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Inventory of Odonata in Kisangani city and its surroundings: A study of fish ponds and fields (Democratic Republic of the Congo)

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ABSTRACT

This study assessed the diversity and distribution of Odonata in two habitat types in Kisangani and its surroundings, Democratic Republic of the Congo: fish ponds and fields. Sampling was conducted between January and March 2025 using sweep nets. A total of 939 individuals were recorded, belonging to two suborders, three families, 23 genera, and 42 species. Fish ponds showed higher species richness, with 42 species and 725 individuals, compared with 31 species and 214 individuals in fields. The assemblages were dominated by Anisoptera, particularly the family Libellulidae. In fish ponds, *Chalcostephia flavifrons* was the dominant species, accounting for 38.06% of individuals, whereas *Palpopleura portia* dominated in fields, representing 20.09%. Diversity indices demonstrated high diversity in both habitats, with Shannon index values of 2.628 for fish ponds and 2.739 for fields. Evenness was also high, indicating a relatively balanced distribution of individuals among species. The Jaccard similarity index revealed 65% similarity between the two habitats. These results indicate that fish ponds constitute favourable habitats for maintaining Odonata diversity, probably due to the permanence of water and the presence of aquatic vegetation. Fields also supported notable diversity, but were dominated by species more tolerant of disturbance. This study, therefore, provides baseline data for monitoring Odonata and for the ecological management of aquatic and agricultural habitats in Kisangani. We recommend that local environmental and agricultural management decision makers incorporate the protection of fish ponds and limit the excessive use of agrochemical inputs in agricultural fields in order to preserve habitat heterogeneity and maintain Odonata diversity as reliable indicators of freshwater ecosystem integrity.

Keywords: Bioindicators, Faunal Survey, Fields, Habitat Disturbance, Kisangani (DR Congo), Odonata, Ponds

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I. INTRODUCTION

Aquatic ecosystems are the most threatened by human pressure (Abell, 2002). Populations of odonates are in decline due to the loss and degradation of freshwater habitats caused not only by pollution, but also by climate change (International Union for Conservation of Nature [UICN], 2009). In the Kisangani region, odonates remain poorly known, and there are no data on their diversity. Furthermore, there has been a progressive increase in polluting activities in the region in recent years due to population pressure (Boyemba, 2011).

Hence, odonates are a particularly pertinent group for this type of study. Indeed, they depend on both aquatic environments and terrestrial habitats, and they react to variations in water quality, vegetation, shade, riverbank integrity and landscape structure. Odonates are widely known as excellent bioindicators of the ecological state of freshwater ecosystems (Clausnitzer et al. 2009; Corbet, 1999; Kalkman et al. 2007; Oliveira et al. 2015). Across Africa, they play an increasingly important role in the evaluation of the biodiversity of continental freshwater and in the identification of priority sites for conservation (Clausnitzer et al. 2012) its surroundings face increasing human pressure. The expansion of agricultural activities, sand mining, deforestation, occupation of riverbanks and the progressive degradation of catchment areas can profoundly transform rivers, streams, ponds and other wetlands by altering sedimentation, water quality, riverbank cover and habitat structure (Naiman et al. 2006; Reid et al. 2019). However, several studies show that urbanization, agriculture and, more broadly, the transformation of aquatic habitats directly influence the species richness, composition of assemblages and biotic value of Odonate communities (Deacon & Samways, 2021; Kietzka et al. 2018; Villalobos et al., 2016). In such a context, it becomes difficult to determine which species persist, which are declining and which types of environment maintain the most favourable conditions for their survival.

The research objective comprises multiple facets: establishing species lists, analyzing Odonate distribution across pond and field habitats, identifying favorable ecological characteristics, and quantifying human pressure impact on diversity and distribution. Reliable baseline data production is thus essential for monitoring Odonate community dynamics and informing management, restoration, and conservation decisions for Kisangani's aquatic and riverine environments. We analyze Odonate diversity, document distribution, and characterize habitats within Kisangani and its surrounding areas.

The fish ponds and fields are also affected by the aforementioned concerns. We conducted an Odonate inventory study in Kisangani and its surroundings. This provides recent odonatological diversity data for rational, sustainable management of these two environments. We establish an odonatological inventory of ponds and fields via bibliographic synthesis. We determine conservation status according to the IUCN Red List and compare specific diversity across environments.

1.2 General objective

To study the diversity and distribution of Odonates in fish ponds and fields in Kisangani city and its surroundings, and to assess the ecological importance of these habitats.

1.2.1. Specific objectives

1. To carry out an inventory of Odonate species found in fish ponds and fields;
2. To determine the structure of Odonate communities according to different habitats studied;
3. To assess the degree of similarity of Odonate populations between fish ponds and fields.

II. LITERATURE REVIEW

2.1 Theoretical review of literature

Odonates associate closely with aquatic ecosystems. Odonate distribution depends on water quality, habitat type, vegetation cover, and local climatic conditions. Lotic species link to flowing, well-oxygenated waters; lentic species occur in ponds, pools, and other stagnant water bodies (Corbet, 1999). This strong ecological dependence positions odonates as key freshwater ecosystem quality bioindicators. Sensitive species decline rapidly in degraded habitats (e.g., pollution, eutrophication, wetland loss, urbanization, climate change). Tolerant species persist under disturbed conditions (Samways, 2008). Africa exhibits high odonate diversity in specific regions: West Africa, the Congo Basin, East Africa, and the Ethiopian Highlands (Clausnitzer et al., 2012). These regions exhibit permanent water bodies, dense riparian vegetation, and stable microclimates. These ecological requirements designate odonates as essential organisms for biodiversity monitoring and freshwater conservation (Samways, 2008; Dijkstra & Clausnitzer, 2014).

2.2. Empirical Review

Numerous African studies examine odonate diversity, ecology, and conservation. Moroccan odonate distribution varies with climate, altitude, humidity, and the availability of aquatic habitat. Wetland degradation and climate change represent major threats to suitable habitats (Uyizeye et al., 2021). Tchibozo et al. (2008) demonstrated a critical need for further entomological studies in Southern Benin's Lokoli swamp forest. This poorly explored wetland ecosystem suffers from forest cover loss and human disturbance. Clausnitzer et al. (2012) identified four major odonate diversity hotspots at the continental scale: West Africa, the Congo Basin, East Africa, and the Ethiopian Highlands.

These areas face an increasing threat from habitat degradation and water pollution. Odonates serve as reliable bioindicators for environmental change assessment. Seidu et al. (2017) demonstrated that land-use change in Ghana's Atewa Range Forest Reserve alters odonate community structure. Significant differences emerged between mature forest and agricultural habitats. Djeiial and Mabrek (2022) determined that odonate richness, abundance, and diversity correlated with aquatic habitat quality in Algeria's Chréa National Park. Firas and Kalache (2021) reported low odonate richness in Saharan habitats. Arid climatic conditions, scarce permanent water bodies, and strong hydrological fluctuations shape community composition.

Despite this growing body of research, adult odonates are poorly documented in Kisangani. We conducted an inventory of adult odonate species to address this data gap. This inventory contributes critical data to the understanding of the Congo Basin freshwater biodiversity.

III. METHODOLOGY

3.1 Description of the Study Area

This study was conducted in Kisangani, specifically in ponds and fields. Kisangani, which covers an area of 2,109 km², is the capital of the Province of Tshopo (Omasombo, 2020). It is located in the North-East of the Central Congolese basin. Its geographical coordinates are between 0°31' N and 25°11' E, meaning that Kisangani straddles the Equator. The average altitude varies between 376 and 450 metres. According to the National Institute of Statistics (INS), its population is 1,686,287 with a density of around 883 inhabitants per km² (INS, 2016 in Akuboy et al., 2024). In Kisangani, daily temperatures range from 20 to 30 °C, with an annual average of around 25 °C (Omasombo, 2020). Annual precipitation varies between 1500 and 2000 mm, with an average of 1750 mm (Boyemba, 2011). Seasonality is low, that is, the temperature remains high throughout the year, and there is no dry month. According to the Köppen climate classification system of 1936, the climate is of type Af, a tropical climate with monthly mean temperatures >18°C and heavy rainfall throughout the year (Peel et al., 2007).

The soils of Kisangani and its surroundings are generally classified into two main groups: those derived from the rock substrate and those derived from alluvium. They are generally ferralitic, sandy-loamy and acidic. They are deep and heavily leached by rainwater (Kahindo, 2011). According to Lubini (1982), the monthly insolation in tenths of hours in Kisangani varies from 31.5% to 57%. These values, which are a little low for an Equatorial region, are due to the continentality of the region. The importance of this climatic factor has also been recognized by Omasombo, (2020). This low insolation to several factors, including the high cloud cover of around 7 tenths on average, creates a high level of atmospheric opacity and fog.

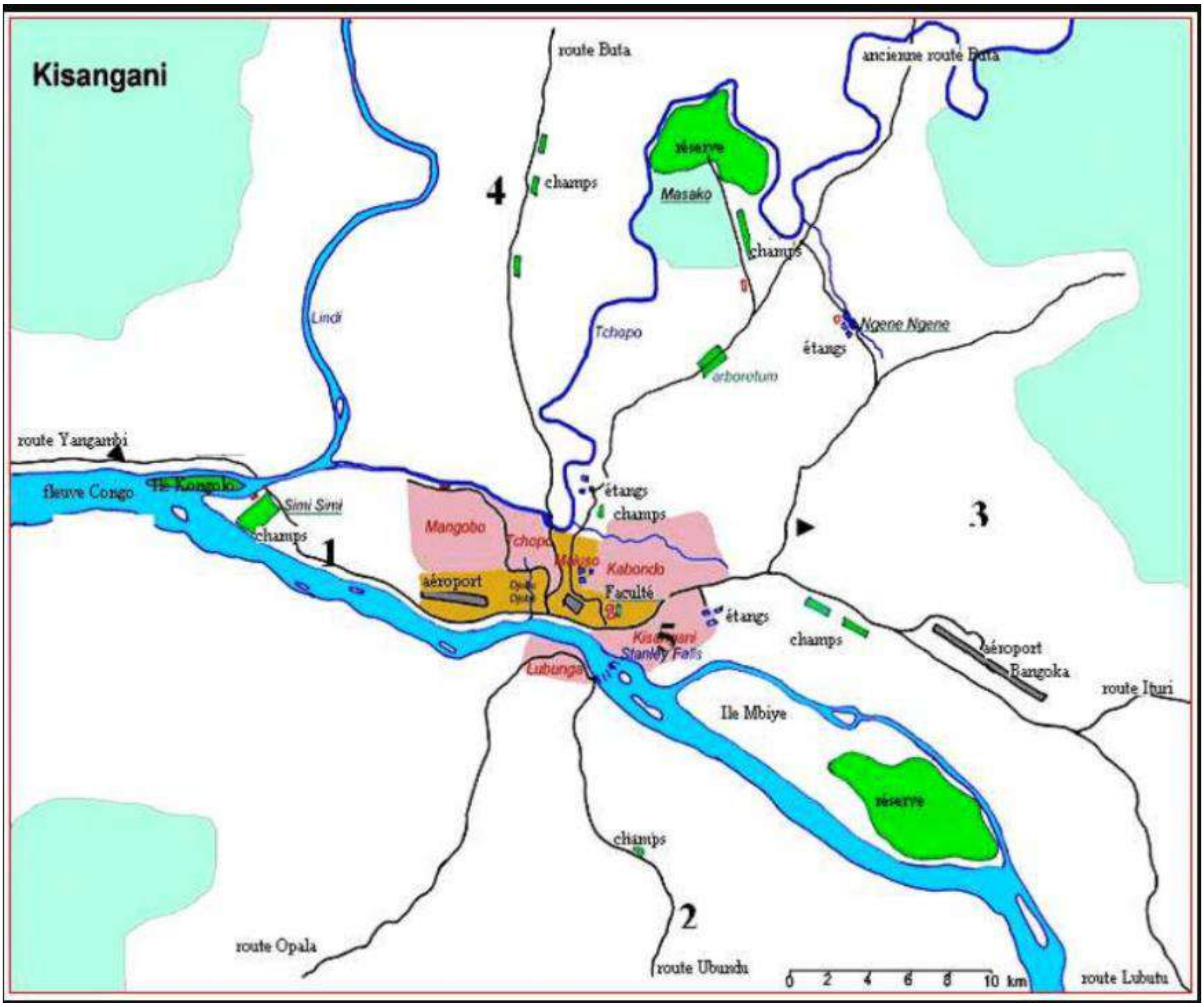

Figure 1

Map of Kisangani and its surroundings

Source : www.researchgate.net/profile/Pius-Tshimankinda-Mpiana

The vegetation around the sampling site along the fish ponds constitutes an amenity area whose flora is composed of species that develop exclusively in the aquatic environment, such as: *Vossia cuspidata* (Poaceae), *Nymphaea lotus* (Nymphaeaceae) and *Colocasia esculenta* (Araceae). Next come the cultivated species, the list of which is as follows: *Elaeis guineensis* (Arecaceae), *Ananas comosus* (Bromeliaceae), *Coffea canephora* (Rubiaceae), *Musa* sp. (Musaceae) and *Dacryodes edulis* (Burseraceae). Finally, there are spontaneous species*: Albizia* sp. (Fabaceae), *Trichilia* sp. (Meliaceae) and *Chlamydocola chlamydata* (Sterculiaceae), currently *Cola chlaydata* (Malvaceae).

In fields, the distribution of species shows a representation of ruderal vegetation with species such as: *Talinum triangulare* (Portu*lacaceae), Imperata cylindrica (Poaceae), Cnestis frruginea (Connaraceae), Alchornea cordifolia* (Euphorbiaceae), *Sida acuta* (Malvaceae), *Mariscus cylindristachyus* (Cyperaceae), *Solanum lypersicum* (Solanaceae), *Bambusa vulgaris* (Poaceae) and *Sphenoclea zeylanica* (Poaceae). The characteristic cultivated species of our study area are: *Ananas comosus* (Bromeliaceae), *Elaeis guineensis* (Arecaceae), *Manihot esculenta* (Euphorbiaceae), *Saccharum officinarum* (Poaceae), *Zea mays* (Poaceae) and *Amaranthus viridis* (Amaranthaceae).

3.2 Capture Techniques

Odonates were captured over a period of three months, that is, from January to March 2025, primarily between 10 am and 4 pm when adult Odonates are generally the most active. Every capture session was carried out with the support of a local guide whose knowledge of the field enabled access to the various sites surveyed. Individuals were captured using two fauchoir nets, used to catch the specimens during the flight or at rest on the vegetation. In the field, certain behavioural differences were observed between the groups. Anisoptera that are often more visible and easier to spot from a distance, could sometimes be photographed before capture, whereas Zygoptera, that are generally more discreet, required more careful searching in the riverine or herbaceous vegetation (Djeilal & Mabrek, 2022). After capture, we treated the Odonate specimens with acetone in a well-ventilated area. They were kept in solvent-resistant plastic containers with airtight lids. This treatment of at least 24 hours aimed to preserve the specimens effectively.

We dried our specimens in the open air for a few hours. They were then removed using an entomological pin to avoid direct contact with the solvent. Once dry, the specimens were placed individually in numbered white envelopes, labelled with the main collection information, such as the date, location, geographical coordinates and the collector's name. This method of conservation ensured both the traceability of the samples and their proper organisation for the next steps in the process. The identification of Odonates was carried out at the "Centre de Surveillance de la Biodiversité" (CSB), using identification keys and reference publications on African Odonates, such as: (Dijkstra & Clausnitzer, 2014), (Dijkstra et al. 2015), (Tchibozo et al. 2008). The iNaturalist app was also used as a supplementary tool to confirm some identifications.

3.3 Data Analysis

The diversity indices (Shannon, Simpson, and Equitability) were used to assess the diversity of Odonates in the two environments. The index of similarity was calculated to classify the stations according to their taxonomic abundance, determined by the sampling technique. The Past software was used for this calculation.

IV. FINDINGS & DISCUSSION

4.1 Inventory of Odonata in fish ponds and fields in Kisangani city and its surroundings

A total of 725 Odonate specimens belonging to two suborders, two families, 23 genera, and 42 species were captured in fish ponds, and 214 Odonate specimens were captured in fields. The Odonates from the fields are divided into two suborders, two families, 16 genera and 31 species. The list of Odonates captured and their abundance in fish ponds and fields and their status on the IUCN Red List in 2025, are presented in Table 1 below.

Table 1

Species of Odonates captured and their abundance in ponds and fields, alongside their conservation status on the IUCN Red List (version 2025-2).

Suborder	Families/Species	Fish Ponds			Fields			
Anisoptera	Libellulidae	Occurrence	Individual Count	Abundance Rate (%)	Occurrence	Individual Count	Abundance Rate (%)	IUCN Red List
	Acisoma inflatum (Selys, 1882)	+	11	1,51	+	3	1,4	LC
	Acisoma trifidum (Kirby, 1889)	+	22	3,03	+	3	1,4	LC
	Acisoma variegatum (Kirby, 1898)	+	36	4,96	+	26	12,14	LC
	Aethriamanta rezia (Kirby, 1889)	+	15	2,06	-	0		LC
	Brachythemis leucosticta (Burmeister, 1839)	+	17	2,34	-	0		LC
	Brachythemis lacustris (Kirby, 1889)	-	0		+	1	0,46	LC
	Crocothemis erythraea (Brullé, 1832)	+	1	0,13	+	1	0,46	LC
	Chalcostephia flavifrons (Kirby, 1889)	+	276	38,06	+	9	4,2	LC
	Diplacodes luminans (Karsch, 1893)	+	5	0,68	-	0		LC
	Hadrothemis defecta (Karsch, 1891)	+	8	1,1	+	4	1,86	LC
	Hadrothemis infesta (Karsch, 1891)	-	0		+	7	3,27	LC
	Hemistigma albipunctum (Rambur, 1842)	+	1	0,13	-	0		LC
	Nesciothemis pujoli (Pinhey, 1971)	+	16	2,2	+	5	2,33	LC
	Olpogastra lugubris (Karsch, 1895)	+	5	0,68	-	0		LC
	Orthetrum icteromelas (Ris, 1910)	+	1	0,13	+	1	0,46	LC
	Orthetrum trinacria (Selys, 1841)	+	9	1,24	+	7	3,27	LC
	Orthetrum sp1	-	0		+	1	0,46	
	Orthetrum sp2	-	0		+	5	2,33	
	Orthetrum sp3	+	1	0,13	+	4	1,86	
	Orthetrum sp4	+	1	0,13	+	7	3,27	
	Orthetrum sp5	-	0		+	1	0,46	
	Orthetrum sp6	-	0		+	1	0,46	
	Orthetrum sp7	+	5	0,68	+	11	5,14	
	Orthetrum sp8	+	4	0,55	-	0		
	Orthetrum sp9	+	5	0,68	-	0		
	Oxythemis phoenicosceles (Ris, 1909)	-	0		+	2	0,93	LC
	Palpopleura lucia (Drury, 1773)	+	50	6,89	+	29	13,55	LC
	Palpopleura portia (Drury, 1773)	+	6	0,82	+	43	20,09	LC
	Pantala flavescens (Fabicius, 1781)	-	0		+	3	1,4	LC
	Rhyothemis notata (Fabicius, 1781)	+	10	1,37	-	0		LC
	Rhyothemis semihyalina (Desjardins, 1832)	-	0		+	1	0,46	LC
	Trithemis dejouxi (Pinhey, 1978)	+	48	6,62	-	0		LC
	Trithemis annulata (Palisot de Beauvois, 1807)	+	4	0,55	-	0		LC
	Trithemis arteriosa (Burmeister, 1839)	+	9	1,24	+	2	0,93	LC
	Trithemis hecate (Ris, 1912)	+	3	0,41	-	0		LC
	Trithemis imitata (Pinhey, 1961)	+	4	0,55	+	24	11,21	LC
	Trithemis aenea (Pinhey, 1961)	+	22	3,03	-	0		LC
	Trithemis navasi (Lacroix, 1921)	+	17	2,34	-	0		DD
	Tholymis tillarga (Fabicius, 1798)	+	5	0,68	+	2	0,93	LC
	Tetrathemis sp1	+	1	0,13	-	0		
	Tetrathemis sp2	+	1	0,13	-	0		
	Urothemis edwardsii (Selys, 1849)	+	20	2,75	+	1	0,46	LC
	Urothemis assignata (Selys, 1872)	+	18	2,48	+	7	3,27	LC
	Urothemis sp	-	0		+	1	0,46	
	Zygonyx torridus (Kirbys, 1889)	+	1	0,13	-	0		LC
	Zygonyx sp	-	0		+	1	0,46	

Zygoptera	Coenagrionidae							
	Aciagrion steeleae (Kimmins, 1955)	+	1	0,13	-	0		LC
	Agriocnemis victoria (Fraser, 1928)	+	36	4,96	-	0		LC
	Ceriagrion glabrum (Burmeister, 1839)	+	20	2,75	-	0		LC
	Ceriagrion corallinum (Campion, 1914)	+	7	0,96	-	0		LC
	Ceriagrion sp	+	1	0,13	-	0		
	Pseudagrion nubicum (Selys, 1876)	+	1	0,13	-	0		LC
	Mesocnemis singularis (Karsch, 1891)	+	1	0,13	-	0		LC
	Chlorocyphidae							
	Chlorocypha aphrodite (Le Roi, 1915)	-	0		+	1	0,46	LC
	Total	42	725	100	31	214	100	

(DD: insufficient data, LC: minor concern). Ar: relative abundance; (+): present; (-): absent.

As the table above shows, the suborder of Anisoptera has 18 genera for fish ponds, followed by Zygoptera with 5 genera. The Libellulidae have more species, followed by the Coenagrionidae with seven species. The Chlorocyphidae family comprises just a single species. *Chalcostephia flavifrons* is the most abundant Odonate species (38.06%), followed by *Palpopleura lucia* (6.89%), *Trithemis dejouxi* (6.62%), *Acisoma variegatum* (4.96%), and *Agriocnemis victoria* (4.96%) that are relatively less abundant. For the fields, the suborder of Anisoptera is richer with 15 genera, followed by Zygoptera with one genus. *Palpopleura portia* is the most abundant species (20.09%), followed by *Palpopleura lucia* (13.55%), *Acisoma variegatum* (12.24%) and *Trithemis imitata* (11.21%). Among the species recorded in the two habitats during our study, 39 were classified as species of least concern and one as a species for which there are insufficient data on the IUCN Red List.

This difference is probably because we conducted non-selective captures to give all species the same chance. The low frequency or absence of some species is also due to difficult capture techniques or their ability to escape the traps used. These species include: *Crocothemis erythraea* (0.46%), *Orthetrum icteromelas* (0.46%), *Zygonyx torridus* (0.13%), *Mesocnemis singularis* (0.13%), *Chlorocypha aphrodite* (0.46%) and *Pseudagrion nubicum* (0.13%). The higher richness and abundance recorded in fish ponds (42 species; 725 individuals) indicate that these lentic habitats provide more favourable conditions for Odonata than fields. This pattern is consistent with (Corbet, 1999), who emphasised the dependence of dragonflies and damselflies on aquatic conditions, breeding sites and marginal vegetation. In the present study, the presence of permanent water and aquatic plants such as *Vossia cuspidata*, *Nymphaea lotus* and *Colocasia esculenta* probably created suitable oviposition sites, emergence substrates, perches and refuges. This also agrees with (Clausnitzer et al. 2012; Dijkstra & Clausnitzer, 2014) water bodies and dense vegetation are major ecological conditions supporting odonate richness in African freshwater systems, including the Congo Basin.

Fields also supported a notable assemblage (31 species; 214 individuals), but their lower richness and abundance suggest that agricultural habitats are less stable for Odonata. Ploughing, burning, vegetation clearing, and the possible use of agrochemicals can reduce aquatic microhabitats, alter vegetation structure, and favour tolerant species. The dominance of *Palpopleura portia*, *Palpopleura lucia*, *Acisoma variegatum*, and *Trithemis imitata* in fields therefore suggests an assemblage composed mainly of disturbance-tolerant and open-habitat species. This interpretation is consistent with (Deacon & Samways, 2021; Kietzka et al. 2018; Samways, 2008; Villalobos et al. 2016), who showed that urbanisation, agriculture and habitat transformation filter odonate communities and often reduce sensitive taxa while allowing generalist species to persist.

4.2 Evaluation of the biodiversity of fish farming ponds and fields

4.2.1 Index of diversity of Odonates observed in the two environments

The biological diversity of the two environments is presented in Table 2.

Table 2

Diversity of Odonates observed in fish ponds and fields.

Diversity indices	Fish Ponds	Fields
Taxa_S	42	31
Individuals	725	214
Simpson_1-D	0,8336	0,9023
Shannon_H	2,628	2,739
Equitability_J	0,703	0,7975

Table 2 shows contrasting but complementary diversity patterns between the two environments. Fish ponds had the highest species richness (S = 42) and abundance, whereas fields showed slightly higher Shannon diversity (H = 2.739) and evenness (J = 0.7975) than ponds (H = 2.628; J = 0.703). This apparent contrast can be explained by the strong dominance of *Chalcostephia flavifrons* in ponds, where a single species accounted for 38.06% of individuals. Thus, although ponds supported more species, their community was less even than that of fields. The Simpson values were high in both habitats, indicating that neither assemblage was completely dominated by a single taxon. However, the lower evenness in ponds suggests that favourable aquatic conditions can promote high abundance while still allowing a few well-adapted species to become numerically dominant. This is ecologically coherent with (Corbet, 1999), who noted that odonate assemblages are strongly structured by aquatic habitat characteristics, including water permanence, vegetation and microhabitat availability.

In fields, the higher evenness does not necessarily indicate better ecological quality. Rather, it may reflect the absence of a highly dominant pond-associated species and the persistence of several tolerant taxa at moderate abundance. This distinction is important because diversity indices alone can obscure habitat degradation when assemblages are composed mostly of widespread or disturbance-tolerant species. Similar caution is recommended in studies using Odonata as bioindicators, where species composition and habitat affinity are as important as richness or diversity values (Oliveira et al. 2015; Samways, 2008; Uyizeye et al., 2021).

Overall, the two habitats can both be considered odonatologically diverse, but they do not play the same ecological role. Fish ponds appear to function mainly as breeding and population-maintenance habitats, whereas fields seem to act as secondary or complementary habitats used by tolerant species for foraging, dispersal or temporary occupation.

The predominance of Libellulidae in both habitats supports this interpretation. Members of this family are often abundant in open, sunny and lentic or semi-disturbed environments, which explains their strong representation in ponds and fields. By contrast, the low representation of Zygoptera and Chlorocyphidae may reflect the limited availability of shaded, well-vegetated and less disturbed marginal habitats required by many damselflies. Most recorded species were classified as Least Concern on the IUCN Red List, but this should not be interpreted as an absence of local conservation concern. Freshwater biodiversity remains highly vulnerable to pollution, wetland degradation, agricultural expansion and other persistent pressures (Naiman et al. 2006; Reid et al., 2019). The occurrence of *Trithemis navasi* as Data Deficient further highlights the need for continued surveys and better ecological documentation of Odonata in Kisangani.

4.2.2 Jaccard similarity index

Figure 2 shows the degree of similarity between the fish ponds and the fields.

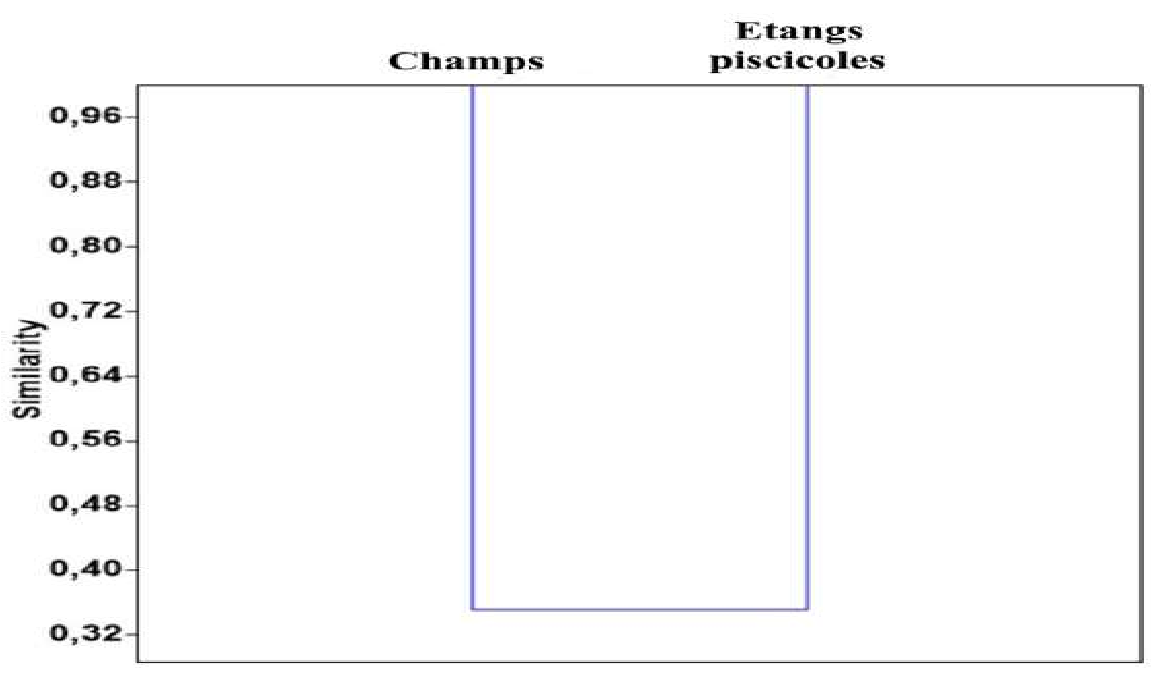

Figure 2
Similarity Dendrogram

The 65% Jaccard similarity between ponds and fields indicates a substantial overlap in species composition, probably driven by widespread generalist taxa that can move between aquatic and agricultural habitats. Nevertheless, the remaining dissimilarity shows that each habitat also supports a distinct component of the local odonate fauna. This reinforces the need to conserve pond margins and aquatic vegetation while reducing disturbance in surrounding fields, because the local assemblage depends on the complementarity between aquatic breeding habitats and adjacent terrestrial environments.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study enabled an inventory of Odonates in fish ponds and fields in Kisangani city and its surroundings, highlighting a higher species richness in the fish ponds (42 species) compared to the fields (31 species). This difference confirms the crucial role of stable aquatic habitats and associated vegetation in maintaining odonatological diversity. However, the presence of a significant number of species in the fields, mainly tolerant taxa, indicates a certain capacity for adaptation of Odonates to environmental disturbances. The diversity and equitability indices indicate relatively balanced community structure in the two environments, while the observed degree of similarity suggests the existence of a common species assemblage, particularly ubiquitous ones. Although the majority of the recorded species are classified as 'least concern' on the IUCN Red List currently, the growing human impact in the region could alter the composition and dynamics of the communities, to the detriment of the most sensitive species in the long term. This study provides essential reference data for understanding and monitoring Odonates in Kisangani. It highlights the importance of preserving fish ponds while incorporating fields into management and conservation strategies.

5.2 Recommendations

We suggest that fish ponds should be prioritised in local conservation strategies, as they are home to a greater diversity of odonate species and provide suitable breeding habitats. Preserving the aquatic vegetation around these ponds is essential for maintaining favourable ecological conditions and protecting sensitive species. In fields, human activities affecting the environment, particularly uncontrolled bushfires, intensive land clearing and the excessive use of plant protection products, should be reduced in order to limit habitat degradation. Although these environments still support several tolerant odonate species, the adoption of more sustainable agricultural practices could help maintain ecological balance and reduce pressures on ecosystems. Furthermore, awareness campaigns should be organised for farmers, fish farmers, and local communities to highlight the ecological importance of odonates as bioindicators of the health of freshwater ecosystems. Finally, we recommend further studies incorporating vegetation structure and seasonal variations to better understand the factors influencing the distribution and diversity of odonates in tropical ecosystems, especially in the Kisangani region.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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