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# ASSESSMENT OF ODONATA COMMUNITY STRUCTURE AND SPECIES DIVERSITY ACROSS TWO COASTAL ECOSYSTEMS IN LAGOS STATE, NIGERIA

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## ABSTRACT
Odonata are globally recognized bioindicators of freshwater ecosystem health. This study examined their species composition, distribution, abundance, and diversity across two ecologically distinct coastal sites in Lagos State namely: Badagry and Ojo. The study also assessed the physicochemical properties of associated water bodies to determine how environmental conditions influence odonate assemblages. A nine-month field survey was conducted across multiple sampling locations in Badagry and Ojo, with systematic collection and identification of Odonata specimens to species level. A total of 1,335 Odonata individuals representing 35 species from two families (Libellulidae and Coenagrionidae) were recorded. Species distribution exhibited marked spatial heterogeneity, with 11 species found exclusively in Badagry and never recorded in Ojo. Diplacodeslefebvri demonstrated strong habitat specificity, with all 64 individuals (8.25 % relative abundance) collected solely from one sampling point (Opposite Lasu foundation, Topo, Badagry). Similarly, Brachythemisleucostica (38 individuals) was found exclusively at the Nigerian French Language Village. Regional distributional asymmetry was also evident, with Orthetrumjulia (n=34) and Chalcostrephiaflavirons (n=27) showing higher abundance in Ojo, while Trithemisstrictica was completely absent from this location. Taxa diversity varied significantly across sites, ranging from 12 individuals at Gberefu Island and Opposite General Hospital to 98 at Nigeria French Village. These findings provide a valuable biodiversity baseline for Lagos State's freshwater ecosystems and emphasize the need for site-specific conservation strategies to protect ecologically sensitive odonate communities across the Lagos coastal wetland mosaic.

**Keywords:** Odonata, Biodiversity, Habitat specificity, Freshwater ecosystems, Distribution, Composition

## INTRODUCTION
Odonata is the insect order that encompasses dragonflies and damselflies, recognized for their distinctive appearance and predatory behaviour; approximately 6500 species have been identified and classified (Dijkstra, 2007; Adelete *et al.*, 2024). They are aquatic insects who live in a wide range of habitats including, but not limited to seeps, pools, ponds, swamps and marshes (Abbot, 2005; Rana & Bhatia, 2025). Their presence and abundance in freshwater habitat is an indication of its health and good ecosystem quality. They love to roost in the sun especially, around open water bodies. Some species spend the largest part of their time in open places. Such species have a broad niche (Dijkstra, 2007; Olsen *et al*, 2022). All known species are predators as adults and larvae. Dragonflies are mostly generalists that feed on whatever suitable prey is abundant. Economically, odonates serve as important pest & beneficial insect. They also serve as biological control agents for various plant pests and disease spreading vectors such as mosquitoes (Kemabonta *et al*., 2019; Ramlee, 2022).
The dispersal ability of odonata reflects their ecological needs. Species with narrow habitat requirements (stenotopic) show limited dispersal, whereas widespread species readily colonize temporary habitats, including those created by human activity (Mahn, 2021). Recent increased interest in odonata has been prompted by the decline of freshwater bodies across the globe which play host to the dragonflies and damselflies who primarily live, feed and reproduce in them (Nelson *et al*., 2011; Dutra & Marco 2015). Previous studies have shown that odonata species richness and distribution are sensitive to fluctuations in water quality and habitat conditions. While some species can adapt to disturbed environments, many are negatively affected by changes in physicochemical parameters of water bodies (Abdul *et al*., 2017; Holtmann *et al*., 2018).
Despite their ecological importance, data on the odonata assemblages in the coastal towns of Badagry and Ojo in Lagos State remain limited and outdated. This study aims to fill this knowledge gap by assessing the diversity and abundance of odonata in these locations. Additionally, the study evaluated the physicochemical characteristics of the water bodies associated with odonate habitats to better understand

the relationship between environmental conditions and species distribution.

## MATERIALS AND METHODS

### Study location

The study was conducted in Badagry and Ojo Local Government Areas (LGA). Badagry is situated on the south-west coast of Nigeria, southeastern part of Lagos; It lies on the coast of the Atlantic Ocean (06.4316˚N, 2.8876˚E) and covers about 170 sq $m^2$ (441 $km^2$), with a population of 24,093 (Harris, 2017). It falls into the ecological zone of wetland soils with a mangrove vegetation (Okosodo & Sarada, 2021).

Ojo covers about 70 sq m (182 $km^2$) with an estimated population of 838,900. Ojo site is located within the premises of Lagos State University in Ojo, Lagos State (06.46988˚N, 003 198 36˚ E altitude 0.41 m) which lies in the rain forest zone of Nigeria. Vegetation cover includes ornamental plants as well as farmlands with sparse shrubs and grasses.

Eight different sampling points were selected in each location based on their proximity to water bodies such as ponds and canals. The sampling point in Badagry is along Gbagi, Barracks, Topo axis of Badagry town (Fig. 1). In Ojo, sampling was conducted close to fish ponds, the water distribution office and close to human activities (Fig. 2).

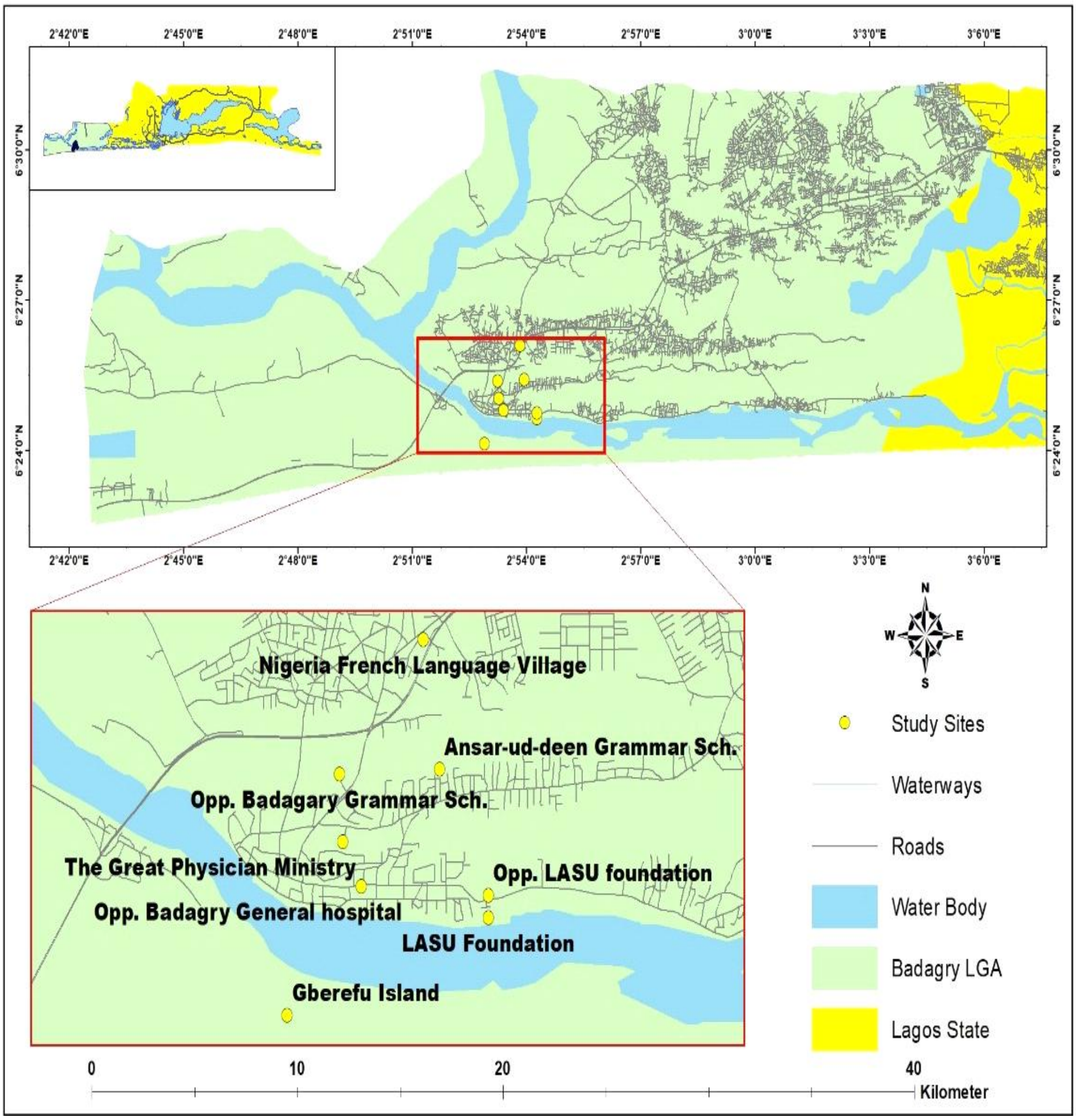



**Figure 1: Sampling points in Badagry study site**

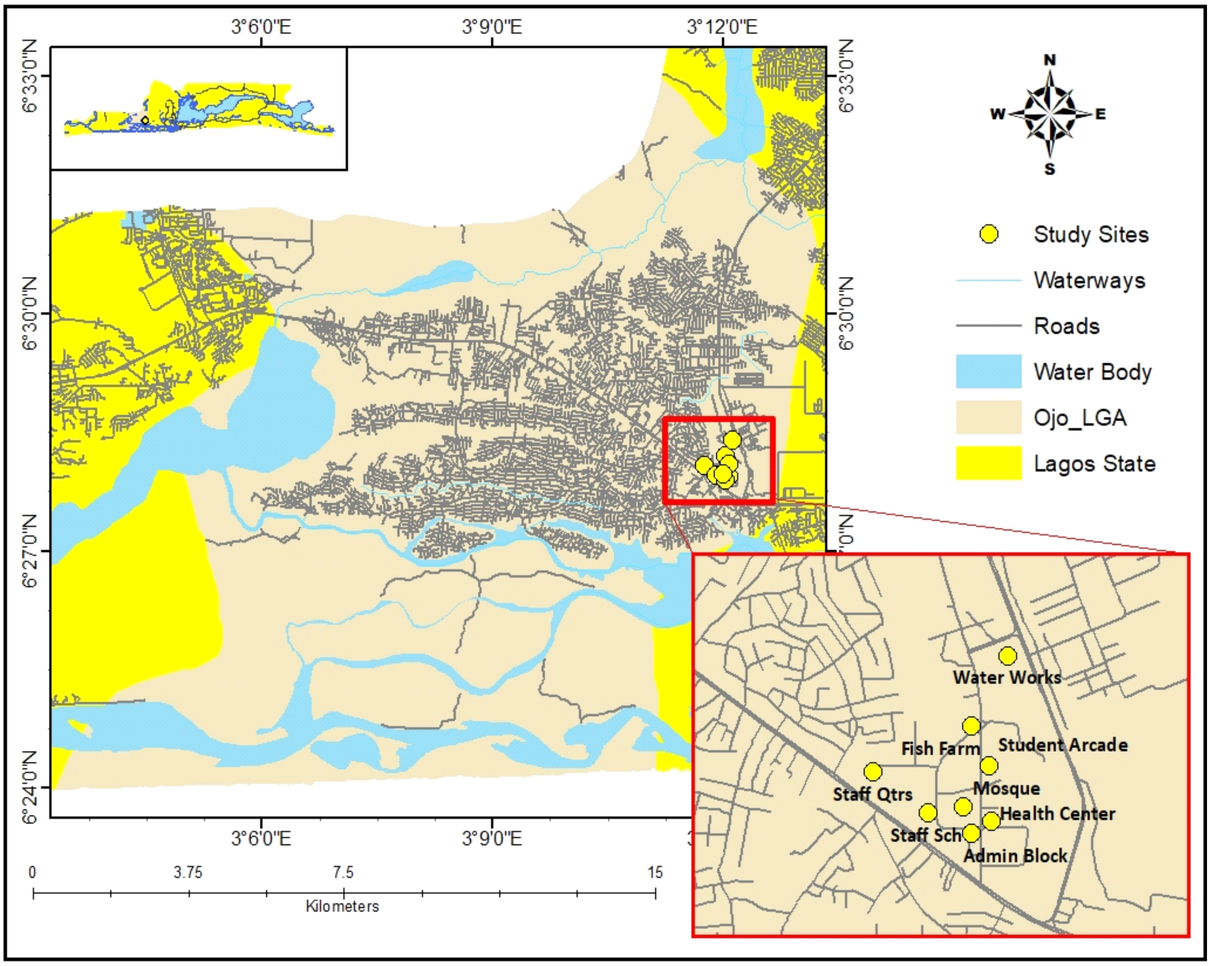



**Figure 2: Odonata and water sampling points in Ojo study site**

### Sample collection

Collection of adult specimens was carried out fortnightly between 7.00 a.m. and 10.00 a.m. Individuals were collected using standard insect sweep nets with 30 cm diameter and 110 cm long handle, either in flight or while perching on rocks, vegetation, walls. Samples were collected in various micro-habitats; on vegetation, sticks, stumps, rocks and walls.The individuals were removed from the net by carefully holding their wings through the net to restrict their movement and uncovering the net to remove the captured insects (Adu *et al*., 2016). The collected samples were placed in triangle shaped envelopes and enclosed in glass ware containing acetone for twelve hours after which they were air dried. The dried samples were then kept in brown envelopes. Samples were identified using keys from Dijkstra and Clausnitzer (2014) and confirmation was done online at http://addo.adu.org,za/

### Water Quality Assessment

The quality of water body at the sampling locations was measured after sample collection using water activity meter Horiba® U-50 which was immersed into water at a depth of 30 cm for about 3 min and all parameters measured ex-situ was recorded immediately after removal from water (Hansen *et al.*, 2018; Karmakar & Singh, 2021). The parameters recorded were: Temperature ($^oC$), pH, Conductivity (Ms/cm), Turbidity (NTU), Dissolved Oxygen (Mg/L), Total dissolved solid (g/L), Salinity (PPT) and Water depth (m).

### Data Analysis

All data collected at the study sites were analyzed using PAST statistical software. Species diversity (H') for each site was determined by using the Shannon-Wiener Index, while richness index was measured by Margalef's Index (R) and the distribution pattern of species in relation to other species in a sampled per unit area was calculated using evenness index (E). The hierarchical relationship between the species collected in each location was determined using combined rescaled distance clusters of the species collected in the studied sites. Pearson's product moment correlation was used to determine the relationship in relation to the physicochemical properties of the water bodies. Level of significance was set at $P < 0.05$.

## RESULTS AND DISCUSSION

A total of 1,335 odonata individuals were recorded across the study sites, comprising 35 species distributed across two families: Libellulidae and Coenagrionidae (Table 1). This faunistic diversity affirms the ecological richness of the Lagos wetland corridor and underscores the suitability of odonata as bioindicators of freshwater ecosystem health. The numerical dominance of Libellulidae across both Ojo and Badagry is consistent with global and regional biodiversity patterns, which consistently identify this family as the most species-rich and widely distributed among odonata (Dijkstra & Kalkman, 2012; Adu, 2015). The ecological success of Libellulids in anthropogenically disturbed environments has been attributed to their physiological tolerance and behavioural plasticity, enabling them to persist in degraded and modified habitats (Vicks, 2003). These traits are particularly relevant in the Lagos study area, where rapid urban expansion, land-use change, and increasing anthropogenic pressure have significantly altered wetland habitats.

Coenagrionidae, while less abundant, was nevertheless recorded at all major sampling locations. The comparatively lower representation of this family, particularly at Lagos State University (LASU), is attributed to vegetation loss resulting from ongoing anthropogenic disturbance. Although coenagrionids are known to colonise disturbed environments, their persistence depends on the availability of emergent and marginal aquatic vegetation for oviposition and perching (Kemabonta *et al.*, 2016). The progressive loss of riparian vegetation in highly urbanised sites such as LASU therefore constrains suitable microhabitats for this family. The broader dominance of these two families accords with global diversity trends in which Libellulidae and Coenagrionidae together account for the majority of odonate species richness in tropical Africa (Dijkstra & Clausnitzer, 2015).

**Table 1: Composition and Relative Abundance of Odonates species sampled in Badagry and Ojo Area, Lagos State Nigeria, March to December, 2018**

| S/N | Species names | Badagry | Rel. Abundance Badagry % | Species Status Badagry | Ojo | Rel. Abundance Ojo % | Species Status Ojo |
|---|---|---|---|---|---|---|---|
| | **Libellulidae** | | | | | | |
| **1** | *Acisomainflatum* (Selys, 1882) | 56 | 7.22 | CS | 4 | 0.72 | RS |
| **2** | *Acisomapanorpoides* (Rambur, 1842) | 127 | 16.37 | PRS | 26 | 4.65 | RS |
| **3** | *Acisomatrifidum* (Kirby, 1889) | 1 | 0.13 | RS | 0 | 0.00 | |
| **4** | *Brachythemisleucostica* (Burmeister, 1839) | 38 | 4.90 | RS | 0 | 0.00 | |
| **5** | *Bradinopyga cornuta* (Ris, 1911) | 20 | 2.58 | RS | 9 | 1.61 | RS |
| **6** | *Bradinopygastrachani* (Kirby, 1900) | 4 | 0.52 | RS | 0 | 0.00 | |
| **7** | *Chalcostephiaflavifrons* (Kirby, 1889) | 1 | 0.13 | RS | 27 | 4.83 | RS |
| **8** | *Crocothemiserythraea* (Brulle, 1832) | 13 | 1.68 | RS | 37 | 6.62 | CS |
| **9** | *Crocothemis sanguinolenta* (Burmeister, 1839) | 0 | 0.00 | | 6 | 1.07 | RS |
| **10** | *Diplacodeslefebvrii* (Rambur, 1842) | 64 | 8.25 | CS | 0 | 0.00 | |
| **11** | *Diplacodesluminans* (Kirby, 1889) | 5 | 0.64 | RS | 6 | 1.07 | RS |
| **12** | *Hadrothemisinfesta* (Karsch, 1891) | 31 | 3.99 | RS | 3 | 0.54 | RS |
| **13** | *Hemistigmaalbipunctum* (Rambur, 1842) | 55 | 7.09 | CS | 6 | 1.07 | RS |
| **14** | *Orthetrumafricanum* (Selys, 1887) | 14 | 1.80 | RS | 0 | 0.00 | - |
| **15** | *Orthetrumchrysostigma* (Burmeister, 1839) | 2 | 0.26 | RS | 7 | 1.25 | RS |
| **16** | *Orthetrumjulia* (Kirby, 1900) | 1 | 0.13 | RS | 34 | 6.08 | CS |
| **17** | *Orthetrumstemmale* (Burmeister, 1839) | 2 | 0.26 | RS | 15 | 2.68 | RS |
| **18** | *Palpopleuralucia* (Drury, 1773) | 18 | 2.32 | RS | 82 | 14.67 | PRS |
| **19** | *Palpopleuraportia* (Drury, 1773) | 5 | 0.64 | RS | 4 | 0.72 | RS |
| **20** | *Palpopleura albifrons* (Legrand, 1979) | 0 | 0.00 | | 7 | 1.25 | RS |
| **21** | *Pantala flavescens* (Fabricus, 1789) | 43 | 5.54 | CS | 129 | 23.08 | PRS |
| **22** | *Rhyothemissemihyalina* (Desjardins, 1832) | 0 | 0.00 | | 4 | 0.72 | RS |
| **23** | *Sympetrum fomscolombi* | 4 | 0.52 | RS | 0 | 0.00 | |
| **24** | *Thermochoriaequivota* | 9 | 1.16 | RS | 0 | 0.00 | |
| **25** | *Tholymistillarga* (Fabricus, 1798) | 20 | 2.58 | RS | 3 | 0.54 | RS |
| **26** | *Trameabasilaris* (Palisot de Beauvois, 1817) | 0 | 0.00 | | 28 | 5.01 | CS |
| **27** | *Tramealimbata* (Desjardins, 1832) | 2 | 0.26 | RS | 3 | 0.54 | RS |
| **28** | *Trithemis arteriosa* (Burmeister, 1839) | 42 | 5.41 | CS | 29 | 5.19 | CS |
| **29** | *Trithemisstictica* | 12 | 1.55 | RS | 0 | 0.00 | |
| **30** | *Urothermisassignata* (Selys, 1872) | 0 | 0.00 | RS | 3 | 0.54 | RS |
| | **Coenagrionidae** | | | | | | |
| **31** | *Agriocnemis exilis* (Selys, 1872) | 8 | 1.03 | RS | 0 | 0.00 | |
| **32** | *Ceriagrionglabrum* (Burmeister, 1839) | 151 | 19.46 | PRS | 53 | 9.48 | CS |
| **33** | *Ceriagrion suave* (Ris, 1921) | 2 | 0.26 | RS | 34 | 6.08 | CS |
| **34** | *Ischnura senegalensis* (Rambur, 1842) | 20 | 2.58 | RS | 0 | 0.00 | |
| **35** | *Pseudagrionkersteni* (Gerstacker, 1869) | 6 | 0.77 | RS | 0 | 0.00 | |
| | **Total (%)** | **776** | **58.1** | | **559** | **41.9** | |
| | **Grand Total** | | | **1,335** | | | |

N.B: Species that are more than 10% above of the total are labelled as predominant species (PRS), those that are 5 % above are labelled as common species (CS), while those species that are less than 5 % are labelled as rear species (RS)

**Table 2a: Diversity indices of odonates collected in Ojo sites**

| Diversity Indices | AB | FF | HC | MH | SA | SQ | SS | WW |
|---|---|---|---|---|---|---|---|---|
| Taxa_S | 7 | 2 | 6 | 5 | 4 | 14 | 9 | 10 |
| Individuals | 34 | 81 | 38 | 21 | 29 | 104 | 126 | 124 |
| Dominance_D | 0.1505 | 0.5476 | 0.2147 | 0.2109 | 0.2509 | 0.1368 | 0.1973 | 0.2162 |
| Simpson_1-D | 0.8495 | 0.4524 | 0.7853 | 0.7891 | 0.7491 | 0.8632 | 0.8027 | 0.7838 |
| Shannon_H | 1.92 | 0.6447 | 1.657 | 1.583 | 1.385 | 2.308 | 1.83 | 1.908 |
| Margalef | 1.701 | 0.2276 | 1.375 | 1.314 | 0.8909 | 2.799 | 1.654 | 1.867 |

AB – Administrative Block; FF – Fish farm; HC – Health center; MH– Mosque hall; SA – Student arcade; SQ – Staff quarters; SS– Staff school; WW – Water works

**Table 2b: Diversity indices of odonates collected in Badagry study sites**

| Diversity indices | NFLV | LF | GH | OLF | GB | Adebule | AM | GPMC |
|---|---|---|---|---|---|---|---|---|
| Taxa_S | 16 | 9 | 3 | 6 | 1 | 5 | 8 | 6 |
| Individuals | 198 | 136 | 12 | 112 | 12 | 100 | 82 | 124 |
| Dominance_D | 0.1129 | 0.1592 | 0.3333 | 0.3673 | 1 | 0.3336 | 0.5268 | 0.4239 |
| Simpson_1-D | 0.8871 | 0.8408 | 0.6667 | 0.6327 | 0 | 0.6664 | 0.4732 | 0.5761 |
| Shannon_H | 2.404 | 1.992 | 1.099 | 1.345 | 0 | 1.232 | 0.927 | 1.062 |
| Margalef (*d*) | 2.836 | 1.628 | 0.8049 | 1.06 | 0 | 0.8686 | 1.588 | 1.037 |

NFLV: Nigerian French Language Village, LF: Lasu Foundation, GH: General hospital, OLF: Opp. Lasu foundation, GB: Gberefu; AM: Agbon Meji, and GPMC: great physician ministry Church

Species richness and abundance exhibited considerable spatial heterogeneity across sampling sites (Tables 2a and 2b). In Badagry, the Nigerian French Language Village recorded the highest abundance (198 individuals), while Gberefu Island and Opposite General Hospital, Badagry each yielded the lowest counts (12 individuals each). This disparity reflects differences in local habitat integrity, water quality, and vegetation cover rather than random variation. The consistently high abundance at the Nigerian French Language Village site likely reflects the availability of diverse, relatively undisturbed aquatic microhabitats that support a broader range of larval and adult odonate ecological requirements. This findings is in line with work of Bose *et al*. (2021) and Palita *et al.* (2026) which showed that odonatan species abundant is always rich in an undisturbed ecosystem when compared to others area of human activities.

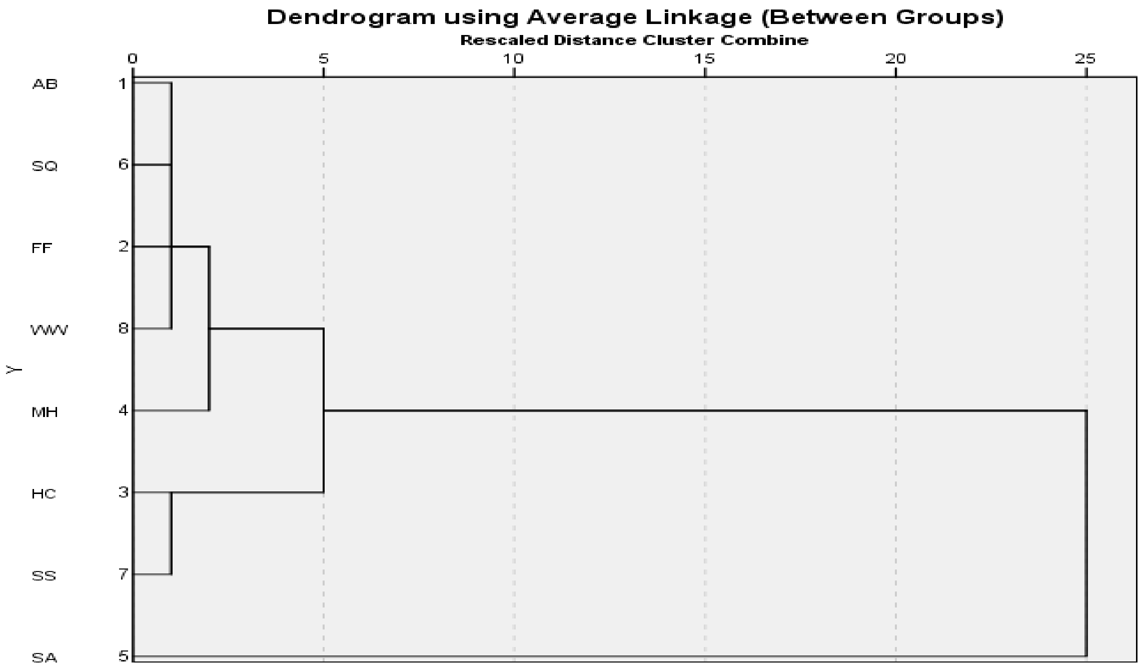
Species exhibiting the highest overall representation across the study sites such as *Ceriagrionglabrum*, *Pantala flavescens*, *Acisomapanorpoides*, *Palpopleuralucia*, and *Diplacodesluminans* recorded more than 50 individuals from either Ojo or Badagry. Among these, *Ceriagrionglabrum*, *Pantala flavescens*, *Trithemis arteriosa*, and *Palpopleuralucia* were recovered from both towns, qualifying them as ecological generalists with broad habitat tolerances. *Ceriagrionglabrum*, which has a documented distribution across West Africa (Dijkstra & Clausnitzer, 2015), characteristically favours sluggish or standing water bodies (Samways, 2008), these conditions are prevalent across most sampling sites in Badagry, particularly along slow-moving and swampy water courses. *Acisoma* species, also largely restricted to Badagry, similarly correspond with the slow-moving, swampy habitats of that region, consistent with earlier findings (Mens *et al*., 2016).

Taxonomic diversity varied substantially among sampling sites (Tables 2a & b). A notable pattern of habitat and regional specificity was observed in several species. *Brachythemisleucostica*, which recorded the highest individual count (38) at the Nigerian French Language Village, was entirely absent from all other sampling locations. *Diplacodeslefebvri* (n = 64) was collected exclusively from Opposite LASU Foundation in Topo, Badagry, exhibiting a relative abundance of 8.25 % at that site while remaining unrecorded elsewhere (Table 1). Eleven species were exclusively recorded in Badagry and never encountered in Ojo, pointing to distinct habitat conditions such as more diverse and less disturbed wetland microhabitats of Badagry which support species not found in the more urbanised Ojo area. In contrast, *Trithemisstictica*, *Orthetrumjulia*, and *Chalcostrephiaflavifrons* displayed regional specificity in the opposite direction: higher abundances of *O. julia* (n = 34) and *C. flavifrons* (n = 27) were documented in Ojo, whereas *Trithemisstictica* was entirely absent from that location.

The sensitivity of *Pantala flavescens* to habitat disturbance was particularly evident at the Mosque Walkway site in Ojo, where individual counts were notably low, contrasting with relatively higher numbers recorded at less disturbed sites such as Water Works and Student Arcade. This pattern reinforces the well-established utility of odonata as bioindicators, whereby assemblage composition and abundance shifts can reflect the degree of habitat disturbance and water quality degradation (Brasell, 2022).

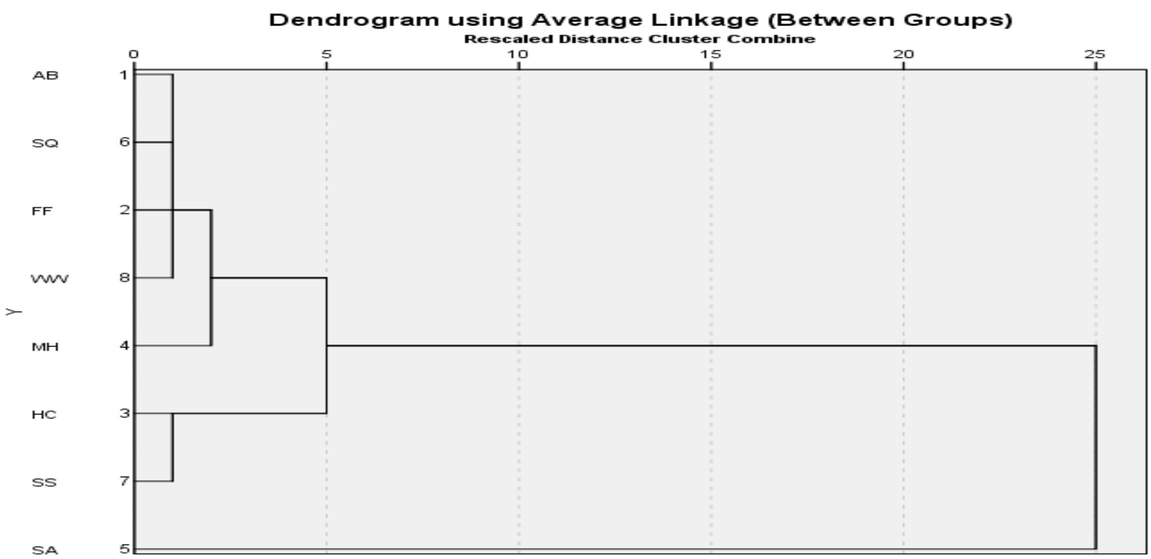
Cluster analysis revealed that species collected in Ojo exhibited a more homogeneous structure, with the computed dendrogram showing greater clustering near the origin of the scale (Fig. 3). Sites AB, SQ, FF, and WW in Ojo were grouped into a single similarity cluster, reflecting comparable species diversity and water quality characteristics. In contrast, the Badagry dendrogram showed fewer clusters near the origin, indicating greater heterogeneity in species assemblages and habitat conditions across sites (Fig. 4). This heterogeneity in Badagry is ecologically significant; as it suggests a mosaic of microhabitats supporting different species assemblages this finding is consistent with the higher overall species richness recorded there.

The Margalef richness index for the Nigerian French Language Village (d = 2.836) suggests moderate levels of water pollution at that site, in line with the classification proposed by Ekpo *et al* 2025). By contrast, the Margalef index for Opposite LASU Foundation (d = 0.8049) indicates heavy pollution, which is consistent with the low species diversity recorded at that location. These index values reinforce the interpretation that anthropogenic pollution is a primary driver of reduced odonate richness in the more urbanised and impacted sites (Dolny *et al* 2021). The Simpson's Diversity Index was highest at Water Works, which paradoxically recorded the lowest dissolved oxygen concentration (4.28 ppt). This outcome may reflect the tolerance of certain dominant odonate species to hypoxic conditions, as several odonata are capable of accessing atmospheric oxygen through cuticular gas exchange when dissolved oxygen in the water column is suboptimal (Lee, 2024).




AB – Administrative Block; FF – Fish farm; HC – Health center; MH– Mosque hall; SA – Student arcade; SQ – Staff quarters; SS– Staff school; WW –Water works

**Figure 3: Dendrogram of odonata species and water quality from eight sampling points in Ojo, using combined rescaled distance clusters**




NFLV: Nigerian French Language Village, LF: Lasu Foundation, Opp. GH: General hospital,
Opp Lasu F: Opp. Lasu foundation, Agbon Me: AgbonMeji, and Great Ph: great physician ministry Church

**Figure 4: Dendrogram of odonata species and water quality from eight sampling points in Badagry, using combined rescaled distance clusters**

**Table 3: Water quality parameters in all sample sites in Lagos State University, Ojo and Badagry**

| Sample Location | Sampling site | Temperature | pH | DO % | TDS (g/l) | Salinity (ppt) | Elec. Conductivity (mS/cm) | Turbidity (NTU) | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| **Ojo** | Admin. Block | 27.75 | 3.77 | 66.9 | 0.246 | 0.2 | 0.376 | 11.2 | 0.25 |
| | Fish Farm | 27.47 | 2.54 | 98.8 | 0.137 | 0.1 | 0.211 | 38.2 | 0.10 |
| | Health center | 27.20 | 4.49 | 339.3 | 0.121 | 0.1 | 0.186 | 3.90 | 0.15 |
| | Mosque hall | 28.62 | 3.35 | 72.0 | 0.202 | 0.1 | 0.311 | 152 | 0.20 |
| | Student arcade | 27.02 | 3.76 | 113.6 | 0.098 | 0.1 | 0.160 | 666 | 0.00 |
| | Staff quarters | 26.70 | 3.21 | 64.6 | 0.213 | 0.2 | 0.347 | 18.3 | 0.10 |
| | Staff school | 28.39 | 5.63 | 305.7 | 0.06 | 0.0 | 0.094 | 3.02 | 0.10 |
| | Water works | 26.96 | 5.20 | 54.4 | 0.250 | 0.2 | 0.384 | 7.2 | 0.10 |
| **Badagry** | Adebule Street | 25.89 | 4.79 | 344.8 | 0.178 | 0.1 | 0.273 | 30.8 | 0.15 |
| | AgbonMeji | 30.16 | 4.85 | 500.0 | 0.201 | 0.1 | 0.301 | 0 | 0.15 |
| | Lasu Foundation | 26.43 | 2.81 | 449.4 | 0.259 | 0.2 | 0.399 | 15.4 | 0.1 |
| | Nigeria French village | 27.76 | 4.66 | 188.2 | 0.08 | 0.1 | 123 | 25.7 | 0.15 |
| | Opp. Lasu Foundation | 26.82 | 3.22 | 307.5 | 0.177 | 0.1 | 0.273 | 0 | 0.1 |
| | Badagry GH | 26.25 | 4.17 | 188.5 | 0.188 | 0.1 | 0.289 | 21.3 | 0.1 |
| | Gberefu | 26.62 | 4.78 | 197.5 | 0.108 | 0.1 | 0.166 | 55.1 | 0.05 |
| | Great Physician Ministry | 29.99 | 4.47 | 255.1 | 0.461 | 0.3 | 0.72 | 54.2 | 0.15 |

The physicochemical properties of sampled water bodies are presented in Table 3. Water temperature ranged from 25.89 °C at Adebule to 30.16 °C at AgbonMeji, values broadly consistent with the thermal tolerance range of tropical Odonata (Dallas & Rose-Gillespie, 2015; Calvao *et al.*, 2025). The elevated temperature at AgbonMeji corresponded with markedly low species diversity (H' = 0.927), aligning with the proposition that thermal stress at the higher end of the tropical range can constrain odonate assemblage richness by reducing larval developmental success and adult activity (Suhling *et al.*, 2015; Castillo-Perez *et al.*, 2025). Average salinity remained uniformly low across all water bodies (0.1–0.2 %), indicating predominantly freshwater conditions conducive to the majority of recorded species (Uboni *et al*., 2020).

Water pH values across sampling sites were generally acidic, ranging from 2.81 to 5.63 — values that fall substantially below the optimal range for most aquatic macroinvertebrates. Acidification of water bodies, particularly in AgbonMeji and Gberefu Island, corresponded with the lowest recorded species diversity at those locations. This corroborates findings by Ebenebe *et al.* (2016) and Ishak *et al.* (2021), who demonstrated that acidic conditions exert negative effects on aquatic insect community structure by impeding larval development and reducing prey availability. The consistently acidic pH values observed across the study area may, in part, reflect organic loading from urban runoff and decomposing vegetation, both of which are characteristic of disturbed urban wetlands in Lagos State; this is in line with the findings of Bakare *et al.* (2024), who reported similar occurrence in Akure Ondo State, South Western Nigeria.

Dissolved Oxygen (DO) was highest at the Health Centre site (26.51 ppt) and lowest at Water Works (4.28 ppt). Pearson's correlation analysis revealed a strong negative correlation between DO and Total Dissolved Solids (TDS) in Badagry, significant at $p < 0.05$. This inverse relationship is well-documented in aquatic ecology and reflects the oxygen-depleting effects of dissolved inorganic and organic material loads (Wetzel, 2001; Pinter & Vriens, 2023). Although Pearson's analysis showed only a weak positive correlation between temperature and other water quality parameters across both sites, this finding diverges from the study of Arimoro and Ikomi (2008), who reported strong relationships between temperature, dissolved oxygen, and biodiversity; However, Adnan *et al.* (2025) findings corroborate with this study and the results underscore the multifactorial nature of odonate habitat selection in heterogeneous urban wetlands. odonata are generally considered tolerant of low dissolved oxygen conditions: many species are capable of supplementing aqueous respiration by trapping atmospheric oxygen through cuticular or spiracular exchange, thereby maintaining metabolic function in hypoxic water bodies (Šigutová, 2022; Lee, 2024).

**Table 4: Pearson's correlations between physicochemical parameters of water bodies in Badagry and Ojo, Lagos**

| Parameter | | Temp_A | PH_A | Cond_A | Turbid_A | DO_A | TDS_A | Salinity_A | WaterD_A | Temp_B | PH_B | Cond_B | Turbid_B | DO_B | TDS_B | Salinity_B | WaterD_B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temp_A | Pearson Correlation | 1 | .131 | -.237 | -.159 | .204 | -.202 | -.585 | .490 | -.082 | .507 | .644 | .309 | -.251 | -.637 | -.394 | -.036 |
| | Sig.(2-tailed) | | .758 | .572 | .706 | .628 | .631 | .127 | .217 | .847 | .200 | .085 | .456 | .549 | .089 | .334 | .932 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| PH_A | Pearson Correlation | .131 | 1 | -.238 | -.185 | .538 | -.219 | -.278 | -.090 | -.122 | -.094 | -.248 | .794* | -.330 | .339 | .535 | -.506 |
| | Sig. (2-tailed) | .758 | | .570 | .660 | .169 | .602 | .505 | .832 | .773 | .825 | .553 | .019 | .424 | .411 | .172 | .201 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Cond_A | Pearson Correlation | -.237 | -.238 | 1 | -.321 | -.755* | .998** | .912** | .500 | .146 | .326 | .195 | .212 | -.219 | .400 | .311 | .721* |
| | Sig. (2-tailed) | .572 | .570 | | .439 | .030 | .000 | .002 | .207 | .730 | .431 | .644 | .615 | .602 | .326 | .453 | .044 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Turbid_A | Pearson Correlation | -.159 | -.185 | -.321 | 1 | -.165 | -.340 | -.169 | -.594 | -.123 | -.455 | .069 | -.515 | -.049 | -.203 | -.267 | -.110 |
| | Sig. (2-tailed) | .706 | .660 | .439 | | .695 | .410 | .690 | .120 | .772 | .258 | .871 | .191 | .909 | .630 | .522 | .794 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| DO_A | Pearson Correlation | .204 | .538 | -.755* | -.165 | 1 | -.741* | -.700 | -.083 | -.346 | -.440 | -.238 | .121 | .216 | -.155 | .050 | -.721* |
| | Sig. (2-tailed) | .628 | .169 | .030 | .695 | | .036 | .053 | .845 | .401 | .275 | .570 | .774 | .608 | .714 | .907 | .044 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| TDS_A | Pearson Correlation | -.202 | -.219 | .998** | -.340 | -.741* | 1 | .898** | .534 | .168 | .343 | .207 | .230 | -.193 | .410 | .332 | .746* |
| | Sig. (2-tailed) | .631 | .602 | .000 | .410 | .036 | | .002 | .173 | .691 | .406 | .624 | .584 | .647 | .313 | .422 | .034 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Salinity_A | Pearson Correlation | -.585 | -.278 | .912** | -.169 | -.700 | .898** | 1 | .267 | .064 | .055 | -.141 | .005 | -.028 | .530 | .339 | .611 |
| | Sig. (2-tailed) | .127 | .505 | .002 | .690 | .053 | .002 | | .522 | .881 | .897 | .739 | .990 | .947 | .177 | .411 | .108 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| WaterD_A | Pearson Correlation | .490 | -.090 | .500 | -.594 | -.083 | .534 | .267 | 1 | -.223 | .385 | .401 | .258 | .023 | -.184 | -.064 | .445 |
| | Sig. (2-tailed) | .217 | .832 | .207 | .120 | .845 | .173 | .522 | | .595 | .347 | .325 | .537 | .956 | .663 | .881 | .270 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Temp_B | Pearson Correlation | -.082 | -.122 | .146 | -.123 | -.346 | .168 | .064 | -.223 | 1 | .353 | .067 | .010 | .270 | .513 | .449 | .537 |
| | Sig. (2-tailed) | .847 | .773 | .730 | .772 | .401 | .691 | .881 | .595 | | .392 | .875 | .981 | .518 | .194 | .265 | .170 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| PH_B | Pearson Correlation | .507 | -.094 | .326 | -.455 | -.440 | .343 | .055 | .385 | .353 | 1 | .228 | .437 | -.271 | -.173 | -.222 | .327 |
| | Sig. (2-tailed) | .200 | .825 | .431 | .258 | .275 | .406 | .897 | .347 | .392 | | .588 | .279 | .516 | .682 | .596 | .429 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Cond_B | Pearson Correlation | .644 | -.248 | .195 | .069 | -.238 | .207 | -.141 | .401 | .067 | .228 | 1 | .009 | -.388 | -.435 | -.200 | .341 |
| | Sig. (2-tailed) | .085 | .553 | .644 | .871 | .570 | .624 | .739 | .325 | .875 | .588 | | .984 | .343 | .282 | .635 | .408 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Turbid_B | Pearson Correlation | .309 | .794* | .212 | -.515 | .121 | .230 | .005 | .258 | .010 | .437 | .009 | 1 | -.583 | .269 | .433 | -.184 |
| | Sig. (2-tailed) | .456 | .019 | .615 | .191 | .774 | .584 | .990 | .537 | .981 | .279 | .984 | | .129 | .520 | .283 | .662 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| DO_B | Pearson Correlation | -.251 | -.330 | -.219 | -.049 | .216 | -.193 | -.028 | .023 | .270 | -.271 | -.388 | -.583 | 1 | .204 | .076 | .285 |
| | Sig. (2-tailed) | .549 | .424 | .602 | .909 | .608 | .647 | .947 | .956 | .518 | .516 | .343 | .129 | | .627 | .857 | .494 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| TDS_B | Pearson Correlation | -.637 | .339 | .400 | -.203 | -.155 | .410 | .530 | -.184 | .513 | -.173 | -.435 | .269 | .204 | 1 | .924** | .317 |
| | Sig. (2-tailed) | .089 | .411 | .326 | .630 | .714 | .313 | .177 | .663 | .194 | .682 | .282 | .520 | .627 | | .001 | .445 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| Salinity_B | Pearson Correlation | -.394 | .535 | .311 | -.267 | .050 | .332 | .339 | -.064 | .449 | -.222 | -.200 | .433 | .076 | .924** | 1 | .226 |
| | Sig. (2-tailed) | .334 | .172 | .453 | .522 | .907 | .422 | .411 | .881 | .265 | .596 | .635 | .283 | .857 | .001 | | .591 |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |
| WaterD_B | Pearson Correlation | -.036 | -.506 | .721* | -.110 | -.721* | .746* | .611 | .445 | .537 | .327 | .341 | -.184 | .285 | .317 | .226 | 1 |
| | Sig. (2-tailed) | .932 | .201 | .044 | .794 | .044 | .034 | .108 | .270 | .170 | .429 | .408 | .662 | .494 | .445 | .591 | |
| | N | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 |

A strong positive correlation (r = 0.998) was observed between Total Dissolved Solids (TDS) and Electrical Conductivity (EC) in Ojo. This relationship is expected, as dissolved ionic salts directly increase the electrical conductivity of water; higher TDS concentrations consequently elevate measured conductivity (APHA, 2017). Both parameters exhibited significant positive correlations with species diversity across sampling sites, suggesting that moderate levels of ionic content within the tolerance range of most tropical odonates may indirectly support habitat conditions that favour greater species richness, possibly by influencing aquatic prey availability or vegetation structure. Pearson's analysis further confirmed no significant differences ($p > 0.05$) between Ojo and Badagry in pH, salinity, turbidity, or depth of sampled water bodies (Table 4), indicating that the observed disparities in species richness and composition between the two sites are more likely driven by vegetation cover, habitat complexity, and land-use pressure than by gross physicochemical differences in water quality (Dolny *et al*., 2021; Ishak *et al*., 2021).

## CONCLUSION

The findings of this study collectively highlight the ecological vulnerability of odonata communities in the Lagos urban-peri-urban gradient. The marked differences in species composition, richness, and habitat specificity between Ojo and Badagry demonstrate that generalised conservation approaches are inadequate; rather, site-specific management strategies are necessary to safeguard the distinct assemblages associated with each location. The relatively higher species richness and habitat heterogeneity in Badagry, particularly at less disturbed sites, points to the conservation priority of protecting remaining semi-natural wetlands in the region from further urbanisation and pollution. Conversely, the degraded odonate fauna at heavily polluted sites such as Opposite LASU Foundation underscores the urgent need for wetland remediation and pollution control measures in the Ojo corridor. As reliable bioindicators of freshwater ecosystem integrity, the odonata assemblages documented in this study provide a valuable baseline against which future environmental change can be assessed, and they should be incorporated into routine biological monitoring programmes for Lagos State aquatic ecosystems.

**Conflict of interest:** The authors declare no conflicts of interest.

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## REFERENCES

Abbott, J. ed. (2005). *Dragonflies and Damselflies (Odonata) of Texas* (Vol. 1). Lulu. com.

Abdul, N., Rawi, C. M. D., Ahmad, A. H. and Al-Shami, A. (2017). Effect of Environmental disturbances on Odonata assemblages along a tropical polluted river. *Ekologia* (*Bratislava*), 36(4), 388-402.

Adeleke, S. O., Sanni, R. O., Adebayo, V. J., Olaseewo, N. A. and Abdulwakeel, K. D. (2024). Odonata, Characterisations and their Ecosystem Services: Exploring STEM Frontiers. A festschrift in honour of Dr. FO Balogun, Sustaine.

Adnan, N. A. A., Abd Rahman, A., Kassim, N. F. A. & Seri, N. A. (2025). Distribution and population abundance of odonates in relation to abiotic factors in an urbanized freshwater ecosystem: A case study from Universiti Sains Malaysia. *Pertanika J. of Sci. and Techn.*, 33, 1923-42.

Adu, B. W., Ogbogu, S. S. and Kemabonta, K. A. (2015). Dragonflies and damselflies (insecta: odonata) as tools for habitat quality assessment and monitoring. *FUTA Journal of Research in Sciences*, 1, 36-45.

Adu, B. W., Kemabonta K. A. and Ogbogu, S. S. (2016). Composition and abundance of odonates at Alatori stream in south-west, Nigeria *UNILAG J. of Med., Sci. and Techn.*, 96-110.

Arimoro, F. O. and Ikomo, R. B. (2008). Response of macroinvertebrates to abattoir wastes and other anthropogenic activities in a municipal stream in the Niger Delta, Nigeria. *Environmentalist*, 28, 85-98.

Bakare, A. B., Adu, B. W. and Ehikhamele, E. I. (2024). Effects of anthropogenic disturbances on adult *Odonata fauna* in Akure, south west Nigeria. The *Journal of Basic and Applied Zoology*, 85(1), 56.

Brasell, K. A. (2022). Molecular and paleolimnological investigations of natural disturbance effects on in-lake biological communities. A Doctoral dissertation, University of Auckland.

Castillo-Pérez, E. U., Rivera-Duarte, J. D., Abellán, P., del-Val, E., González-Tokman, D. and Córdoba-Aguilar, A. (2025). Thriving in the heat: How high temperatures and habitat disturbance shape odonate taxonomic and functional diversity in the tropics. *Insect Conservation and Divers.*, 18(3), 343-356.

Dallas, H. F. and Ross-Gillespie, V. (2015). Sublethal effects of temperature on freshwater organisms, with special reference to aquatic insects: A review. *Water SA*., 41(5), 712-726.

Dijkstra, K. B. and Clausnitzer, V. (2015). The dragonflies and damselflies of East Africa: Handbook for all Odonata from Sudan to Zimbabwe. *Studies in Afrotropical Zoology*. Belgian Royal Museum for Central Africa, Pensoft. 264pp.

Dijkstra, K. B. and Kalkman, V. J. (2012). Phylogeny, classification and taxonomy of European dragonflies and damselflies (odonata): A review. *Organisms Diversity & Evolution*, 12, 209-227.

Dijkstra, K. B. (2007). Dragonflies and damselflies (Odonata) of the Atewa range, Ghana. In: McCullough, A. J., Naskrecki, L. E., Wright, P. and Osei-Owusu, H. E. (eds.) *A Rapid Biological Assessment of the Atewa Range Forest Reserve, Eastern Ghana.* RAP Bulletin of Biological Assessment. Conservation International, Arlington, VA, 50-54.

Dolný, A., Ožana, S., Burda, M. and Harabiš, F. (2021). Effects of landscape patterns and their changes to species richness, species composition, and the conservation value of Odonates (Insecta). *Insects*, 12(6), 478.

Dutra, S. and De Macro, P. (2015). Bionomic differences in Odonates and their influence on the efficiency of indicator species of environmental quality. *Ecological Indicators.* 49, 132-142.

Ekpo, I. E., Jonah, U. E. and Anyanwu, E. D. (2025). Water quality and plankton assemblages in Eniong Creek: Implications for biodiversity and anthropogenic influence. *Journal of Science and Techn.*, 17(1), 143-155.

Hansen, A. M., Fleck, J. A., Kraus, T. E. C., Downing, B. D., von Dessonneck, T., and Bergamaschi, B. A. (2018). Procedures for using the Horiba Scientific Aqualog® fluorometer to measure absorbance and fluorescence from dissolved organic matter. *U.S. Geological Survey Open-File Report* 2018–1096, 31 p. https://doi.org/10.3133/ofr2018109

Harris, L (2017). *Sea Ports and Sea Power: African Maritime Cultural Landscapes.* Springer International Publishers, 119pp.

Holtmann, L., Juchem, M., Brüggeshemke, J., Möhlmeyer, A. and Fartmann, T. (2018). Stormwater ponds promote dragonfly (Odonata) species richness and density in urban areas. *Ecological Engineering*, 118, 1-11. DOI: 10.1016/j.ecoleng.2017.12.028

Ishak, M., Norhisham, A. R., Thomas, S. M., Nurhidayu, S., Ghazali, A. and Azhar, B. (2021). Physicochemical properties as driver of Odonata diversity in oil palm waterways. *Frontiers in Forests and Global Change*, 4, 613064.

Karmakar, B. and Singh, M. (2021). Assessment of water quality status of water bodies using water quality index and correlation analysis in and around industrial areas of West District, Tripura, India. *Nature Env. and Pollution Techn.*, 20. DOI: 10.46488/NEPT.2021.v20i02.011.

Kemabonta, K. A, Adu, B. W. and Ohadiwe, A. C. (2016). Impact of human disturbance on the abundance, diversity and distribution of Odonata in the University of Lagos, Akoka, Lagos, Nigeria. *Appl. Tropical Agric.*, 21(3), 143-150.

Lee, D. J. (2024). On the respiratory consequences of the air-to-water transition in insects. A Doctoral dissertation, University of British Columbia.

Mähn, L. A. (2024). Responses of Odonate assemblages to climate: Importance of body size, dispersal and phylogeny. *Philipps-Universität Marburg*. https://doi.org/10.17192/z2025.0488

Mens, L. P., Schütte, K., Stokvis, F. R. and Dijkstra, K. B. (2016). Six, not two, species of *Acisoma* pintail dragonfly (Odonata: Libellulidae). *Zootaxa*. 4109(2), 153.

Nelson, B., Ronayne, C. and Thompson, R. (2011). *Ireland Red List No. 6: Damselflies and Dragonflies (Odonata).* National Parks and Wildlife Service, Department of the Environment, Heritage and Local Government, Dublin, Ireland, 27pp

Okosodo, E. F. and Sarada, P. M. (2021). Diversity of bird species in damaged mangrove swamp along the Badagry creek Lagos Southwest Nigeria. *European Scholar Journal*, 2(5), 17-28.

Olsen, K., Svenning, J. C. and Balslev, H. (2022). Niche breadth predicts geographical range size and northern range shift in European dragonfly species Odonata). *Diversity*, 14(9), 719.

Pinter, J. and Vriens, B. (2023). Imprints of wastewater discharge on trace element dynamics in the Grand River, Ontario. *Environmental Monitoring and Assessment*, 195(6), 718.

Ramlee, S. (2022). Odonata nymphs as potential biocontrol agent of mosquito larvae in Malaysia. *The Southeast Asian J. of Trop. Med. and Public Health*, 53(4), 426-435.

Rana, L. and Bhatia, S. (2025). The role of Odonata in wetland ecosystems: An ecological perspective. *Int. J. Env. Chem.*, 11(1), 15-20.

Samways, M. J. (2008). *Dragonflies and Damselflies of South Africa* (No. 70). Pensoft Publishers.

Šigutová, H., Dolný, A., Samways, M. J., Hardersen, S., Oliveira-Junior, J. M. B., Juen, L., ... and Bried, J. T. (2023). Odonata as indicators of pollution, habitat quality, and landscape disturbance. In: *Dragonflies and Damselflies: Model Organisms for Ecological and Evolutionary Research* (pp. 371-384). Oxford University Press.

Suhling, F., Sahlén, G., Gorb, S., Kalkman, V. J., Dijkstra, K. D. B. and van Tol, J. (2015). Order Odonata. In: Thorp, J., Rogers, D. C., *Ecology and General Biology* (pp. 893–932). Thorp and Covich's Freshwater Invertebrates, Acad. Press.

Uboni, C., Jugovic, J., Tordoni, E., Pizzul, E., Riservato, E. and Bacaro, G. (2020). Dragonfly (Odonata) diversity patterns in mixohaline coastal wetlands. *Estuaries and Coasts*, 43(2), 375-386.

Vicks, G. S. (2003). Notes on the genus *Notogomphus selys*, 1858 in Cameroon with the descriptions of two new species (Anisoptera: Gomphidae). *Odonatolog.*, 32(1), 47- 60.