Jt = Month of July, Au = Month of August, in red: 1 to 25 = cell numbers of the SOM card

4. Discussion

This study is the first to examine the odonatological fauna within the perimeter of the forest reserve of the University of Peleforo Gon Coulibaly. Despite their preliminary nature, the results made it possible to draw up an inventory of 28 species of Odonata, 02 species of Zygoptera and 26 species of Anisoptera. The captured Zygoptera belonged to the family Coenagrionidae, which has two species: *Ceriagrion glabrum* and *Pseudagrion kersteni*. Additionally, there were only two families of Anisoptera, the Aeshnidae with a single species and the Libellulidae. Among all the species in the population, the Libellulidae were the most represented with 25 species, or a proportion of 98.66%. Indeed, the Libellulidae family is the largest family of Anisoptera capable of colonizing very diverse environments [27, 28]. This observation has also been made in other works. In Côte d'Ivoire [15,16], in Ghana in the Ankasa reserve [19] and in India at the Kundavada lakes [29]. The results obtained in this work are identical to certain work already carried out in Côte d'Ivoire [16] and Ghana [19]. In this study, 28 taxa were identified. This wealth is lower than that obtained in Côte d'Ivoire in the Taï forest or in the works of Legrand and Courturier [14] who identified 51 species of Odonata [28]. Concerning the work of Yapo, 35 and 33 Odonata species were identified [15, 16] in the Korhogo area. These differences could be attributed to the study period and the areas explored. Yapo's research was conducted during wet and dry seasons and in dam lake areas.

The Shannon-Weaver index, commonly used to compare the 4 study sites, revealed that site S2 had significantly higher diversity values. Similarly when sample biases are reduced, rarefied richness was significantly higher at site S2. This result would be linked to the appearance of this site. Indeed, this site is very open and characterized by diversified vegetation due to different cultures, thus offering favorable conditions for reproduction and the good development of the life cycle of Odonata. On the other hand, sites S3 and S4 presenting lower diversity values are shaded by tree belts and very dense herbaceous vegetation, thus reducing the supply of light. According to [30] the sunshine of a site conditions the odonatological population. An open, sunny environment will have greater diversity. Concerning the S1 site, urbanized although being more open and therefore very sunny, presents low diversity, due to the low vegetation cover. This is confirmed by the distribution profile of Odonata with SOM (Self Organising Map) which highlights two sets: the set made up of groups (G1 and G3) of the hierarchical classification analysis (HCA), made up of samples from sites S2, S3 and S4 provided with vegetation that can provide prey, perches and shelter; the set composed of group G2 of the hierarchical classification analysis (HCA), including samples from site S1, under the influence of urbanization poor in vegetation. These organisms would therefore be very linked to their habitats and would depend enormously on the surrounding vegetation, which is the cradle of their various bodily functions.

5. Conclusion

This first study of the odonatological fauna of Peleforo Gon Coulibaly University forest reserve enabled us to record 28 species, 02 Zygoptera and 26 Anisoptera. The Libellulidae family was the most representative with 25 species. The Shannon-Weaver index in relation to rarefied richness indicated that site S2 had significantly higher diversity values than the other sites, due to the different crops that provide favourable conditions for the survival of Odonata. Site S1 proved to be the least inhospitable for Odonata, as it had little vegetation. This result was also confirmed by the Odonata distribution profile based on the Self-Organising Map (SOM).

Although this study has enabled us to draw up an initial list of Odonata in Peleforo Gon Coulibaly University's forest reserve, other more in-depth studies, incorporating seasonality and environmental parameters, will provide a better understanding of the ecology of Odonata in this forest reserve.

Compliance with ethical standards

Acknowledgments

The authors would like to express their gratitude to the staff of the Department of Animal Biology at the University of Peleforo Gon Coulibaly, Côte d'Ivoire. Special thanks to Dr Soro Nangounon for the statistical analysis.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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