INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 26, No. 6, p. 66-73, 2025
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Characterisation of bioecological traits of aquatic macroinvertebrates in some agro-pastoral Dams in Tchologo (Ivory Coast)

Berté Siaka[1], Aimé Louis Stevens[*2], Kouyaté Kassoum[3]

[1]*Biosciences UFR, Laboratory of Natural Environment and Conservation of Biodiversity, Felix Houphouët-Boigny University, Abidjan, Ivory Coast*

[2]*Medical and Veterinary Entomology Center, Alassane Ouattara University, Bouaké, Ivory Coast*

[3]*UFR Science et Technology, Alassane Ouattara University, Bouaké, Ivory Coast*

Article published on June 05, 2025

Key words: Aquatic macroinvertebrates, Bioecological traits, Dams, Ivory Coast

Abstract

Global index methods based on aquatic macroinvertebrates are commonly used in bioindication. However, these global index methods cannot be used to diagnose the real causes of degradation. This study therefore aims to integrate recent theoretical advances linking the bioecological strategies of organisms (maximum size, life cycle, food type, feeding mode, respiration and locomotion) to disturbances in their environment. Five (05) reservoirs were visited. Sampling took place from June 2016 to June 2018. A total of 68 taxa were identified, divided into 35 families, 11 orders and 3 classes (Achaetes, Gastropods and Insects). The analysis of the bioecological characteristics of macroinvertebrates in the aquatic environments of the hydrosystems studied in the north of Côte d'Ivoire showed that The Torla, Korokara, Noumousso and Mambiadougou dams would be characteristic of resilience with small organisms, short life cycle and tegumentary respiration, whereas the Sambakaha station would be characteristic of resistance with small organisms, short life cycle and aerial respiration.

[*]Corresponding Author: Aimé Louis Stevens ✉ loiusstev@yahoo.fr

Introduction

Aquatic macroinvertebrates are organisms visible to the naked eye (larger than 0.5 mm) that spend at least part of their life cycle in water. Aquatic macroinvertebrates are the source of many biotic indices, most of which are based on the abundance or richness of a number of indicator taxonomic groups (Tachet *et al.*, 2010). These biotic indices provide a much more accurate picture of the integrity of an ecosystem (Tenkiano, 2017). However, according to (Archaimbault *et al.*, 2010), non-taxonomic measures such as biological and ecological traits can also provide a wealth of information. In fact, biological and ecological traits bring together all the qualitative and quantitative information related to the biology of organisms and their relationships with the environment. This means that the bio-ecological trait approach provides a more comprehensive picture than the traditional taxonomy-based approach and allows for a better understanding of ecosystem functioning (Bremner, 2008). As well as having the potential to identify anthropogenic disturbances and discriminate between different types of pollution, bio-ecological traits do not require large field approach or laboratory equipment (Kra, 2020). The aim of this study is to determine the bioecological characteristics of macroinvertebrates in a number of dams in the north of Ivory Coast.

Materials and methods

Study sites

The dams studied are located in the north of Ivory Coast in the Tchologo region, specifically at Ouangolodougou and Ferkessédougou. This region has a subtropical climate. These two climates have two seasons : a dry season from November to March and a rainy season from April to October (Aime, 2022). The hydrological regime in the north is characterised by a single flood (August to October), a low water period in November, June and July, very little run-off in the months preceding the high water period (April and May) and a very pronounced low water period with very little run-off (December) or none at all (January, February and March) (Goula, 2006). To carry out this work, five (05) agro-pastoral dams were selected in the Tchologo region of northern Ivory Coast (Fig. 1). These dams are Torla, Mambiadougou, Korokara, Noumousso in the department of Ouangolodougou and Sambakaha in the department of Ferkessédougou. The criteria used to select these stations were the perenniality of the water, the accessibility of the station in all seasons, the diversity of habitats and the availability of resources.

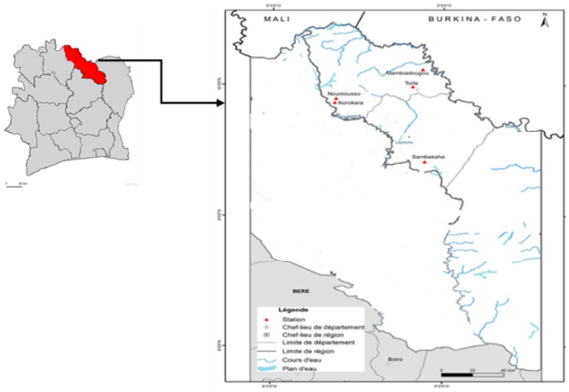

Fig. 1. Geographical location of study sites and sampling stations from June 2016 to June 2018

Data collection

The different sampling campaigns were carried out between June 2016 and June 2018. Aquatic macroinvertebrate samples were collected using a Van Veen bucket and sieve. The samples were washed and fixed with 5% formaldehyde in labelled jars. In the laboratory, organisms were sorted, identified to the lowest taxonomic level using identification books (Durand et Lévêque, 1980 ; Dejoux *et al.*, 1981 ; Moor and Day, 2002 ; Moisan, 2010) then counted.

Data processing

Bioecological traits are variables that describe the biological and ecological potential of taxa (Statzner and Bêche, 2010). The use of bioecological traits in aquatic macroinvertebrates to assess water quality is independent of seasonal conditions (Charvet, 1999). To assess water quality on the basis of bioecological, he first step is to select the bioecological traits. Thus, from the 22 bioecological traits described by Tachet *et al.* (2010), 06 traits comprising 39 modalities were selected for this study based on the availability of a priori predictions in

the literature (Kra, 2020). These are maximum size, life cycle, food type, feeding mode, respiration and locomotion mode (Table 1) (Kra, 2020).

Table 1. Bioecological traits of selected aquatic macroinvertebrates and their corresponding modalities (= category)

Traits	Codes	Modalites
1- Maximum size (mm)	TM1	< 2,5
	TM2	2,5 - 5
	TM3	5 - 10
	TM4	10 - 20
	TM5	20 - 40
	TM6	40 - 80
	TM7	> 80
2- Life cycle (duration)	CV1	≤ 1 year
	CV2	> 1 year
3- Type of food	TN1	fine sediment + micro-organisms
	TN2	Plant debris < 1 mm
	TN3	plant debris >1 mm
	TN4	live microphytes
	TN5	macrophytes vivants
	TN6	dead animals > 1 mm
	TN7	microinvertébrés vivants
	TN8	living macroinvertebrates
	TN9	vertebrates
4- Feeding mode	MA1	absorption through the integuments
	MA2	thin sediment eater
	MA3	shredder
	MA4	scraper, grazer
	MA5	filter-feeding
	MA6	burglar (algivore or sucker predator)
	MA7	predator (Cut or swallow)
	MA8	parasite
5- Respiration	RP1	integuments
	RP2	branchia
	RP3	plastron
	RP4	stigmata (aerial respiration)
	RP5	hydrostatic vesicle
6- Mode of locomotion	LO1	flying
	LO2	surface swimmer
	LO3	Pelagic Swimmer (plankton, nekton)
	LO4	rampant
	LO5	digger (épibenthic)
	LO6	endobenthic (interstitial)
	LO7	temporary fixation
	LO8	permanent fixation

Fuzzy coding was then used to code the bioecological traits of the taxa. Fuzzy coding makes it possible to assign to the different taxa encountered a value that quantifies the affinity of these taxa for the different modalities of a given bioecological trait (Chevenet *et al.*, 1994). For each taxon, an affinity score is assigned to each of the modalities of a given trait. This affinity score can be divided into four [0-3] or six [0-5] levels and provides an estimate of the actual frequency of use of the modality by the taxon. According to Chevenet *et al.* (1994) each affinity level can be given a verbal meaning, e.g. for a coding with four affinity levels the numerical translations (arbitrary) are 0 = 'never', 1 = 'sometimes', 2 = 'often' and 3 = 'generally'. The choice of the number of affinity levels used to code a taxon depends on the number of categories defined within the described character and the underlying biological complexity.

Taxonomic abundances are then coupled with bioecological traits to produce a frequency distribution of modalities (Tachet, 2010). For this purpose, a database of taxon abundances per station was constructed. The listed taxa were then coded in a second database using an affinity score according to Tachet (2010). The linkage involved multiplying the affinities of the character modalities by the abundance of each taxon per station. For each station, the sums obtained for the different trait modalities can be expressed as a frequency distribution. This frequency distribution is presented graphically.

Finally, an analysis of the frequency distribution of bioecological trait modalities was carried out to provide a diagnosis of the ecological status of the environment (Tachet, 2010). The analysis of the distribution of relative frequencies of bioecological trait modalities was carried out using the method of Tachet (2010). This method characterises the environment by the frequency of the highest modality for a given trait.

Results

Global analysis of abundance

Analysis of the taxonomic composition of all stations in the north revealed 68 taxa in 35 families, 11 orders and 3 classes (Achaetes, Gastropoda, Insects). A total of 2628 aquatic macroinvertebrates were collected from all stations in the north. Most of these organisms were collected at the Korokara station (45%) (Fig. 2). Insects were the most abundant aquatic

macroinvertebrates in the northern study area. They represent 98.15% of the samples. They are followed by gastropods (1.56%) and achaete (0.29%) (Fig. 3).

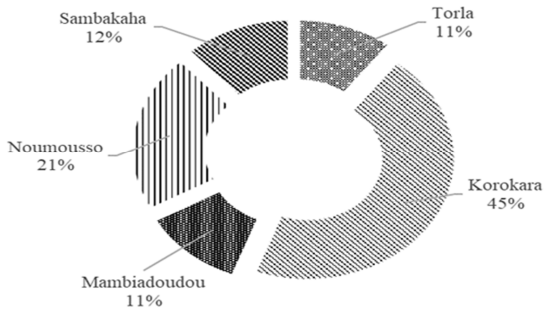

Fig. 2. Relative abundance of aquatic macroinvertebrates collected at the different sampling stations in the northern zone of Ivory Coast studied

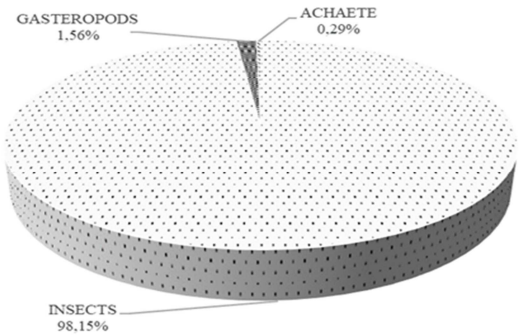

Fig. 3. Relative abundances of main aquatic macroinvertebrate classes collected in the northern zone of Ivory Coast

Frequency distribution of bioecological traits in aquatic macroinvertebrates in central ivory coast

Organisms in the size class [10-20] mm (TM4) dominate at all northern stations. However, the frequency value for the [10-20] mm size class (TM4) is highest at the Mambiadougou station (Fig. 4A). Organisms with a life cycle of less than one (1) year (CV1) are relatively dominant in the northern sampling stations, except at Sambakaha station where organisms with a life cycle of more than one (1) year (CV2) dominate (Fig. 4B). In terms of food type (TN), organisms consuming detritus smaller than 1 mm (TN2) dominated at Torla, Korokara, Noumousso and Mambiadougou stations. On the other hand, at the Sambakaha station, organisms consuming live macroinvertebrates (TN8) dominated (Fig. 4C). In terms of feeding mode, organisms feeding on fine sediments (MA2) dominated at Torla, Korokara, Noumousso and Mambiadougou stations. In contrast to the other northern stations, crushing organisms (MA3) dominate at Sambakaha (Fig. 4D). In terms of respiration, tegumen-breathing organisms (RP1) dominate at Torla, Korokara, Noumousso and Mambiadougou stations. In terms of locomotion, crawling organisms (LO4) dominate the aquatic macroinvertebrate communities at the Torla, Korokara, Noumousso and Mambiadougou stations, whereas open-water swimmers (LO3) are in the majority at the Sambakaha station (Fig. 4F).

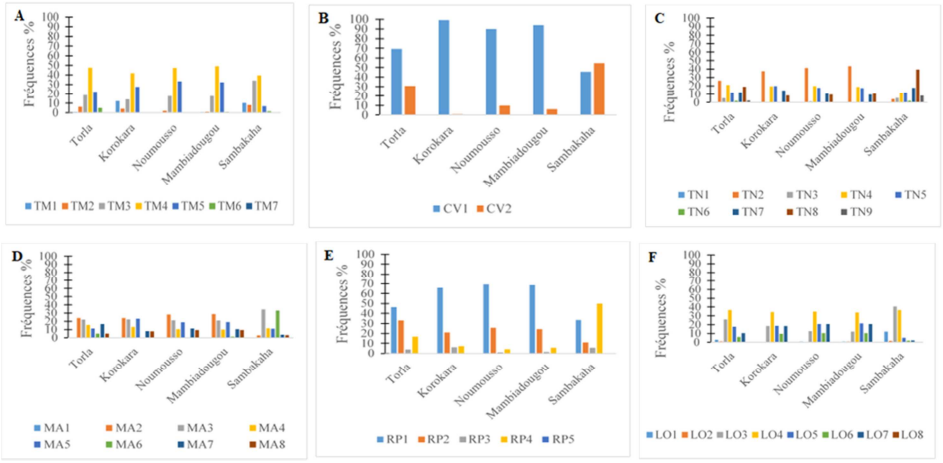

Fig. 4. Frequency distribution of modalities for the six (6) bioecological traits of aquatic macroinvertebrates at stations in northern Ivory Coast: A= Maximum size (TM); B= Life cycle (CV); C= Type of food (TN); D= Mode of feeding (MA); E= Respiration (RP); F= Mode of locomotion (LO); See table page for modality codes

Discussion

The aim of the study of the aquatic macroinvertebrate population of a number of dams in the centre is to determine the quality of their water on the basis of bio-ecological characteristics. Organisms between [10-20] mm (TM4) dominate at the Torla, Korokara, Noumousso, Mambiadougou and Sambakaha. In addition, the aquatic macroinvertebrates collected at all dams consisted mainly of small organisms (maximum size <40 mm). According to Kra (2020), large organisms range in size from 40 mm to 80 mm or more. The small size of aquatic macroinvertebrates in all the dams is attributed to strong anthropogenic pressure. Tape (2020) made the same observation in the urban reservoirs of Yamoussoukro. He stressed that the aquatic macroinvertebrates collected were mainly small organisms due to the high anthropogenic pressure that these urban lakes are subjected to. The analysis of characteristics related to mobility revealed a dominance of crawling organisms (LO4) at the Korokara, Noumousso and Mambiadougou stations. This mode of movement facilitates the search for shelter and recolonization (Nieto *et al.*, 2017). These organisms could therefore have refugia away from disturbed areas (Kra, 2020). However, at the Sambakaha station, the majority of organisms move in open water (LO3). This type of movement would require dissolved oxygen. In his study of Lake Kodjoboué (Côte d'Ivoire), Charvet (1999) showed that dissolved oxygen is significantly associated with the LO3 modality (swimming in open water). The dominance of tegumen-breathing organisms (RP1) at the Torla, Korokara, Noumousso, and Mambiadougou stations effectively confirms that these reservoirs are strongly affected by organic pollution. Furthermore, the preponderance of organisms with tegumentary respiration would indicate a strong disturbance (Kra, 2020). Similar observations were made by Feio and Dolédec (2012), who associated tegumentary respiration with high organic pollution. Furthermore, the dominance of air-breathing organisms (RP4) at the Sambakaha station may be due to resistance to the effects of anthropogenic activities. Indeed, resistance traits allow organisms to withstand the effects of a complex set of harmful or even lethal factors that occur during an unfavourable period (Calapez *et al.*, 2018). At all sites the organisms are short-lived (life cycle <1 year) (CV1) except at Sambakaha station, where organisms are long-lived (life cycle >1 year) (CV2). The results obtained at Torla, Korokara, Noumousso and Mambiadougou are characteristic of resilience. In fact, short life cycles are also an advantage for recolonization of refugia in disturbed environments, thus promoting greater resilience to pollution (Snook and Milner, 2002). In the case of the Sambakaha dam, the long lifespan of the organisms observed would be characteristic of resistance due to the constancy of the habitats. In fact, more constant habitats should support long-lived species that can have multiple reproductive episodes and are therefore characteristic of resistance (Townsend and Hildrew, 1994). Food type (TN) and feeding mode (MA) are two inseparable variables (Charvet *et al.*, 2000). The importance of the fine sediment feeders (MA2) in the Torla, Korokara, Noumousso and Mambiadougou stations are due to the fact that all this dam would be very exposed to inputs of wastewater and runoff rich in organic matter. On the other hand, in the Sambakaha station, the dominance of shredders (MA3) would be linked to the availability of live macrophytes (TN5); live macroinvertebrates (TN8). Studies in Guinean rivers have suggested that the density of shredders is controlled by the availability of organic matter (Tenkiano, 2017). In short, the Torla, Korokara, Noumousso are Mambiadougou dams are characteristically resilient, with small organisms, short life cycles and tegumentary respiration. The corresponding taxa are mainly snails and bivalves (Kra, 2020). In addition, the Sambakaha station would be characteristic of resistance with organisms of small size, short life cycle and aerial respiration. The relevant taxa are Heteroptera and Coleoptera (Kra, 2020).

The aquatic macroinvertebrates collected in the reservoirs studied at the center comprise 68 taxa in 35 families, 11 orders and 3 classes (Achaetes, Gastropoda, Insects). The number of taxa obtained is higher than the 55 taxa collected by Yapo *et al.*

(2020). in the two Korhogo dam lakes. This difference is due to the sampling period. The collection of aquatic macroinvertebrates in the two Korhogo dam lakes was carried out from January to March 2020, which corresponds to the dry season. However, the present study was carried out during both seasons (dry and rainy). The faunal composition of the aquatic macroinvertebrates present in our study corresponds in general to that of African freshwaters and in particular to that of West Africa (Sarr *et al.*, 2011; Yapo *et al.*, 2012; Sanogo *et al.*, 2014). The taxonomic composition showed that insects represented 98.15% of the taxonomic richness obtained at the center. This dominance of insects is due to the fact that they represent almost 95% of the organisms present in aquatic environments (Gagnon and Pedneau, 2006). In addition, the short life cycle of insects, with several generations per year, gives them an exceptional capacity to adapt (Casa and Pincebourde, 2017). Some authors (Edia, 2008; Camara, 2013). have also noted the high proportion of insects in the waterways of tropical Africa.

Conclusion

This study enabled the bioecological characteristics of a number of dams in northern Ivory Cost to be determined. The Torla, Korokara, Noumousso, Mambiadougou and Kongobo dams would be characteristic of resistance with organisms of small size, short life cycle and tegumentary respiration. On the other hand, the Sambakaha station would be characteristic of resistance with small organisms, short life cycle and aerial respiration. The aquatic macroinvertebrates collected from the dams studied in the north comprise 68 taxa, 35 families, 11 orders and 3 classes (Achaetes, Gastropods and Insects) with an abundance of insects.

Recommendation(s)

Although these results were obtained from a small number of sites, they are promising. This approach therefore deserves to be further developed in order to make better use of it, as its robustness has already been demonstrated in several studies. its robustness has already been demonstrated in several studies.

To find out more about the bio-ecological trait approach, we need to: (1) Continue to accumulate knowledge on the ecology of macroinvertebrate species in Ivorian hydrosystems by Deepen and extend this study to other bioecological traits (trophic level, reproduction, etc.) in order to establish other diagnoses on the causes of the degradation of these ecosystems. (2) Deepen and extend this study to other bio-ecological traits (trophic level, reproduction, etc.) in order to establish other diagnoses on the origin of the degradation of these hydrosystems; (3) To carry out ecological research focusing on the biology of species found in Ivorian hydrosystems in order to make full use of this approach in the management of water resources. water resources.

References

Aime SL, Berte S, N'da SA, Kone N. 2022. First inventory of aquatic macroinvertebrate of small dams in center and north of Ivory Coast. European Scientific Journal **18**(24), 165.

Archaimbault V, Rosebery TJ, Morin S. 2010. Biological and ecological characteristics, interest and perspectives for the bio-indication of toxic pollution. Sciences et Territoires **1**, 46–51.

Bremner J. 2008. Species traits and ecological functioning in marine conservation and management. Journal of Experimental Marine Biology and Ecology **366**, 37–47.

Calapez AR, Serra SRQ, Santos JM, Branco P, Ferreira T, Hein T, Brito AG, Feio MJ. 2018. The effect of hypoxia and flow decrease in macroinvertebrate functional responses: A trait-based approach to multiple-stressors in mesocosms. Science of the Total Environment **637–638**, 647–656.

Camara AI. 2013. Composition, structure and determinism of macroinvertebrates in the Banco River (Banco National Park; Ivory Coast). Doctoral thesis, Nagui Abrogoua University, Abidjan, Ivory Coast, 138 p.

Casa J, Pincebourde S. 2017. Insect adaptation to climate change. Report of the Academy of Sciences, France, 153 p.

Charvet S, Statzner B, Usseglio-Polatera P, Dumont B. 2000. Traits of benthic macroinvertebrates in semi-natural French watercourses: a first application to biomonitoring in Europe. Freshwater Biology **43**, 277–296.

Charvet S. 1999. Integration of recent theoretical knowledge in the diagnosis of ecological quality of watercourses using invertebrate bioindicators. Doctoral thesis, Claude Bernard University, Lyon 1, France, 57 p.

Chevenet F, Doledec S, Chessel D. 1994. Fuzzy coding approach for long-term ecological data analysis. Freshwater Biology **31**, 295–309.

Dejoux C, Elouard JM, Forge P, Maslin JL. 1981. Iconographic catalogue of aquatic insects in Ivory Coast. ORSTOM Report, 178 pp.

Durand JR, Lévêque C. 1980. Aquatic flora and fauna Sahel-sudanian of Africa. ORSTOM, Paris, France, tome 1, 390 p.

Edia OE. 2008. Taxonomic diversity and entomological structure of coastal rivers Soumié, Eholié, Ehania, Noé, South-east Ivory Coast. Doctoral thesis, University of Abobo-Adjamé, Abidjan, Ivory Coast, 156 p.

Feio MJ, Dolédec S. 2012. Integration of invertebrate traits in predictive models for the indirect assessment of functional integrity of watercourses: a case study in Portugal. Environmental Indicators **15**, 236–247.

Gagnon E, Pedneau J. 2006. Voluntary Monitoring (SurVol) Benthos, volunteer guide, small watercourse voluntary monitoring program. Report of the CVRB, Quebec, Canada, 25 p.

Goula BTA, Savane I, Konan B, Fadika V, Kouadio GB. 2006. Impact of climate variability on water resources in the N'zo and N'zi basins of Ivory Coast (humid tropical Africa). Vertigo (1), 1–12.

Kra KM. 2020. Aquatic macroinvertebrates of the lower Comoé River basin: taxonomic composition and ecological integrity assessment. Doctoral thesis, University of Nangui-Abrogoua, Abidjan, Ivory Coast, 178 p.

Moisan J. 2010. Guide for identification of the main benthic freshwater macroinvertebrates in Quebec, 2010. Voluntary monitoring of shallow water. Report of the Ministry of Sustainable Development, Environment and Parks, Quebec, Canada, 82 p.

Moor IJ, Day JA. 2002. Guides to the freshwater invertebrates of Southern Africa: Araneae, Water Mites and Mollusca. WRC Report, 141 p.

Nieto C, Fátima R, Celina R, Verónica M. 2017. Macroinvertebrados acuáticos de las vegas de la Puna Argentina. Serie Conservación de la Naturaleza **24**, 13 p.

Sanogo S, Kabre TJA, Cecchi P. 2014. Inventory and spatio-temporal distribution of macroinvertebrates bioindicators of three water bodies in the Volta basin in Burkina Faso. International Journal of Biological and Chemical Sciences **8**(3), 1005–1029.

Sarr A, Kinzelbach R, Diouf M. 2011. Specific diversity and ecology of continental molluscs in the lower Ferlo Valley (Senegal). MalaCo **7**, 383–390.

Snook DL, Milner AM. 2002. Biological traits of macroinvertebrates and hydraulic conditions in a glacier-bed catchment (French Pyrénées). Archives d'Hydrobiologie **153**, 245–271.

Statzner B, Bêche L. 2010. Can biological invertebrate traits resolve effects of multiple stressors on running water ecosystems? Freshwater Biology **55**(1), 80–199.

Tachet H, Richoux P, Bournaud M, Usseglio-Polatera P. 2010. Freshwater invertebrates; systematics, biology, ecology. CNRS Editions, Paris, France, 588 p.

Tape LD. 2020. Responses of aquatic macroinvertebrates to the ecological quality degradation of urban artificial lakes (Yamoussoukro, Cote d'Ivoire). Doctoral thesis, University of Nangui-Abrogoua, Abidjan, Ivory Coast, 161 p.

Tenkiano DSN. 2017. Benthic macroinvertebrates and aquatic hyphomycetes: diversity and implications for ecosystem functioning in Guinean rivers. Doctoral thesis, University of Toulouse, France, 169 p.

Townsend CR, Hildrew AG. 1994. Species traits in relation to a habitat templet for river systems. Freshwater Biology **31**, 265–275.

Yapo ML, Atse BC, Kouassi P. 2012. Aquatic insect inventory of Southern Ivory Fish Farm Ponds. Journal of Applied Biosciences **58**, 4208–4222.

Yapo ML, Boua DP, Kone KN, Diomande D. 2020. Assessment of aquatic insect species composition, abundance and diversity within two dam lakes in Korhogo: Koko & Natiokobadara (Northern Ivory Coast). International Journal of Fisheries and Aquatic Studies **8**(5), 282–288.