

(RESEARCH ARTICLE)



SPATIO-TEMPORAL STRUCTURE OF MOLLUSC COMMUNITIES IN LAKE ZIENKOLO: INFLUENCE OF PHYSICO-CHEMICAL GRADIENTS (NORTHERN CÔTE D'IVOIRE)

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ABSTRACT

Aquatic molluscs play an essential role in the functioning of lakes and are commonly used as indicators of water quality. However, their diversity remains little studied in the reservoirs of northern Côte d'Ivoire. This study characterizes the composition and spatio-temporal structure of these communities in Lake Zienkolo (Korhogo). It also evaluates their relationships with the physico-chemical parameters of the water. Sampling was carried out monthly from January to December 2025 at three stations, using a hand net and a Van Veen grab. The collected specimens were then identified in the laboratory. The physicochemical parameters were measured *in situ*. In total, 15 taxa belonging to 8 families, 5 orders, and 2 classes were identified, with a clear dominance of gastropods (98.65%). The Shannon index (1.25–2.03) and Pielou's evenness (0.52–0.84) varied between stations. Monthly variability in abundance and taxonomic richness was also observed during the sampling period. The structural parameters of the communities (abundance, frequency of occurrence, and taxonomic richness) were used to characterize the structure of mollusc communities. The redundancy analysis (RDA) revealed that temperature and dissolved oxygen were the physico-chemical parameters most strongly associated with the distribution of molluscs in Lake Zienkolo. These results highlight the role of environmental factors in structuring mollusc communities and underscore the importance of regular monitoring of the physico-chemical parameters of Lake Zienkolo.

Keywords: Gastropoda, Diversity Indices, Taxonomic Richness, Redundancy Analysis, Korhogo

1 INTRODUCTION

The quality of continental aquatic ecosystems is closely dependent on the structure of their biological communities, among which benthic macroinvertebrates play a decisive role [1]. Of the macroinvertebrates used as bioindicators, molluscs occupy a prominent position because of their sedentary habit and their ability to react to variations in environmental conditions [2]. Their sensitivity to fluctuations in the physico-chemical parameters of water makes them relevant indicators for monitoring the state of hydrosystems [3,4].

Mollusc communities in sub-Saharan Africa have been the subject of several studies, particularly in wetlands and lagoons. Adandedjan et al. [5] showed that the structure of macrobenthic communities in the Porto-Novo lagoon is influenced by mineralization parameters and sediment grain size. The diversity and abundance of gastropods have been characterized in the natural ponds of Ruzizi [6]. Adandedjan et al. [2] also reported spatio-temporal variations of benthic mollusc communities in a coastal lagoon of Benin.

Work on malacofauna in Côte d'Ivoire has historically focused on southern lagoons, particularly the Aby lagoon, where seasonal variations of mollusc communities have been observed [7], and the Ouladine lagoon at Grand-Bassam [8]. These studies mainly addressed the taxonomic composition of assemblages and their relationship with salinity and sediment grain size. More recent studies have been extended to the artificial hydrosystems of the central and southwestern parts of the country, notably the Bouaké [9] and Soubré [4] hydro-agricultural dams, where the distribution of molluscs was recently studied in the river-lake area, as well as the Daloa fish ponds and rice farms [3,10], with emphasis placed on the influence of the physico-chemical parameters of the water on the distribution of species. Studies on molluscs from northern Côte d'Ivoire's dam lakes are still limited. This gap is all the more notable given that the retention lakes in this region are artificial environments whose conditions can influence the composition and distribution of mollusc communities. Lake Zienkolo, located in the Korhogo region, illustrates this category of artificial hydrosystems. No study of its mollusc community has ever been carried out. The characterization of this community and its spatial and temporal variability is thus a prerequisite for ecological monitoring of this hydrosystem. The present study aims to characterize the spatio-temporal structure of mollusc communities in Lake Zienkolo and to identify the influence of physico-chemical gradients on their distribution.

2 MATERIALS AND METHODS

2.1 Study area and sampling sites

Lake Zienkolo is an artificial water body created in the 1970s to support agricultural activities during periods of drought [11]. It is located in the village of Zienkolo, in the department of Korhogo (Poro region), in northern Côte d'Ivoire. Its geographical coordinates are approximately 9°29'16" N and 5°49'35" W (Figure 1). The climate is of the Sudano-tropical type. It comprises a dry season (November-April) and a rainy season (May-October) [12]. The dry season is marked by the harmattan between December and January. Temperatures range from 17 to 36 °C [13]. Annual rainfall ranges between 800 and 1500 mm, with a maximum observed in July and August [14]. The relief consists of gently undulating plateaux, located at altitudes between 300 and 450 m. Granite outcrops are common. This relief favors the formation of shallow, temporary or semi-permanent water bodies, including Lake Zienkolo [15]. The soils are mainly ferruginous and ferralitic on the plateaus. The lowlands are occupied by hydromorphic, sometimes gleyed soils [16]. These characteristics influence water retention, infiltration, evapotranspiration, and the hydrological functioning of the catchment [15].

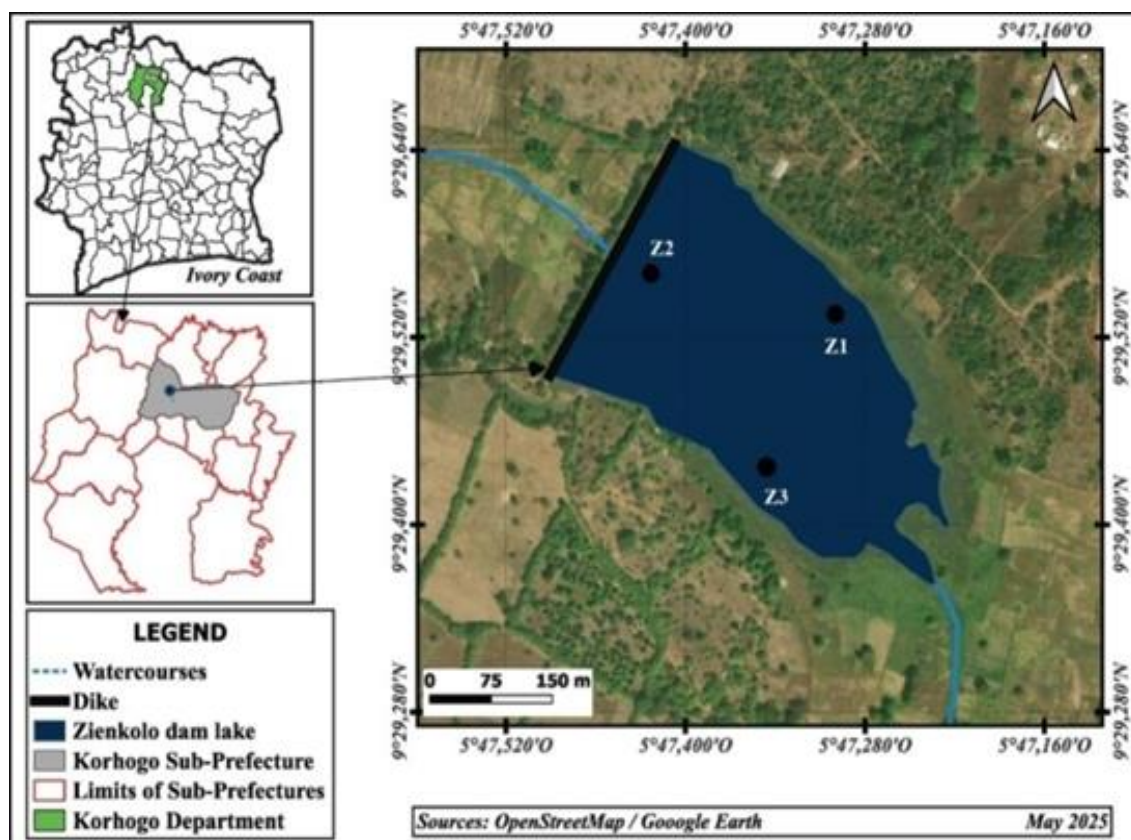


Figure 1: Location of the different sampling stations on Lake Zienkolo

2.2 Mollusc sampling and physico-chemical measurements

Sampling of aquatic molluscs was carried out monthly from January to December 2025. Three stations were monitored, with different levels of anthropogenic pressure (Figure 1). The molluscs were collected using a Van Veen grab and a hand net (400 μm mesh size) between 8 a.m. and 12 p.m. The net was swept over 2 m for 2 minutes, covering a sampled area of 1 m^2 (2 m $\times$ 0.5 m). The benthic macroinvertebrates of the sediment were taken by grab, with three samples of 0.15 m^2 each, for a total surface area of 0.45 m^2 . The samples were kept in one-liter plastic jars containing 70% ethanol. In the laboratory, the molluscs were sorted from all aquatic macroinvertebrates in a glass Petri dish with a gridded background under a binocular microscope at 40 $\times$ magnification. The specimens were counted and identified to the lowest possible taxonomic level with identification keys and reference works. The measurements of the physico-chemical parameters (temperature, pH, dissolved oxygen, conductivity, total dissolved solids, depth and transparency) were made *in situ* between 6 a.m. and 8 a.m. using a HANNA multiparameter probe. The depth of the sampling point was measured with a graduated rod and transparency with a Secchi disc.

2.3 Data analysis

The community structure of molluscs was characterized using species richness, abundance, Shannon-Weaver index, Pielou's evenness and frequency of occurrence. Spatial and seasonal variations were analyzed using statistical tests and redundancy analysis (RDA). Species richness is the total number of species recorded in the environment at a given time [17], and abundance is the total number of individuals counted [18]. The Shannon-Weaver index measures the degree of complexity of the assemblage by combining species richness and relative abundances; it provides an assessment of the structure and balance of the community. Pielou's evenness index [19], which ranges from 0 to 1, reflects the distribution of individuals among taxa and the degree of organization of the assemblage [20]. The frequency of occurrence, on the other hand, expresses the degree of presence of a species in the environment, regardless of its numerical abundance [21]; it allows taxa to be classified according to the following thresholds: constant (%OF $\geq$ 50), accessory ($25 \leq$ %OF < 50), and accidental (%OF < 25). In order to test the significance of these variations, the parameters were subjected to the Kruskal-Wallis and Mann-Whitney tests, respectively for spatial and seasonal variations, with a significance threshold set at 0.05. A redundancy analysis (RDA), performed with CANOCO 4.5, examined the relationships between environmental and biotic variables [22].

3 RESULTS

3.1 Spatial and seasonal variations of physico-chemical parameters

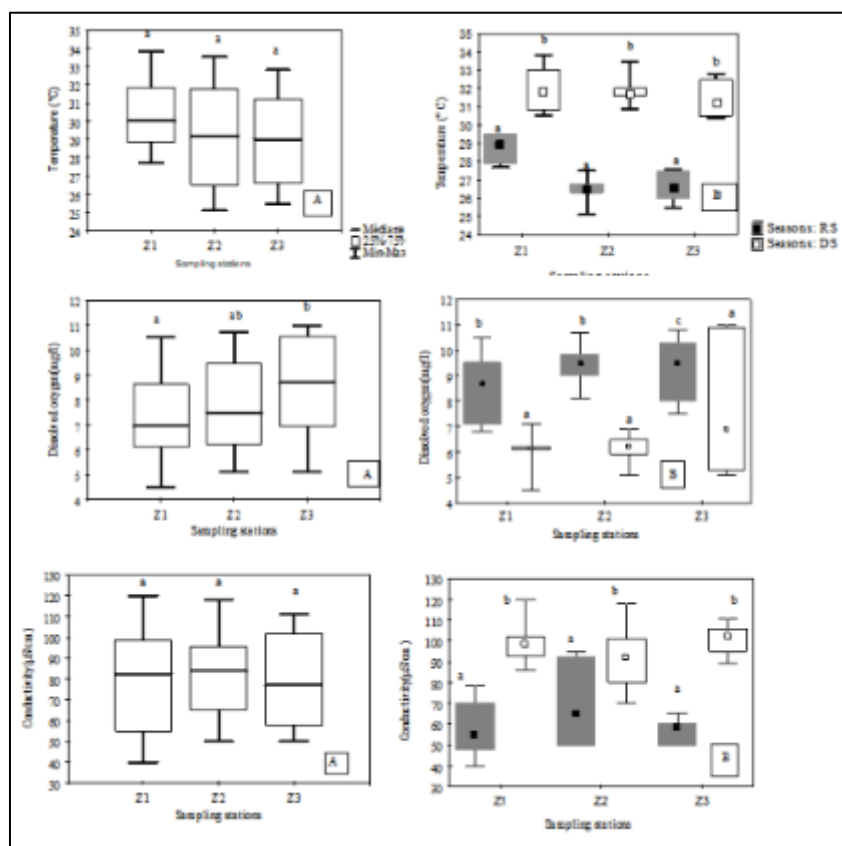


Figure 2: Spatial (A) and seasonal (B) variations in the physico-chemical parameters (Temperature, Dissolved oxygen, and Conductivity) of Lake Zienkolo from January to December 2025: median values sharing at least one common letter (a, b, c, or d) do not differ significantly (Kruskal–Wallis test; $p > 0.05$; Mann–Whitney test; $p > 0.05$). RS = rainy season; DS = dry season

Figure 2 shows the spatial and seasonal variations of physico-chemical parameters (Temperature, Dissolved oxygen, and Conductivity) at the different sampling stations in Lake Zienkolo. Across all stations, the minimum (25.1 °C) and maximum (33.8 °C) temperatures were obtained at stations Z2 and Z1, respectively. The highest median temperature was observed at Z1 (30 °C), while the lowest was recorded at Z3 (29 °C). However, no significant differences were observed between stations (Kruskal–Wallis test, $p > 0.05$). At the seasonal scale, the lowest temperatures were measured during the rainy season, while the highest were observed during the dry season at all stations. Temperatures differ significantly between the two seasons (Mann–Whitney test, $p < 0.05$).

For dissolved oxygen, the minimum (4.5 mg/L) and maximum (11 mg/L) values were recorded at stations Z1 and Z3, respectively. The highest median was noted at Z3 (8.7 mg/L), while the lowest was recorded at Z1 (6.9 mg/L). The Kruskal–Wallis test showed significant spatial variation between stations ($p < 0.05$). The lowest levels were observed during the dry season, while the highest levels were recorded in the rainy season. Median values of dissolved oxygen vary significantly between the two seasons (Mann–Whitney test, $p < 0.05$).

The conductivity varied between 40 µS/cm and 120 µS/cm, these two extremes having been recorded at station Z1. The highest median was obtained at Z2 (84 µS/cm), while the lowest was recorded at Z3 (77 µS/cm). Statistical analysis showed no significant difference between stations (Kruskal–Wallis test, $p > 0.05$). On the other hand, the lowest values were recorded during the rainy season and the highest during the dry season. The median values of conductivity differ significantly between the two climatic seasons (Mann–Whitney test, $p < 0.05$).

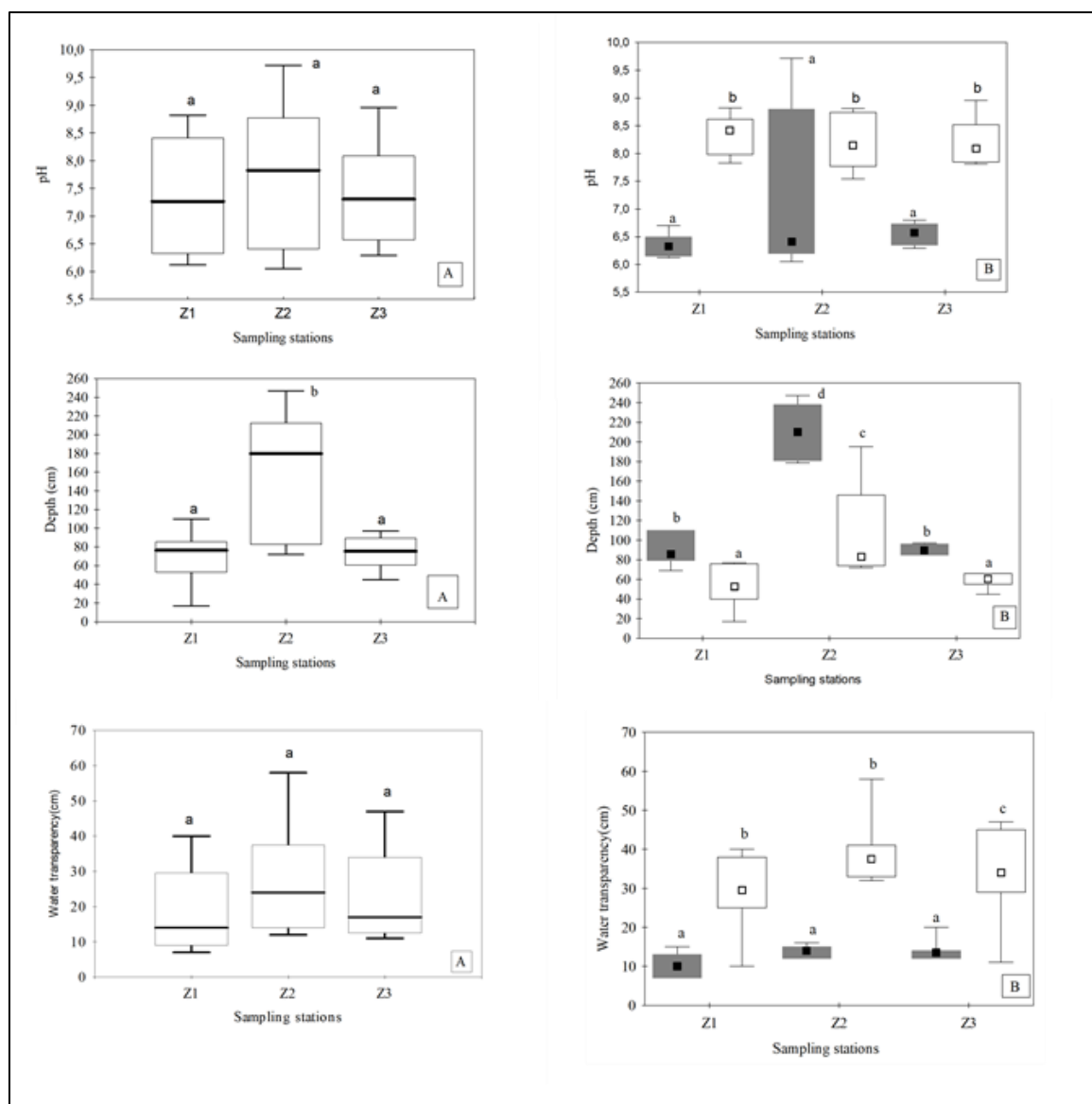


Figure 3: Spatial (A) and seasonal (B) variations in the physico-chemical parameters (pH, Depth, and Transparency) of Lake Zienkolo from January to December 2025: median values sharing at least one common letter (a, b, c, or d) do not differ significantly (Kruskal-Wallis test; $p > 0.05$; Mann-Whitney test; $p > 0.05$). RS = rainy season; DS = dry season.

Figure 3 shows the spatial and seasonal variations of physico-chemical parameters (pH, Depth, and Transparency). The pH values ranged between 6.05 and 9.7, both extremes being observed at station Z2. The highest median was also recorded at Z2 (7.8), while the lowest was obtained at Z1 (7.2). The Kruskal-Wallis test showed no significant spatial difference ($p > 0.05$). At the seasonal scale, the lowest pH values were recorded during the rainy season, in contrast to the highest values observed during the dry season. The pH differs significantly between the two climatic seasons (Mann-Whitney test, $p < 0.05$).

Regarding the depth, the minimum value (17 cm) was obtained at station Z1, while the maximum value (247 cm) was recorded at Z2. The highest median was observed at Z2 (179.7 cm), compared to the lowest at Z3 (75.5 cm). The median values of depth differ significantly from one station to another (Kruskal-Wallis test, $p < 0.05$). The largest depths were measured during the rainy season, while the lowest were recorded in the dry season. The depth also differs significantly between the two climatic seasons (Mann-Whitney test, $p < 0.05$).

The transparency varied between 12 cm at station Z1 and 78 cm at station Z3. The highest median was recorded at Z2 (49.5 cm), while the lowest was observed at Z3 (34 cm). From a spatial point of view, no significant difference was observed between the stations (Kruskal-Wallis test, $p > 0.05$). The lowest values were obtained during the rainy season, while the highest values were recorded during the dry season. Transparency differs significantly between the two climatic seasons (Mann-Whitney test, $p < 0.05$).

3.2 Composition and distribution of molluscs

In the study area, a total abundance of 1,926 individuals of aquatic molluscs was recorded during the sampling period. Spatially, 892 individuals were sampled at Z1, 446 at Z2, and 588 at Z3. This assemblage is largely dominated by gastropods, which account for 98.65% of the organisms collected, while bivalves account for only 1.35%. The phylum Mollusca comprises two classes, divided into five (5) orders, eight (8) families, and fifteen (15) taxa (Table 1): Bivalvia, with one order (Unionoida), one family (Unionidae) and one taxon (*Coelatura* sp.), and Gastropoda, with four (4) orders, seven (7) families and fourteen (14) taxa. Within this last faunal group, the family Thiariidae is the most abundant, with 1,084 individuals, or 56.28% of molluscs; it is also well represented at the three sampling stations, through the single taxon *Melanoides tuberculata*. It is followed by the families Planorbidae (18.80%) and Lymnaeidae (8.93%). The families Viviparidae and Hydrobiidae have more modest proportions (4.98% and 4.05%), while the families Ampullariidae, Physidae and Unionidae are the least abundant, with 3.01%, 2.60% and 1.35% of the assemblage respectively.

The qualitative sampling data are also summarized in Table 1. Station Z3, with 12 taxa, has the highest taxonomic richness. Stations Z1 and Z2 follow, with 11 taxa each. Of the 15 taxa identified in total, only 6 are common to the three stations: *Melanoides tuberculata*, *Lanistes varicus*, *Lymnaea columella*, *Physa acuta*, *Biomphalaria pfeifferi* and *Bulinus globosus*.

Table 1: Taxonomic list of molluscs collected at the different stations of Lake Zienkolo from January to December 2025.

Class	Orders	Family	Taxa	Z1	Z2	Z3
Bivalvia	Unionoida	Unionidae	<i>Coelatura</i> sp.	*	**	
Gastropoda	Cerithioidea	Thiariidae	<i>Melanoides tuberculata</i>	***	***	***
	Littorinimorpha	Ampullariidae	<i>Lanistes varicus</i>	**	*	*
		Hydrobiidae	<i>Gabbiella africana</i>	***		**
		Viviparidae	<i>Bellamya unicolor</i>		*	**
			<i>Viviparus</i> sp.		**	**
	Hygrophila	Lymnaeidae	<i>Lymnaea columella</i>	**	*	*
			<i>Lymnaea natalensis</i>			*
			<i>Radix natalensis</i>	***		*
		Physidae	<i>Physa acuta</i>	*	*	*
		Planorbidae	<i>Biomphalaria pfeifferi</i>	**	***	**
			<i>Bulinus africanus</i>	**	***	
			<i>Bulinus globosus</i>	*	**	*
			<i>Bulinus truncatus</i>	**	***	
			<i>Gyraulus costulatus</i>			*
Total number of taxa			15	11	11	12

(Z1, Z2, Z3): sampling stations; * = Accidental taxa; ** = Accessory taxa; *** = Constant taxa

Stations Z1 and Z2 share the largest number of taxa (3): *Coelatura* sp., *Bulinus africanus* and *Bulinus truncatus*. The Z1-Z3 and Z2-Z3 pairs share fewer, with two taxa each. The first includes *Gabbiella africana* and *Radix natalensis*. The second brings together *Bellamya unicolor* and *Viviparus* sp. Station Z3 contains the most exclusive taxa (2): *Lymnaea natalensis* and *Gyraulus costulatus*. No exclusive taxon was recorded at Z1 or Z2.

Table 2 presents the percentages of constant, accessory and accidental taxa at the three stations. Occurrence frequency was used to distinguish the stable core of the mollusc assemblage (constant taxa) from occasional taxa (accessory and accidental) at each station. The relative contribution of each class differed among stations. *Melanoides tuberculata* was the only taxon constant at all three stations, whereas *Physa acuta* remained accidental throughout (Table 1). The constant taxa varied between 8.33% (Z3) and 36.36% (Z2). The accessory taxa ranged between 27.27% (Z2) and 45.45% (Z1). The accidental taxa were most numerous at Z3 (58.33%) and least numerous at Z1 (27.27%) (Table 2).

Table 2: Percentage per station (%) of the categories of mollusc taxa based on occurrence in Lake Zienkolo from January to December 2025

Stations	Constant taxa (%)	Accessory taxa (%)	Accidental taxa (%)
Z1	27.27	45.45	27.27
Z2	36.36	27.27	36.36
Z3	8.33	33.33	58.33

3.3 Taxonomic richness

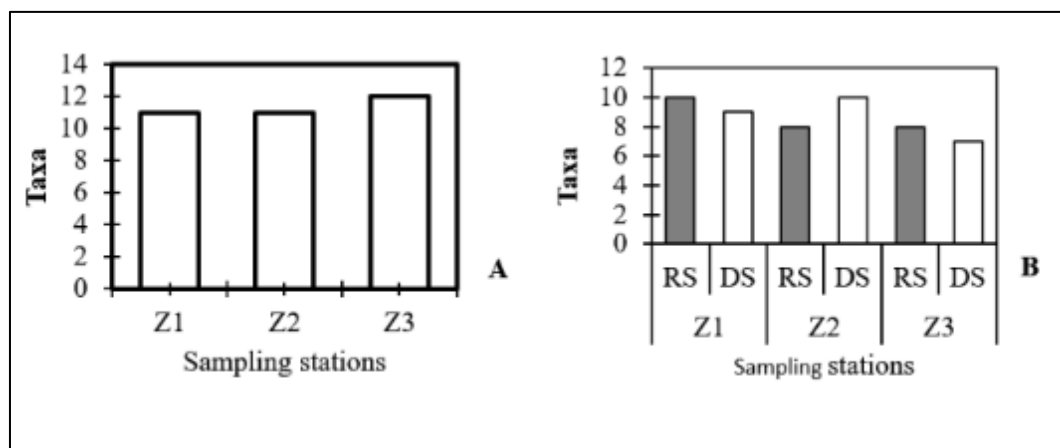
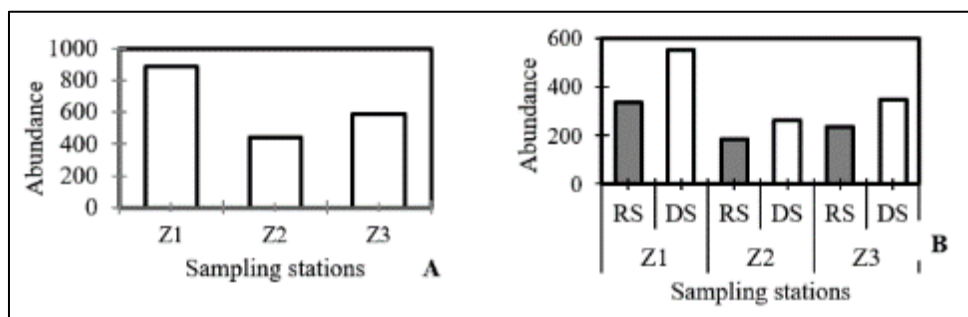
**Figure 4: Spatial (A) and seasonal (B) variation in the taxonomic richness of molluscs in Lake Zienkolo between January and December 2025. RS: rainy season; DS: dry season**

Figure 4 shows the spatial and seasonal variation in taxonomic richness, which varies from 11 to 12 taxa depending on the station. Station Z3 is distinguished by the highest richness (12 taxa), while stations Z1 and Z2 each have 11 taxa. A seasonal variation is also observed: at station Z1, richness is higher in the rainy season (10 taxa) than in the dry season (9 taxa); at station Z3, the same trend is observed (8 taxa in the rainy season against 7 in the dry season). At station Z2, however, the trend is reversed, with richness higher in the dry season (10 taxa) than in the rainy season (8 taxa). The maximum value of taxonomic richness per season (10 taxa) is recorded at station Z1 during the rainy season and at station Z2 during the dry season, while the minimum value (7 taxa) is observed at station Z3 during the dry season.

3.4 Abundance

**Figure 5: Spatial (A) and seasonal (B) variation in the abundance of molluscs in Lake Zienkolo between January and December 2025. RS: rainy season; DS: dry season**

Abundance varies from 446 to 892 individuals depending on the station: Z1 has the highest abundance (892 individuals), followed by Z3 (588 individuals), while Z2 records the lowest value (446 individuals). These spatial and seasonal variations are illustrated in Figure 5. From one season to another, abundance also changes: at all three stations, it is higher in the dry season (DS) than in the rainy season (RS), with 554 individuals compared to 338 at station Z1, 264 against 182 at station Z2 and 350 against 238 at station Z3. The maximum value of seasonal abundance (554 individuals) is recorded at station Z1 during the dry season, while the minimum value (182 individuals) is observed at station Z2 during the rainy season (Figure 5).

3.5 Shannon diversity index

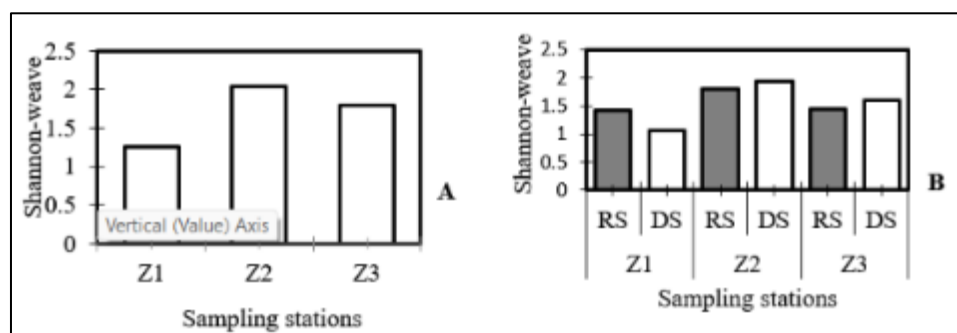


Figure 6: Spatial (A) and seasonal (B) variation of the Shannon index in Lake Zienkolo between January and December 2025. RS: rainy season; DS: dry season

Figure 6 illustrates the spatial and seasonal variation of the Shannon diversity index, which varies from 1.25 to 2.03 depending on the station. The highest value is recorded at Z2 (2.03), followed by Z3 (1.79), while Z1 displays the lowest value (1.25). Seasonally, differences are also observed between stations: at Z1, the index is higher in the rainy season (1.42) than in the dry season (1.06), whereas at Z2 and Z3, the trend is reversed, with higher values in the dry season Z2 (1.93) and Z3 (1.59) than in the rainy season Z2 (1.81) and Z3 (1.44).

3.6 Pielou's evenness index

Evenness varies from 0.52 to 0.84 among stations. The highest value is recorded at Z2 (0.84), followed by Z3 (0.72), while Z1 has the lowest value (0.52). Seasonal variation also depends on the station: at stations Z1 and Z2, evenness is higher in the rainy season than in the dry season, with 0.61 compared to 0.48 at Z1 and 0.87 compared to 0.84 at Z2. At Z3, however, the trend is reversed, with a higher evenness in the dry season (0.81) than in the rainy season (0.69). The maximum value of evenness per season (0.87) occurs at Z2 in the rainy season, while the minimum value (0.48) is observed at Z1 in the dry season (Figure 7).

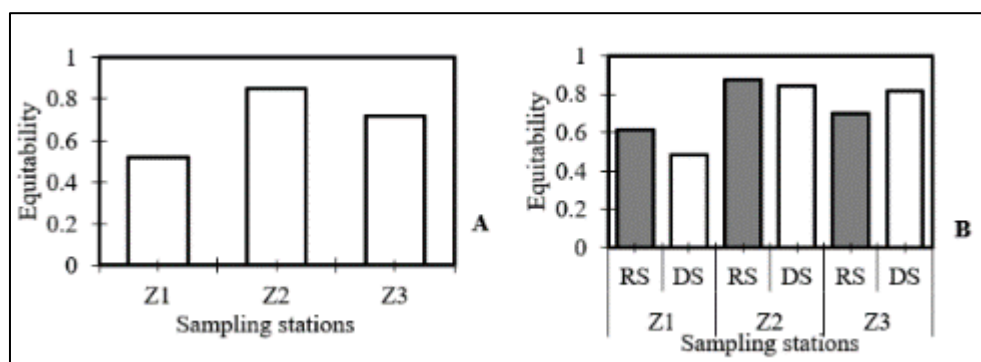


Figure 7: Spatial (A) and seasonal (B) variation in the evenness of mollusc communities in Lake Zienkolo between January and December 2025. RS: rainy season; DS: dry season

3.7 Influence of environmental variables on the distribution of aquatic molluscs in Lake Zienkolo

A canonical redundancy analysis (RDA) (Figure 8) was carried out to study the relationships between environmental parameters and the distribution of molluscs in Lake Zienkolo. The first two axes alone explain 88.5% of the total variance, with 65% for axis 1 and 23.5% for axis 2. These two axes were therefore retained for the interpretation of the results. Temperature and dissolved oxygen appear to be the environmental variables most associated with the distribution of aquatic molluscs in Lake Zienkolo. On axis 1, there is a strong positive association between *Radix natalensis*, *Lymnaea columella* and station Z1, on the one hand, and temperature, on the other. It is, however, negative with transparency, pH, conductivity and depth, variables associated with *Biomphalaria pfeifferi*, *Bulinus truncatus*, *Viviparus* sp. and *Bulinus africanus*, grouped at station Z2. On axis 2, *Physa acuta*, associated with station Z3, is positively correlated with dissolved oxygen, while *Gabbiella africana* and *Melanoides tuberculata* occupy an intermediate position in the factorial plane, without a marked association with a dominant variable.

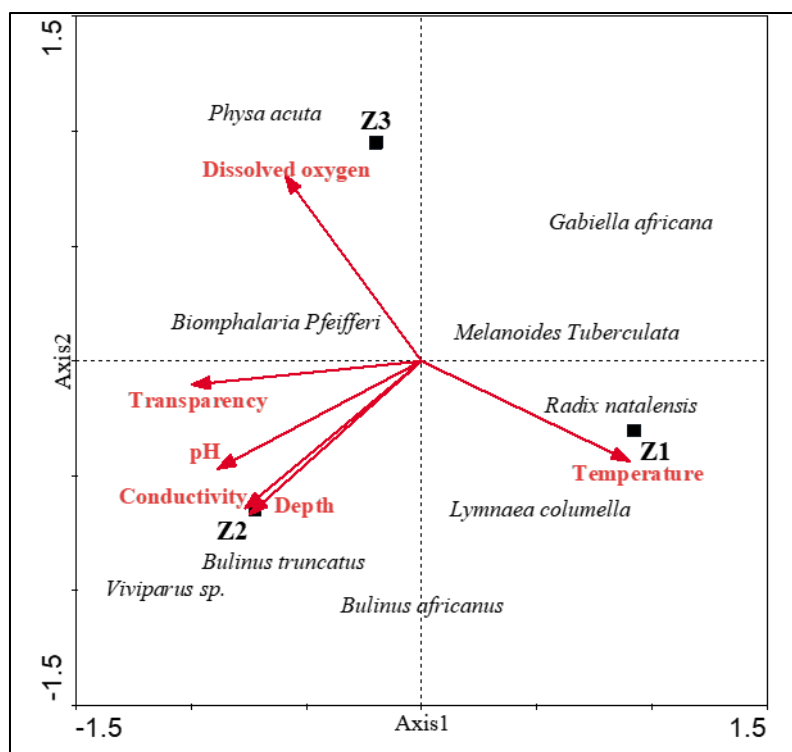


Figure 8: Redundancy analysis showing the relationships between environmental variables and molluscs collected in Lake Zienkolo from January to December 2025. (Z1, Z2, Z3): sampling stations

4 DISCUSSION

4.1 Physico-chemical parameters

The temperatures recorded in Lake Zienkolo (25.1–33.8 °C) show a seasonal variation. Sanogo and N’doufou [23] also reported, in northern Côte d’Ivoire, that variations in physico-chemical parameters depend more on season than on the position of the stations. The values observed at Zienkolo are close to those reported by Yapo et al. [24] in the Koko and Natiokobadara lakes at Korhogo (18.6–31.9 °C), but with higher minima. This difference could be related to depth or wind exposure.

Dissolved oxygen concentrations vary between stations (4.5–11 mg/L), with maximum values higher than those reported by Yapo et al. [24] in Korhogo (3.99–6.84 mg/L). This variability may reflect depth, aquatic vegetation or local mixing. A similar trend was observed by Aimé et al. [25] in small dams in the north of the country, where dissolved oxygen and pH were among the most sensitive parameters to station position. Seasonally, dissolved oxygen levels decrease in the dry season with increasing temperature and then increase in the rainy season as the water cools and is renewed.

At Zienkolo, the conductivity varies between stations (40–120 $\mu\text{S}/\text{cm}$), reflecting a relatively low mineralization. These values remain within the range reported by Yapo et al. [24] for the Korhogo lakes (32.9–272.2 $\mu\text{S}/\text{cm}$). Low mineralization was also observed by Boua et al. [26, 27] in three dam lakes of the same department. In this work, however, conductivity was not a major discriminating parameter. It increases in the dry season, probably due to the concentration of salts linked to evaporation, then decreases in the rainy season through dilution. The pH values (6.05–9.7) indicate slightly acidic to alkaline waters, with greater variability than in the Korhogo lakes (6.71–7.79; [24]). This variability differs from that observed by Aimé et al. [25] in the small northern dams, where pH was among the discriminating parameters. It could be linked to the small size of the dams or to the intensity of human use. Conversely, Kouamé et al. [28] observed low spatial pH variability in Lake Buyo. Seasonally, the higher dry season values could be explained by photosynthetic activity, which reduces dissolved CO_2 and increases pH [29]. In the rainy season, their decrease may be attributed to inputs of weakly mineralized, naturally acidic rainwater. A similar seasonal evolution of pH, dissolved oxygen and transparency was reported by Motchié et al. [30] in Lake Sokotè. At Zienkolo, depth is greater during the rainy season, when water inputs are higher. This variation could be linked to the characteristics of the catchment. N’Da et al. [31] also showed physico-chemical differences between the Nanan and Zatta dams at Yamoussoukro. Despite their proximity, the Nanan dam has warmer and more mineralized waters. The transparency, between 12 and 78 cm, varies little between stations. It decreases in the rainy season, probably due to runoff, then

increases in the dry season with the settling of suspended particles. These results suggest that seasonal variations could have a greater influence on the physico-chemical characteristics of the lake than the position of the stations.

4.2 Composition, structure, and spatio-temporal distribution of mollusc communities

Of the 1,926 molluscs collected, gastropods clearly dominate (98.65%) over bivalves (1.35%), as observed at Soubre [4] and Daloa [10, 3]. The Thiariidae are the dominant family (56.28%), represented only by *Melanoides tuberculata*, a constant taxon at all three stations. Its presence could be linked to its high ecological plasticity, rapid growth [32], reproduction by parthenogenesis and the alkaline waters favorable to its colonization [10, 3]. Mollusc abundances are higher in the dry season at stations Z1 (554), Z2 (264) and Z3 (350), probably due to the stabilization of microhabitats and the concentration of populations during the partial drawdown of water. Conversely, floods during the rainy season can disrupt these poorly mobile organisms, despite the seasonal development of aquatic vegetation [33, 34, 35].

The Shannon and Pielou indices show differences in community structure between stations. The Z2 station has the highest values of diversity (2.03) and evenness (0.84), with a substantial proportion of constant taxa (36.36%), suggesting a relatively diverse and balanced community. Conversely, station Z1 has the lowest values (Shannon 1.25; evenness: 0.52), with a decrease in the Shannon index to 1.06 during the dry season. This decline could be linked to the strong dominance of *Melanoides tuberculata*. Such an imbalance can be associated with environments subject to anthropogenic or organic pressures, where tolerant and opportunistic taxa may become dominant [36, 37, 38]. A comparable situation was reported in an urban reservoir of Ouagadougou (Burkina Faso), where the proliferation of *Melanoides tuberculata* was associated with domestic and industrial discharges from the catchment area [39]. At station Z3, despite the highest taxonomic richness (12 taxa), the community remains characterized by a high proportion of accidental taxa (58.33%) and only one constant taxon.

Redundancy analysis (RDA) highlights associations between environmental variables and mollusc distribution. Temperature is associated with the presence of *Radix natalensis* and *Lymnaea columella* at Z1. At Z2, pH, conductivity, transparency, and depth are associated with the distribution of *Biomphalaria pfeifferi*, *Bulinus truncatus*, *Viviparus* sp. and *Bulinus africanus*. At station Z3, dissolved oxygen is mainly associated with the presence of *Physa acuta*. These results suggest that the distribution of molluscs is related to variations in hydrochemical conditions between stations. These conditions may also be influenced by the characteristics of the catchment and the activities taking place there [40,4]. This study is based on a single annual cycle and three stations in one lake. Its findings cannot be generalised or interpreted causally. Future surveys should span several years, cover more sites and include habitat descriptors.

5 CONCLUSION

The first study of the mollusc community of Lake Zienkolo shows that physico-chemical parameters influence the distribution of molluscs. Spatially, only dissolved oxygen and depth show significant variation among stations. Seasonally, temperature, pH, conductivity, transparency, dissolved oxygen and depth all vary. Temperature, pH, conductivity and transparency increase in the dry season, while dissolved oxygen and depth are higher in the rainy season. Temperature and dissolved oxygen appear to be the most important environmental variables. The families Thiariidae and Planorbidae quantitatively dominate the malacological community. *Melanoides tuberculata*, *Biomphalaria pfeifferi* and *Bulinus truncatus* are among the most represented taxa. This monitoring identified the main spatio-temporal trends in the physico-chemical characteristics and the malacological community of the lake. It should nevertheless be continued over several years. This would consolidate these results and clarify the effect of inter-annual variations on the ecosystem.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

Authors contribution

- Junior Yomi SIMMOU : conceived the study, defined the methodology, identified the taxa, performed the analyses and wrote the first draft of the manuscript
- Claver Kémomadjèhi DJIRIEOULOU : carried out the fieldwork and managed the data.

- Magouana Paul Morgane ANVO: participated in the fieldwork and carried out the laboratory work.
- Laurince Michel YAPO : contributed to the analyses and data visualization, and to the review and revision of the manuscript.

All authors have read and approved the final version of the manuscript.

REFERENCES

- [1] Simmou YJ, Kouadio KN, Konan YA, Koné T, Kouassi KP. Benthic macroinvertebrates community composition, abundance and distribution in three Lagoons (Aby, Tendo and Ehy) (Côte d'Ivoire). *International Journal of Entomology Research*. 2019;4(4):148-56.
- [2] Adadedjan D, Chikou A, Ahouansou S, Laleye P, Gourene G. Spatio-temporal variations of benthic mollusc communities in a coastal lagoon of Benin. *Cahiers du CBRST*. 2014; 5:46-78.
- [3] Kressou A, Djene KR, Allouko JR, Bony KY. Composition and distribution of aquatic molluscs in relation to water quality in rice and fish ponds in Daloa city (Centre-West, Côte d'Ivoire). *International Journal of Zoological and Entomological Letters*. 2022; 2(1):11-6.
- [4] Gougloin THE, Dietoa YM, Tah L. Inventory of aquatic molluscs in the Soubré river-lake dam area to assess the biological status of this aquatic ecosystem (Sassandra River, Côte d'Ivoire, West Africa). *International Journal of Advanced Research*. 2023;11(7):725-36. doi:[10.21474/IJAR01/17281](https://doi.org/10.21474/IJAR01/17281)
- [5] Adadedjan D, Ahouansou Montcho S, Chikou A, Lalèye P, Gourène G. Characterization of benthic macroinvertebrate assemblages using the self-organizing map (SOM). *Comptes Rendus Biologies*. 2013;336(5-6):244-8. doi:[10.1016/j.crv.2013.04.009](https://doi.org/10.1016/j.crv.2013.04.009)
- [6] Rukahusa SR, Shekani AC, Bugabanda NN, Kumbusa TP. Diversity and relative abundance of gastropod molluscs in the wetlands of the lower Ruzizi plain, eastern Democratic Republic of the Congo. *Afrique Science*. 2020; 16(5):261-71.
- [7] Kouadio KN, Soro N, Akadje CMA, Konan KM, Diomandé D. Seasonal variation of mollusc's community living in a tropical lagoon (Aby lagoon, Côte d'Ivoire). *Journal of Biodiversity and Environmental Sciences*. 2019; 15(4):32-42.
- [8] Keumean KN, Koffi BY, Ahoussi KE, Gonehi BTA. Impact of urban waste on the water quality of the Ouladine Lagoon (Grand-Bassam, South-East of the Ivory Coast). *American Journal of Environmental Protection*. 2022;11(4):103-9. doi:[10.11648/j.ajep.20221104.13](https://doi.org/10.11648/j.ajep.20221104.13)
- [9] Diakité NR, Ouattara M, Bassa FK, Coulibaly G, N'Goran EK. Diversity and dynamics of the malacological fauna during the establishment of a hydro-agricultural dam, Bouaké, central Côte d'Ivoire. *Journal of Applied Biosciences*. 2024;193:20455-66. doi:10.35759/JABs.193.2
- [10] Allouko JR, Kressou A, Djéné KR, Bony KY. Influence of physico-chemical parameters on the distribution of aquatic molluscs in rice and fish ponds of Daloa city (Centre-West, Côte d'Ivoire). *International Journal of Innovation and Applied Studies*. 2022;35(4):513-22.
- [11] Le Guen T. The dams of northern Côte d'Ivoire: socio-economic development and health status of the populations [PhD thesis]. University of Western Brittany; 2002.
- [12] Kouassi KD, Diaby M, Soro Y, N'da K. Ichthyofauna of the Solomougou dam lake (Korhogo, Côte d'Ivoire). *International Journal of Biological and Chemical Sciences*. 2020;14(7):2528-37. doi:[10.4314/ijbcs.v14i7.13](https://doi.org/10.4314/ijbcs.v14i7.13)
- [13] Koudou D, Silué PP, Kouadio NKF, Alla KA. Fish farming projects in northern Côte d'Ivoire, a tool for regional aquaculture development: 40 years later. In: Soumahoro M, editor. *Agriculture, fisheries and local development in sub-Saharan Africa*. Éditions Fer de Lance; 2020. p. 219-40.
- [14] Assemian AE, Sangre Y, Koffi KA. Analysis of hydrological and meteorological droughts in the sub-prefecture of Korhogo, Sudanian tropical zone of northern Côte d'Ivoire. *DaloGéo*. 2023;008:29-44.
- [15] Soro TA, Silué KD, Gogbé ZM, Coulialy L, Gooré Bi G. Physico-chemical parameters of the waters of the Upper Bandama basin (Côte d'Ivoire). *Revue Ivoirienne des Sciences et de la Technologie*. 2021;27(1):33-48.
- [16] Yao KM, Ahoussi KE, Kouassi N. Role of rural water reservoirs in water management in northern Côte d'Ivoire. *Journal of Water and Land Development*. 2015;25:35-42.
- [17] Aliaume C, Lasserre G, Louis M. Spatial organization of fish assemblages in *Thalassia* beds of the Grand Cul-de-Sac Marin in Guadeloupe. *Revue d'Hydrobiologie Tropicale*. 1990;23:231-50.
- [18] Ramade F. *Elements of ecology: fundamental ecology*. Dunod; 2003.
- [19] Pielou EC. *An introduction to mathematical ecology*. Wiley Interscience; 1969.

- [20] Amanieu M, Lasserre G. Organization and evolution of lagoon assemblages. *Oceanologica Acta*. 1982;4:201-13.
- [21] Dajoz R. Handbook of ecology: fundamental and applied ecology. 7th ed. Dunod; 2000.
- [22] Ter Braak CJF, Smilauer P. CANOCO reference manual and CanoDraw for Windows user's guide: software for canonical community ordination. Version 4.5. Microcomputer Power; 2002.
- [23] Sanogo GD, N'doufou GHC. Computational statistical approach to the spatial and temporal variation of physico-chemical parameters in the upper Bandama basin (northern Côte d'Ivoire). *International Journal of Biological and Chemical Sciences*. 2026;20(2):1066-82. doi:10.4314/ijbcs.v20i2.41
- [24] Yapo ML, Boua DP, Koné KN, Diomandé D. Assessment of aquatic insect species composition, abundance and diversity within two dam lakes in Korhogo: Koko and Natiokobadara (Northern Côte d'Ivoire). *International Journal of Fisheries and Aquatic Studies*. 2020;8(5):282-8.
- [25] Aimé SL, Berté S, N'da SA, Koné N. First inventory of aquatic intervebrtates from some small dams in central and northern Côte d'Ivoire. *European Scientific Journal*. 2022;18(24):165. doi:10.19044/esj.2022.v18n24p165
- [26] Boua DP, Yapo ML, Gogbe ZM. Ecological status of three sub-Saharan dam lakes based on macroinvertebrates community (Côte d'Ivoire, West Africa). *International Journal of Zoology and Applied Biosciences*. 2024;9(6):43-9. doi:10.55126/ijzab.2024.v09.i06.007
- [27] Boua DP, Kra KM, Yapo ML. Diversity and distribution of macroinvertebrates in three dam lakes of Korhogo department (Côte d'Ivoire): influence of environmental parameters. *International Journal of Entomology Research*. 2025; 10(5):39-46.
- [28] Kouamé HA, Attoungbré SK, Boussou CK, Kouamé MK, Edia OE. Structure of the macroinvertebrate population of Lake Buyo (Guessabo, west Côte d'Ivoire). *World Journal of Advanced Research and Reviews*. 2022; 15(2):682-92. doi:10.30574/wjarr.2022.15.2.0859
- [29] Wetzel RG. Limnology: lake and river ecosystems. 3rd ed. Academic Press; 2001.
- [30] Motchié FE, Konan YA, Gooré BG, Etilé NR, Yao SS. Diversity of benthic macroinvertebrates and biotic indices to evaluate water quality in Lake Sokotè (Côte d'Ivoire). *Journal of Biodiversity and Environmental Sciences*. 2020; 16(4):53-60.
- [31] N'da AS, Koné N, Coulibaly S, Odoukpé KSG, Berté S. Benthic macroinvertebrates structure of two agropastoral dams, Nanan and Zatta: Yamoussoukro, Côte d'Ivoire. *Journal of Advances in Biology & Biotechnology*. 2022;25(10):13-23. doi:10.9734/jabb/2022/v25i10600
- [32] Kouamé MK, Diétoa MY, Da Costa SK, Edia EO, Ouattara A, Gourène G. Aquatic macroinvertebrate assemblages associated with root masses of water hyacinths, *Eichhornia crassipes* (Mart.) Solms-Laubach, 1883 (Commelinales: Pontederiaceae) in Taabo Lake, Ivory Coast. *Journal of Natural History*. 2010; 44(5-6):257-78. doi:10.1080/00222930903457208
- [33] Kabré TA, Dinguiné D, Bouda S. Effect of the shrinking of the water surface area on the macroinvertebrates of the Comoé dam lake, south-western Burkina Faso. *Science et Technique, série Sciences Naturelles et Agronomie*. 2002;26(1):37-49.
- [34] Kouamé MK, Dietoa MY, Edia OE, Da Costa SK, Ouattara A, Gourène G. Macroinvertebrates communities associated with macrophyte habitats in a tropical man-made lake (Lake Taabo, Côte d'Ivoire). *Knowledge and Management of Aquatic Ecosystems*. 2011;(400):03. doi:10.1051/kmae/2010035
- [35] Sanogo S, Kabré JAT, Cecchi P. Inventory and spatio-temporal distribution of bioindicator macroinvertebrates of three water bodies of the Volta basin in Burkina Faso. *International Journal of Biological and Chemical Sciences*. 2014; 8(3):1005-29. doi:10.4314/ijbcs.v8i3.16
- [36] Tauzin D. Use of benthic macroinvertebrates to assess the degradation of river water quality in Quebec [master's thesis]. Laval University; 2008.
- [37] Karrouch L, Chahlaoui A. Bio-évaluation de la qualité des eaux de l'Oued Boufekrane, Meknès, Maroc. *Biomatec Echo*. 2009;3(6):6-17.
- [38] Tachet H, Richoux P, Bournaud M, Usseglio-Polatera P. Invertébrés d'eau douce: systématique, biologie, écologie. CNRS Éditions; 2010.
- [39] Ouedraogo I, Kpoda NW, Oueda A, Bance V, Mano K, Kabre GB. Establishment of an invasive snail *Melanoides tuberculata* (Müller, 1774) in a Sahelian urban reservoir in Ouagadougou, Burkina Faso. *BioInvasions Records*. 2023;12(3):797-808. doi:10.3391/bir.2023.12.3.15
- [40] Bond NR, Downes BJ. The independent and interactive effects of fine sediment and flow on benthic invertebrate communities characteristic of small upland streams. *Freshwater Biology*. 2003; 48:455-65. doi:10.1046/j.1365-2427.2003.01016.x