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RESEARCH ARTICLE

ANALYSIS OF AQUATIC MACROINVERTEBRATE DIVERSITY IN A WETLAND: BANGR-WÉOGO URBAN PARK, IN THE HEART OF OUAGADOUGOU, THE CAPITAL OF BURKINA FASO

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ABSTRACT

Wetlands are rare ecosystems in arid tropical regions, playing multiple ecological roles and providing multiple ecosystem services. Unfortunately, these ecosystems are increasingly subject to strong anthropogenic pressures resulting from high population growth and the effects of climate variability. A good knowledge of the biodiversity of these ecosystems is essential for their sustainable management, as it is both the source and the product of their proper functioning. Macroinvertebrates are one of the most important links in the animal biodiversity of wetlands. However, knowledge of macroinvertebrates in the Bangr-Wéoogo urban park remains limited. This study aims to analyze the diversity of macroinvertebrates in the Bangr-Weoogo urban park, key players in the biological balance and food web of wetlands. To this end, macroinvertebrates were sampled monthly between March and June 2023, using the multihabitat sampling method and a standard AQEM/STAR net sampler with 25 cm × 25 cm opening and 500 µm mesh. Samples were stored in flasks with ethanol (90%). In the laboratory, specimens were sorted with entomological forceps and identified under a magnifying glass, using taxonomic manuals. A total of 21 macroinvertebrate families have been identified, comprising insects, molluscs and crustaceans. Insects are the most abundant and diverse. Taxa known to be sensitive to pollution, such as Ephemeroptera, Plecoptera and Trichoptera, are poorly represented, while molluscs are proportionally dominant. This could indicate the onset of eutrophication. These results show that the park's ecological integrity is under threat. Managers must take urgent action to remedy this degradation of the Bangr-Wéogo Urban Park.

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INTRODUCTION

In sub-Sahelian arid zones, wetlands are rare ecosystems that play several ecological roles and provide multiple ecosystem services. The natural resources of wetlands provide scientific, economic, sociological and aesthetic services, and these hydrosystems are also considered to be reservoirs of faunal and floral diversity (Houhamdi *et al*, 2009 ; Boukrouma *et al*, 2011 ; Bensaci *et al*, 2012). Unfortunately, demographic growth, the main driver of anthropogenic pressures combined with the effects of climatic variability, the main factors responsible for the degradation of ecosystems in general and wetlands in particular, is increasing in sub-Saharan arid zones. Indeed, agricultural expansion with the use of chemical inputs, extensive livestock rearing, galloping urbanization without adequate sanitation systems, and the over-exploitation of natural resources resulting from strong demographic growth are the factors responsible for wetland degradation. The sustainable use of natural resources in general, and wetlands in particular, represents a challenge for mankind. To meet this challenge, we need a synergy of action between local populations, researchers and political decision-makers. Policies need to be informed by scientific knowledge, so that the right decisions can be taken and implemented by local populations who are the direct beneficiaries of ecosystem services. Scientific knowledge of all the compartments that contribute to the proper functioning of wetlands is often limited. This is the case of the Bangr-Weoogo urban park in the heart of Burkina Faso's capital. Biodiversity plays many roles, both source and product of the proper functioning of ecosystems on which ecosystem services depend (Roche *et al*, 2016). A good understanding of ecosystem biodiversity is therefore essential for their sustainable management and use. Macroinvertebrates are fundamental to the functioning of aquatic ecosystems (Sharitz & Batzer, 1999). They contribute to the energy flow of the food web and play a vital role in maintaining biological equilibrium and the food web in the environment (Sanogo *et al*, 2021; Kabore *et al*, 2023a). They are also excellent indicators for detecting dysfunctions caused by environmental pressures. They are therefore used to assess the state of biodiversity in aquatic ecosystems. However, knowledge of macroinvertebrates in the Bangr-Wéoogo urban park is limited. To contribute to sustainable management of the park in a context of ever-increasing pressure on natural environments, it is important to have solid knowledge that will enable us to warn of possible degradation. This study aims to analyze the diversity of macroinvertebrates, key players in the biological balance and food web of wetlands.

METHODOLOGY

Study site : The Bangr-Wéoogo urban park is a wetland located in the heart of the capital of Burkina Faso, between parallels 12°22'59.4" and 12°23'01.7" north latitude and meridians 1°30'10.00" and 1°37'12.2" west longitude. It covers an area of 240 ha (Gnoumou et al, 2008) (figure 1). The Bangr-Weoogo urban park plays several roles : ecological, pharmacopoeia, cultural, scientific, economic, ecotourism and leisure (Gnoumou et al, 2008). Despite these multiple services, the park is increasingly threatened by various anthropogenic pressures. Indeed, there is heavy plastic pollution of the city's water drainage channels in the PUBW (Figure 2 a ; b). In addition to the plastic pollution, there is a high proliferation of water hyacinth (Eichhornia Crassipes), an invasive exotic plant, accompanied by a high mortality rate among woody plants. Despite these multiple services, the park is increasingly threatened by various anthropogenic pressures. The city's drainage channels are being invaded by plastic in the PUBW (Figure 2 a; b). In addition to this, there is a heavy proliferation of water hyacinth (Eichhornia Crassipes), an invasive exotic plant, accompanied by heavy mortality of certain woody plants (Figure 2 c; d).

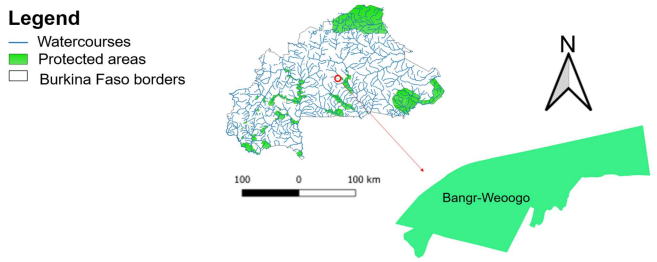


Figure 1. Map of Burkina Faso showing the Bangr-Weoogo urban park

Figure 2. Threats to Bangr-Wéoogo urban park: a ; b channels invaded by plastic in the PUBW ; c=Proliferation of water hyacinth ; d=woody plant mortality

Macroinvertebrate sampling: In order to analyze settlement structure, macroinvertebrates were collected using the multi-habitat sampling method adapted from Barbour et al (1999), using a standard AQEM/STAR net sampler a 500µm mesh, 25x25 cm2 aperture haze net, from March to June 2023. This method makes it possible to obtain a representative sample by carrying out 20 net shots distributed among the available micro-habitats in proportion to their extent in the site. The composite of the 20 shots constitutes the final sample, which was preserved with alcohol (90%) in plastic jars, labelled (date and sampling site) and transported to the laboratory. In the laboratory, each sample was rinsed with tap water under a 100 µm mesh sieve, the organisms sorted and identified to family taxonomic level under a binocular loupe using identification keys and taxonomic manuals (Levêque, 1980 ; Gerber and Gabriel, 2002 ; Tachet et al, 2010), then counted.

Data analysis : Macroinvertebrate diversity was analyzed by determining taxonomic richness, taxa abundance, Shannon-Wiener diversity index (H'), and Pielou equitability index (E) according to equations 1 and 2.

$$H' = \sum ((\text{ni N log } 2(\text{ni} / \text{N})) \quad \text{.....(1)}$$

$$E = \frac{H'}{\log 2(S)} \quad \text{.....(2)}$$

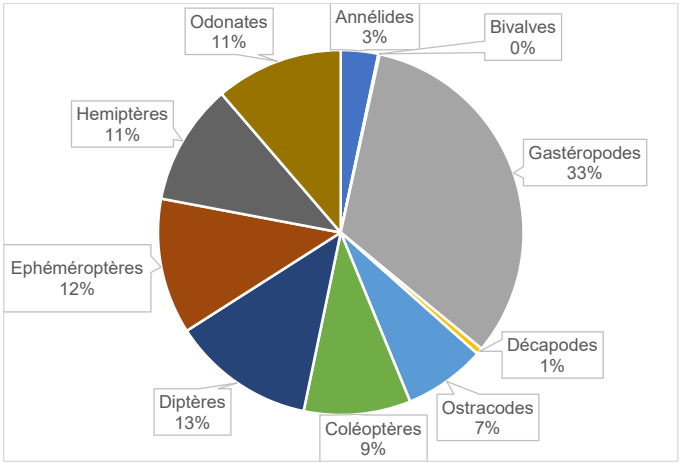
With ni the number of individuals of the taxa of rank i, N the total number of individuals and S the total number of taxa counted. Ecological status metrics such as the EPT index and the proportions of Molluscs (%Mol) and Ephemeroptera, Plecoptera and Trichoptera (%EPT), non-insect taxa (%N-ins) were determined according to formulas 3 and 4 in order to assess the ecological status of Bangr-weoogo urban park (Bancé et al., 2021a ; Kaboré et al., 2022).

$$\%\text{Mollusques} = \frac{\text{abondance des Mollusques}}{\text{abondance totale}} x100 \quad \text{.....(3)}$$

$$\%\text{EPT} = \frac{\text{abondance des taxa EPT}}{\text{abondance totale}} x100 \quad \text{.....(4)}$$

RESULTS

Macroinvertebrate population: A total of 2,593 macroinvertebrate specimens were collected in the Bangr-Weoogo urban park. They were divided into four Classes, with Insects the most abundant (56.2%), followed by Molluscs (32.66%), Crustaceans (7.82%) and Annelids (3.32%). Ten Orders of macroinvertebrates (Figure3) were encountered in the park, dominated by Insects made up of five Orders, namely Diptera (13%), Ephemeroptera (12%), Hemiptera and Odonata (11% each) and Coleoptera (9%). Molluscs are made up of two orders, with gastropods the most abundant (33% of total abundance) and Bivalves the least represented. Crustaceans are represented by Ostracods (7%) and Decapods (1%).



Taxa abundance and diversity : Table 1 shows the diversity and abundance of macroinvertebrates in the Bangr-Wéoogo urban park. A total of 21 macroinvertebrate families were identified. The insect class is the most diverse, with 14 families, followed by the Mollusca class with 4 families, the Crustacea class with two families and the Clitellata class with one family. The Planorbidae family is the most abundant with 542 specimens, followed by the Baetidae and Chironomidae with 312 and 294 specimens respectively.

zones (Kabore *et al*, 2016a ; b ; c ; Tanon *et al*, 2020 ; Sanogo *et al*, 2021 ; Bancé *et al*, 2021a ; b ; Silga *et al*, 2022 ; Kabore *et al*, 2023a ; b ; Zongo *et al*, 2023). Insects are the most diverse and abundant. These results are similar to those of Kaboré *et al* (2016a ; b), Sanogo *et al* (2014 ; 2021), Bancé *et al* (2021a), Tampo *et al* (2021), who found insects to be the most abundant and diverse of tropical aquatic ecosystems. The diversity of the macroinvertebrate population is evidence of the biodiversity hotspot role played by wetlands in arid

Tableau 1. Diversity and abundance of macroinvertebrates in Bangr-Wéoogo urban park

Embranchement	Classe	Order	Familly	Abondance
Annelids	Annelids	Annelids	Hirudinae	86
Molluscs	Molluscs	Bivalva	Unionidae	3
		Gasteropoda	Planorbidae	542
			Thiaridae	193
			Bulinidae	109
Arthropods	Crustaceans	Decapoda	Potamidae	15
		Ostracoda		188
	Insectes	Coleoptera	Dysticidae	218
			Elmidae	13
			Hydrophilidae	14
		Diptera	Chironomidae	294
			Culicidae	22
			Tabanidae	13
		Hemiptera	Belostomatidae	176
			Corixidae	4
			Nepidae	12
			Notonectidae	86
		Ephemeroptera	Baetidae	312
		Odonata	Aeshnidae	8
			Coenagrionidae	243
			Libellulidae	42

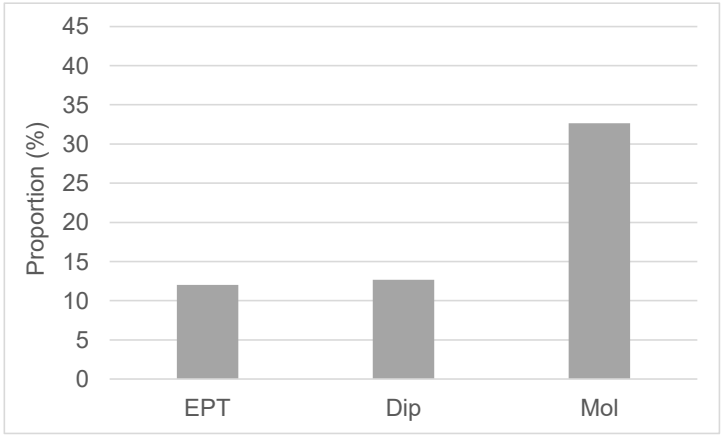


Figure 3. Ecological quality metrics for the macroinvertebrate community in Bangr-Weoogo urban park

Diversity indices and ecological quality metrics : The Shannon diversity indices for the macroinvertebrate population in Bangr-Weoogo urban park is 2.46, and the Piellou equitability index is 0.80. The ecological quality metrics are presented in figure 4. Ecological quality metrics are shown in Figure 4. Despite their low diversity, molluscs are the most abundant. EPT's known for their sensitivity to pollution are represented by the Baetidae. The Order Diptera, with its taxa resistant to pollution, is proportionally low.

DISCUSSION

The PUBW is a specific wetland due to its geographical location. Indeed, it is the lungs of the city of Ouagadougou. It contributes to the purification of the city's air, which is regularly laden with CO2 emitted by the numerous mopeds and automobiles (Gnoumou *et al*, 2008). The PUBW is a natural habitat for a diversity of macroinvertebrates. In the course of this study, 21 macroinvertebrate families were identified, comprising the most dominant insects in terms of abundance and diversity, crustaceans, molluscs and annelids. These macroinvertebrate groups are characteristic of tropical arid tropical environments. However, the low presence of taxa known to be sensitive to environmental degradation indicates that the park is under ecological stress. Kaboré *et al* (2024) have shown that pollution-sensitive taxa are most often abundant in protected areas that are sheltered from anthropogenic pressures. Although the Bangr-Weoogo urban park is a protected wetland, it is under heavy anthropogenic pressure due to its geographical location. Plastic pollution of water drainage channels from the city poses serious threats to the park. Margenat *et al* (2021) have highlighted plastic waste as the emerging threat that is hugely affecting aquatic ecosystems. According to Sigler (2014), aquatic environments are the final destination of non-biodegradable waste such as plastics. Once in aquatic ecosystems, they contribute to the degradation of the physico-chemical quality of the water, disrupting the trophic chain and leading to ecosystem imbalance with devastating corollaries. The proliferation of Eichhornia Crassipes, an invasive alien plant, could be one of the consequences of plastic pollution. Dudgeon *et al* (2006) and Kingsford *et al* (2016) have pointed out that invasive alien species are among the threats to aquatic ecosystems. Also, tree mortality in the park will compromise its ecosystem services. According to Gnoumou *et al* (2008), as a result of deforestation and

urbanization, traditional healers in the city and surrounding area use the park to obtain medicinal plants that have become rare or extinct. This mortality will inevitably affect these medicinal plants, compromising the park's pharmacopoeia services. Woody plants play an important role in climate change mitigation and carbon sequestration (Were *et al*, 2019; Choukrani *et al*, 2023). This sequestration is linked to woody density. Gomgnimbou et al. (2019), linked the low carbon sequestration by green spaces in the city of Bobo Dioulasso to low line density. Dembélé *et al* (2023) confirmed these trends. These authors found high sequestration in the Kou River easement strip, which has a higher density of woody plants compared with the managed green spaces of the city of Bobo Dioulasso. The high mortality of woody plants will affect its role as the city's lung and its carbon sequestration capacity. This study enabled us to confirm that the Bangr-weoogo urban park, as a wetland, is home to a diversity of macroinvertebrates made up of insects, crustaceans, molluscs and annelids. Diversity indices and ecological quality metrics show that this wetland is of good ecological quality. This good ecological quality is threatened by several factors, notably plastic waste from the city, the proliferation of the water hyacinth, an invasive exotic plant, and high tree mortality. For the sustainable management of this wetland, managers need to take urgent action to remedy its plastic pollution, the proliferation of the invasive exotic species and the high mortality of woody plants.

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Author contributions

BANCE Victor: Conceptualization, Methodology, Formal analysis, Validation, Investigation, Writing - Original Draft, Review & Editing.

KABORE Idrissa: Methodology, Formal analysis, Investigation, Visualization, Review & Editing.

Daouda NAKENA: Methodology, Formal analysis, Investigation, Visualization, Review & Editing.

ZONGO Lionel Regis: Formal analysis, Investigation, Writing - Review & Editing.

OUEDA Adama: Methodology, Supervision, Visualization, Validation, Review & Editing.

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