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Environmental Parameters and Diversity of Benthic Diatoms in Tilesdit Dam, Northern of Algeria

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ABSTRACT

This work aims to identify for the first time the benthic diatoms of the Tilesdit dam in the Bouira region (Northern of Algeria) and to determine the factors influencing their distribution. The objective is also to assess their role as bio-indicators of water quality. This study highlighted the relationship between physicochemical parameters and the seasonal distribution of diatom species collected monthly from January 2021 to December 2021. The sampling sites for the biological study were selected downstream of the dam based on environmental criteria. Diatoms were collected and processed according to the NFT 90-345 standard. In parallel, physico-chemical parameters were measured in situ or analyzed in the laboratory using standard methods. The number of species was 40, belonging to 24 genus and 8 families. The most abundant family was Naviculaceae (27.45%). Among the dominants families, those that predominate are Achnanthaceae in autumn (48%), Naviculaceae in summer (67.48%), Coxinodiscaceae in spring (37.70%) and Achnanthidiaceae in winter (34.71%). Principal Component Analysis (PCA) revealed that diatom distribution in Tilesdit Dam is driven by key environmental factors, including dissolved oxygen, conductivity, pH, and nutrients. *Meridion, Cyclotella*, and *Achnanthes* were associated with well-oxygenated, mineralized waters, while *Fragilaria, Melosira*, and *Amphipleura* thrived in nutrient-rich conditions, indicating eutrophication. These results confirm the strong response of diatoms to water quality variations, reinforcing their use as bioindicators. According to the results obtained, this site is characterized by good water quality, with a seasonal disturbance occurring in spring.

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INTRODUCTION

Water is a vital and essential element for all life human (Vasistha & Ganguly, 2020). It is mostly used for bathing, drinking, fisheries and other domestic purposes (Jena et al., 2013). Water resources in the world are under pressure natural and anthropogenic (Ejigu, 2021) and the consumable form of water is limited (Nasir et al., 2022). Eutrophication is the result of a high load of inorganic nutrients and particulate and dissolved organic matter (Ejigu, 2021) in addition to this natural deterioration, water is polluted by other anthropogenic activities such as livestock farming, production and disposal of waste (agricultural, municipal and industrial) (Galal Uddin et al., 2021) .This phenomenon is particularly concerning in artificial reservoirs like the Tilesdit Dam, where nutrient enrichment can lead to an imbalance in aquatic ecosystems. Diatoms, being highly sensitive bioindicators, respond to these changes in water quality, making them valuable for assessing the impact of eutrophication. As primary producers, they play a crucial role in the trophic network by transferring energy to higher organisms (Kultu et al., 2020).

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Therefore, studying their composition and abundance in the Tilesdit Dam provides essential insights into the ecological status of the reservoir and the consequences of nutrient loading. Diatoms have arisen approximately 240 million years ago on account an endosymbiotic event between heterotrophic flagellate and red algae (Saxena et al., 2021). In 1854 Ehrenberg first recognized the distinct diatom flora of western North America (Spaulding et al., 2022). These organisms belonging to the phylum Bacillariophyta are unicellular microalgae (Kaddeche et al., 2022) eukaryotic, photosynthetic, and are often the dominant primary producers in freshwater and marine ecosystems (Wang et al., 2019) with an overall number of around 200,000 species (Sánchez et al., 2019). They are responsible to produce, 20% of oxygen and 40% of the organic carbon yearly. Diatoms' distinctive characteristic is their silicate shells (frustule) (Sharma et al., 2021). The silica content varies from one species to another according to their growth pattern, size and environmental such as temperature, light, salinity and nutrients (Saxena et al., 2021). These photoautotrophic organisms are involved in biogeochemical cycles, (silicon, carbon and nitrogen cycle). Moreover, these microalgae are used to produce nutraceutical compounds, like omega, essential fatty acids for pharmaceutical industries and vegetarian proteins (Sharma et al., 2021). On account of the simplicity of sampling, preparation, and preservation of their frustules, freshwater benthic diatoms are extensively used as environmental indicators (Le et al., 2023). Moreover, the short generation time makes diatoms rapidly respond to environmental changes, and furnish therefore an early signal in pollution.

Diatom communities respond directly to chemical and physical changes in the environment, and the community structure depends on many factors including: pH, nutrients, organic matter, depth and water temperature (Heramza et al., 2021). Diversity of diatoms continues to be limited even by specialists (Spaulding et al., 2022), the majority research on benthic diatoms and their relationships with ecological factors has been conducted in the United States and in Europe (Kaddeche et al., 2022) which were rarely studied in Algeria (Heramza et al., 2021). In Algeria, few studies have been conducted to inventory and analyze diatom communities. For example, the Mellah Lagoon, located in northeastern Algeria, has been the subject of a detailed study on diatom diversity, emphasizing their role as indicators of water quality (Draredja et al., 2019). Similarly, a study on Lake Reghaia, in northern Algeria, identified 24 species of planktonic diatoms, 10 of which were recorded for the first time in the country, highlighting the influence of nutrients and dissolved oxygen on their distribution (El Haouati et al., 2015). These studies illustrate the richness and diversity of diatoms in Algeria, as well as their relevance for the ecological assessment of aquatic environments.

This study aims, for the first time, to establish a detailed taxonomic inventory of diatoms present in the Tilesdit Dam (Northern Algeria). It also seeks to identify the abiotic factors governing their seasonal distribution through an advanced statistical approach (PCA). Finally, it evaluates the role of diatoms as bioindicators of water quality, providing a deeper understanding of the ecological mechanisms shaping this aquatic ecosystem.

MATERIALS AND METHODS

Tilesdit dam is located in the northern central part of Algeria, 4 Km from national road n°5 linking Algiers and Constantine and 18 Km to the East of the town of Bouira. This dam, constructed in 1996 with water filling in 2004, covers a surface area of 843 Km^2, with a water volume of 96,805 hm^3 and 69.10 m height. Topographically, this dam is the only favourable one on oued Eddous allowing the formation of a reservoir with a useful volume of 60 million m^3 of water. In the dam site, the width of the oued is 80m downstream, it widens considerably at the confluence with the Barbar oued (Fig. 1) (ZARUBEZHVODSTROY, 2004). On the Bouira plateau, the climate is dry and continental, with hot summers and cold winters (Zouggaghe & Moali, 2009).

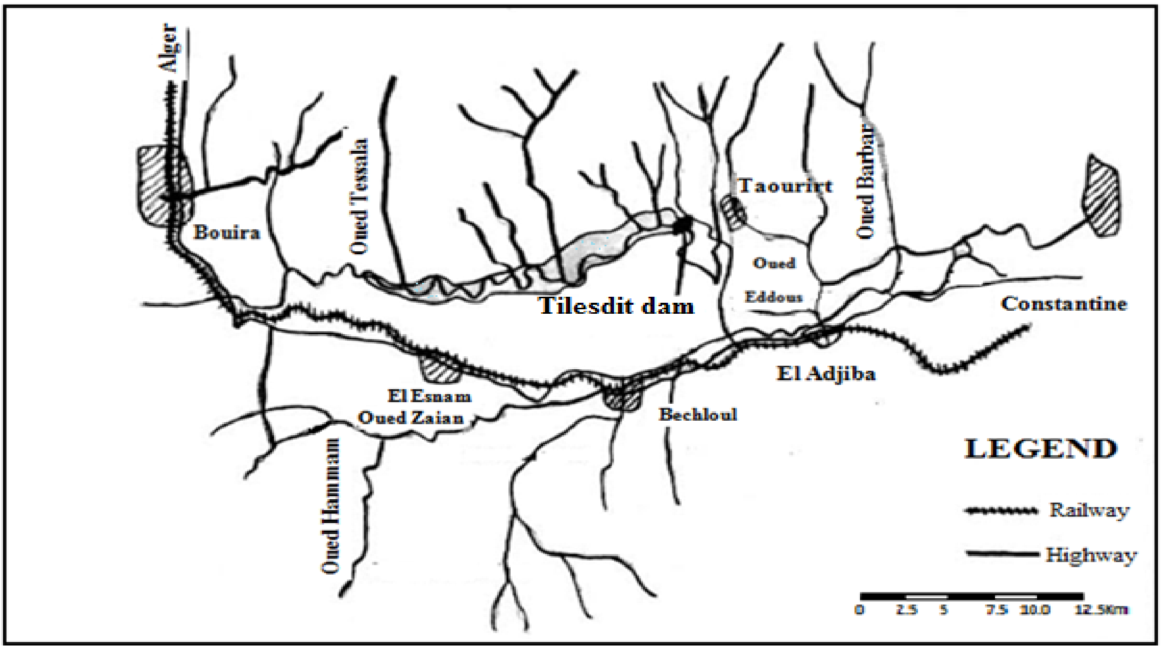

Fig. 1. Geographical location of the Tilesdit dam (ZARUBEZHVODSTROY 2004)

The sampling of physicochemical and biological parameters was carried out monthly from January to December 2021 to obtain a detailed and continuous view of environmental variations. However, to facilitate the interpretation of the results, the analyses were grouped by season. This approach allows for the identification of significant variations in water quality according to the seasons, taking into account the climatic and hydrological influences specific to each period of the year.

For the biological analysis, the sampling sites were selected downstream of the dam based on their accessibility, light availability, water flow, and the presence of substrates. The samples were collected and treated according to the French standard NFT 90-345 (AFNOR, 2007) by scarping 5 substrate (rocks, stones and pebbles) using a small brush, where a total area of the upper substrate surface was 100 cm^2, then the diatom suspensions were conserved in bottles containing 95% ethanol. In laboratory, samples are digested using heating and a few drops of hydrochloric acid to remove any existing carbonate and organic matter. After this step, we carry out a series of rinsing and centrifugations. Finally, permanent slides containing cleaned diatom frustules mounted and conserved using a high refractive index resin. The counting is based on 400 individuals and is performed by scanning the preparation using a light microscope at the highest magnification (x1000 immersion). Finally, the identification of diatoms is done at the species level in accordance with works of Peeters and Ector (2017, 2018, 2019) and Lange-Bertalot (2017).

In parallel with this biological study, a measurement of certain physicochemical parameters was carried out. The water sample for this study were collected from different depths in the center of the dam, in 2.5 L clean plastic bottles immediately transported to the laboratory in an icebox. The physico-chemical analyses of the water were conducted in accordance with Rodier (2005) and ISO standards (2004). Temperature, pH, turbidity, conductivity and dissolved oxygen were measured in-situ using a multi-parameter analyzer, while orthophosphate (PO_4^{3-}) concentration was determined by spectrophotometry at 880 nm after the addition of ascorbic acid and molybdate solution. Nitrites (NO_2^-) concentrations were measured by spectrophotometry at 540 nm following a reaction with a color reagent at pH 1.9. Ammonium (NH_4^+) was quantified by spectrophotometry at 655 nm after treatment with a color reagent and sodium dichloroisocyanurate at pH 12.6. Finally, calcium (Ca^{2+}) concentration was determined by complexometric titration with EDTA using Murexide as an indicator. These parameters were selected due to their influence on the diversity and distribution of diatoms. These key factors affect the physiology and growth of diatoms, as demonstrated in several studies, such as those by Kaddeche et al. (2022) and Taffouo et al. (2017), among others. Our selection is also based on the recommendations of the French standards NFT 90-345. Additionally, these parameters were chosen based on their analytical accessibility and relevance in the context of the ecological assessment of the Tilesdit Dam.

All our statistical analyses were conducted using R, version 4.4.1 (R Core Team, 2024). The relationships between biological and physicochemical parameters were assessed using the non-parametric Spearman correlation with the 'ggcorrplot' package (Kassambara, 2023). We also performed principal component analysis (PCA) using the 'factoextra' (Kassambara & Mundt, 2020) and 'FactoMineR' (Lê et al., 2018) packages on standardized data to characterize the temporal variation of the measured abiotic and biotic variables in Tilesdit Dam.

Several diversity indices were calculated: evenness index (E), Shannon's index (H') and Simpson diversity index (D). To compute the biotic diversity, Shannon's index is the most widely and commonly used method (Shannon & weaver, 1949), determined by the following equation (Grillo &Venora, 2011):

$$H' = -\sum_{i=1}^{s} Pi \ln Pi$$

H': the Shannon diversity index

S: numbers of species encountered

P_i: relative abundance of specie ($P_i = n_i/N$)

Evenness index E is the ration of the diversity observed (H') to maximum diversity (H_{max}) according to the following equation (Ramade, 2009):

$E = H'/ H_{max}$

$H_{max} = \ln S$

S: numbers of species encountered

RESULTS & DISCUSSIONS

The inventory of benthic diatoms resulted of a total of 40 species represented by 3 centric and 37 pennate belonging to 24 genus and 8 families: Fragilariaceae (12 species), Achnanthidiaceae (8 species), Naviculaceae (8 species), Achnanthaceae (8 species), Coxinodiscaceae (3 species), Eunotiaceae (2 species), Bacillariaceae (1 species), Diadesmidaceae (1 species) (Table 1).

Naviculaceae and Achnanthidiaceae have shown the highest species abundance (27 and 23%, respectively). Among the dominants families, those that predominate in terms of abundance are Achanthaceae in autumn (48%), Naviculaceae in summer (67.48%), Coxinodiscaceae (37.70%) and Achnanthidiaceae (26.22%) in spring, Achnanthidiaceae (34.71%) and Achnanthaceae (25.19%) in winter (Fig. 2).

During summer, the taxa *Fallacia subhamulata* (41.46%) was the most dominant among all the species. During spring, most dominant taxa was *Melosira varians* (33.61%). *Achnanthe amphicephala* was frequent during the winter (20.96%) and autumn (48.14%)

The maximum richness was observed in winter (S = 33 species, H' = 2.50, D = 0.89, E = 0.72) and spring (S = 14 species, H '= 2.08, D = 0.83, E = 0.79) (Table 3)

The values of the physicochemical parameters measured in the Tilesdit dam across different seasons are represented in table below (Table 2). Temperature (T) in °C, pH, Dissolved Oxygen (DO) in mg/L, Conductivity (Cond) in µS/cm, Orthophosphate (PO_4^{3-}) in mg/L, Nitrite (NO_2^-) in mg/L, Calcium (Ca^{2+}) in mg/L, and Ammonium (NH_4^+) in mg/L.

Table 1. The diatom species identified in Tilesdit dam, Algeria

Family	Genus	species
Centric		
Coxinodiscaceae	*Melosira*	*Melosira varians*
	Cyclotella	*Cyclotella meneghiniana*
	Aulacoseira	*Aulacoseira granulata*
Penate: absence of raphe		
Fragilariaceae	*Diatoma*	*Diatoma problematica*
		Diatoma moniliformis
	Meridion	*Meridion circular*
		Meridion sp
	Staurosira	*Staurosira venter*
		Staurosira sp
	Tabellaria	*Tabellaria fenestarta*
	Hannaea	*Hannaea arcus*
	Fragilaria	*Fragilaria gracilis*
		Fragilaria crotonensis
		Fragilaria vaucheriae
		Fragilaria tenera
Penate:presence of raphe		
Eunotiaceae	*Eunotia*	*Eunotia botuliformis*
		Eunotia formicina
Achnanthaceae	*Achnanthe*	*Achnanthe amphicephala*
	Cocconeis	*Cocconeis pseudothumensis*
		Cocconeis pseudothumensis
	Psammothidium	*Psammothidium daonense*
		Psammothidium daonense
Naviculaceae	*Amphipleura*	*Amphipleura pellucida*
	Neidium	*Neidium cuneatiforme*
	Caloneis	*Caloneis fontinalis*
	Nupela	*Nupela Sulvahercynia*
	Gomphonema	*Gomphonema pseudoaugur*
	Aldafia	*Aldafia langebertalotii*
		Aldafia sp
	Fallacia	*Fallacia subhamulata*
Bacillariaceae	*Bacillaria*	*Bacillaria paxillifera*
Achnanthidiaceae	*Kolbesia*	*Kolbesia suchlandtii*
	Achnanthidium	*Achnanthidium delmontii*
		Achnanthidium druartii
		Achnanthidium sp3
		Achnanthidium peetersianum
		Achnanthidium hoffmanii
		Achnanthidium tropicocatenatum
		Achnanthidium sp
Diadesmidaceae	*Humidophila*	*Humidophila schmassmannii*

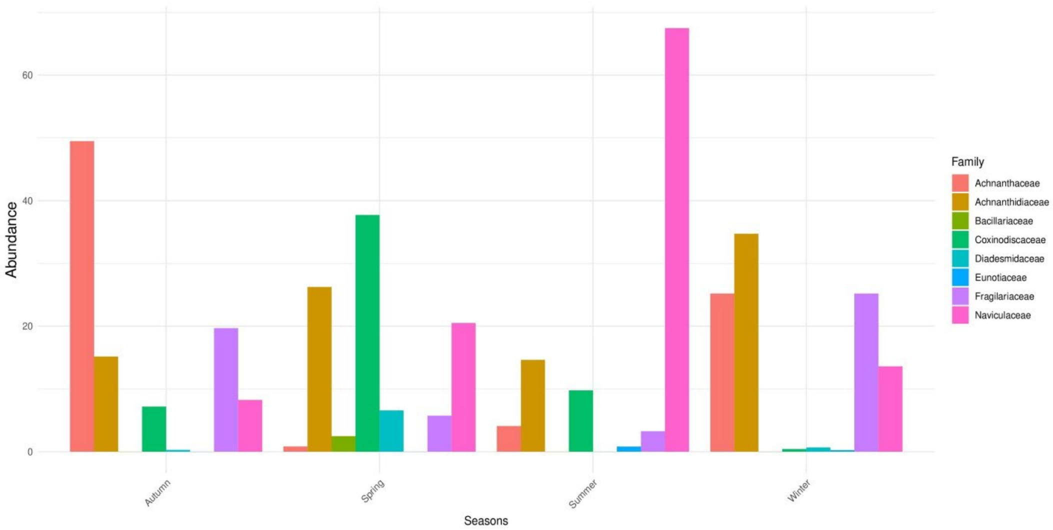

Fig. 2. Seasonal distribution of diatom families in Tilesdit dam

Table 2. Physico-chemical parameters of water measured in the Tilesdit dam, Algeria

	T	pH	DO	cond	PO_4^{3-}	NO_2^-	Ca^{2+}	NH_4^+
Winter	13,18	8,69	4,55	650,07	0,18	0,27	46,93	0,92
Spring	17,40	7,93	3,25	638,20	0,22	0,20	42,47	1,68
Summer	25,15	7,92	2,80	615,23	0,24	0,10	35,20	0,96
Autumn	20,37	7,97	4,65	640,22	0,05	0,18	36,97	0,69

Table 3. Seasonal distribution of ecological indices of diatoms enumerated

	Ecological index			
	S	H'	D	E
Winter	33	2.50	0.89	0.72
Spring	14	2.08	0.83	0.79
Summer	17	1.92	0.78	0.68
Autumn	17	1.78	0.72	0.62

Note: S: number of species, H': Shannon-weaver index, D: Simpson index, E: Regularity index

The conductivity varied from 615.23µs.cm^{-1} (in summer) to 650.07 µs.cm^{-1} (in winter). Temperature maximum values have been recorded in summer (23.22 C° to 26.32 C°). The pH of Tilesdit dam is alkaline (>7.90), high values are recorded in winter (8.69) and low values (7.92) in summer. Maximum dissolved oxygen values have been recording in autumn (4.65 mg/L) and winter (4,35mg/L). Maximum values of nitrite and calcium recorded in winter (0.27 mg/L, 46.93 mg/L respectively). Furthermore, in summer the orthophosphate levels showed values are great than 0.24 mg/L, while values that are less than 0.05 mg/L are observed in autumn.

Our corrplot reveals interesting relationships between the physicochemical parameters of the studied dam water (Fig. 3).

We note that dissolved oxygen and pH are negatively associated with temperature (Pearson coefficient (r) = -0.60 and r = -0.78, respectively). Orthophosphates showed a negative correlation with dissolved oxygen (r = -0.81). The latter is negatively associated with ammonium (r = -0.55), and positively with nitrites (r = 0.70) and pH (r = 0.58).

The PCA highlighted the studied physicochemical parameters as well as the dominant diatom genus (Fig. 4)

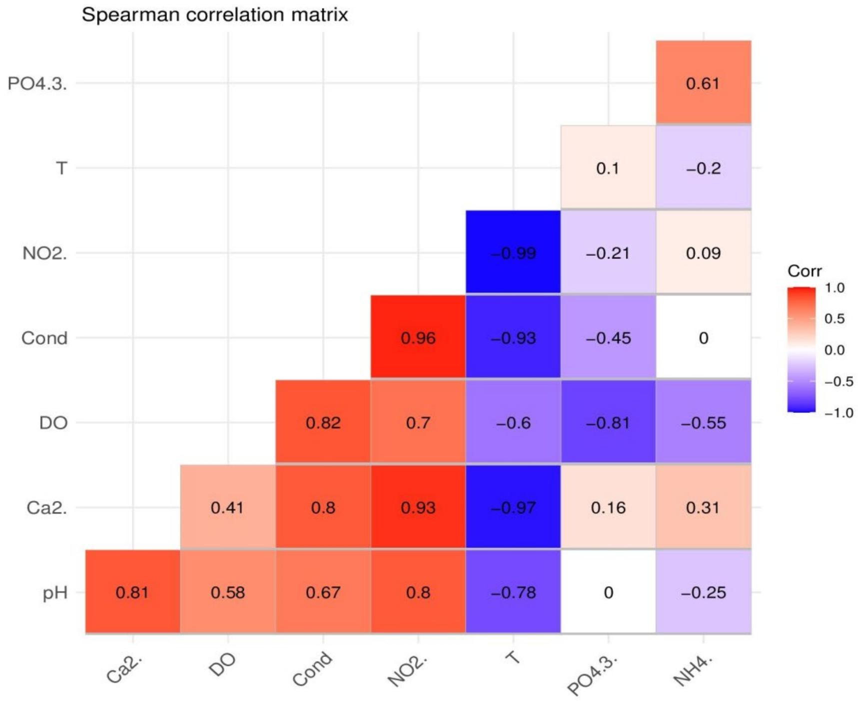

Fig. 3. Corrplot of the r Spearman correlation calculated between all the analyzed physicochemical. Note: T: temperature, NO^{2-} : nitrite, DO: dissolved oxygen, pH: hydrogen potential, PO_4^{3-} : orthophosphates, Cond: conductivity, Ca^{2+}: calcium, NH_4^+: ammonium

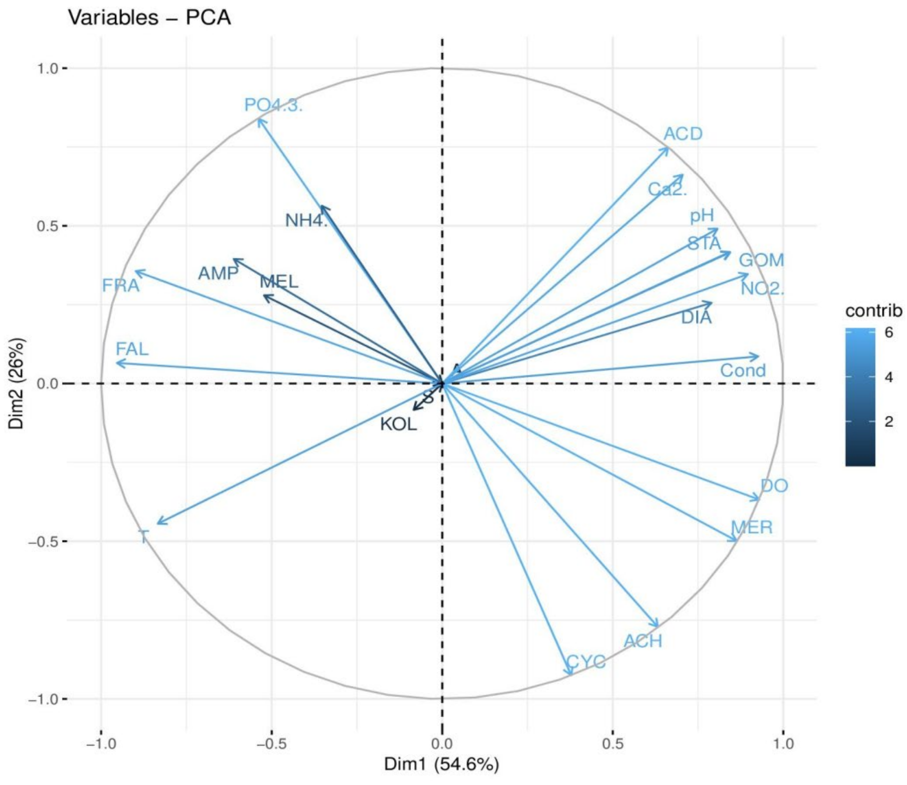

Fig. 4. Principal component analysis carried the physicochemical parameters and dominant genus of diatom. Note: T: temperature, NO^{2-}: nitrite, DO: dissolved oxygen, pH: hydrogen potential, PO_4^{3-} : orthophosphates, Cond: conductivity, Ca^{2+}: calcium, NH_4^+: ammonium, ACD: *Achnantidium*,STA: *Staurosira*, GOM: *Gomphonema*, DIA: *Diatoma*, MER: *Meridion*, ACH: *Achnanthe*, CYC: *Cyclotella*, FAL: *Fallacia*, FRA: *Fragilaria*, AMP: *Amphipleura*, MEL: *Melosira*

Principal Component Analysis (PCA) allowed us to visualize the relationships between physico-chemical parameters and diatom genera based on the first two principal dimensions (Dim1 and Dim2), which explain 54.6% and 26% of the total variance, respectively. That means the two axes explain 84.9% of the total variance of the data, which means that a large part of the information is represented in this plane. In the principal axis analysis, Dim1 reveals a strong structuring of physico-chemical parameters and diatom communities. On the right side (positive), dissolved oxygen (DO), conductivity (Cond), pH, calcium (Ca^{2+}), and nitrites (NO_2^-) are closely correlated. These variables are generally associated with good water quality, characterized by adequate oxygenation, pH stability, and mineral richness. The genera *Meridion*, *Cyclotella*, and *Achnanthes* appear to prefer well-oxygenated waters. There is a significant positive correlation between pH and the genera *Staurosira*, *Gomphonema*, and *Diatoma*.

Conversely, on the left side (negative), an association is observed between ammonium (NH_4^+), phosphates (PO_4^{3-}), and certain diatom genera such as *Fragilaria*, *Fallacia*, *Amphipleura*, and *Melosira*. These elements are often indicators of waters richer in organic matter, potentially suggesting an eutrophication process. Diatoms in this group thus appear to be bio-indicators of nutrient-enriched environments. Calcium is also a nutrient source for certain genera, such as *Achnanthidium*, *Gomphonema*, and *Staurosira*.

Regarding Dim2, the differentiation of variables is less pronounced, but an opposition between certain diatom genera is notable. *Achnanthidium* (ACD) and *Staurosira* (STA) occupy a position suggesting that they are influenced by factors distinct from those present on Dim1. Additionally, *Cyclotella* (CYC) and *Meridion* (MER) are located away from the nutrients NH_4^+ and PO_4^{3-}, which could indicate a preference for waters with lower organic matter content, reflecting a more oligotrophic habitat.

According to table 3, the Shannon index H' and Simpson's diversity index D are higher during the winter season (H' = 2.50, D = 0.89). The average value of these indices in spring is 2.08 and 0.83, respectively. The summer period is characterized by an index of H' = 1.92 and D = 0.78. In autumn, we found a value of H' = 1.78 and D = 0.72. The equitability index is represented by 0.72 in winter, 0.79 in spring, 0.68 in summer and 0.62 in autumn.

Our identified taxa have already been illustrated in the book by Lange-Bertalot et al., (2017), and they are common and cosmopolitan. Our study is the first attempt to determine the diatom taxa found in the Tilesdit dam in the Bouira region (Northern of Algeria), where no previous studies have been conducted. Therefore, we aim to complement the Algerian data base of diatoms previously inventoried in other regions. We recorded 40 diatom species distributed across 24 genus and 8 families. This number of species is considered interesting compared to research published in Algeria. For example, Negadi et al., (2021) recorded 36 taxa in the Chott-Chergui wetland, and El Haouati et al., (2015) recorded 24 taxa in Lake Reghaia.

The species diversity observed in our reservoir during winter is greater than that recorded in other seasons (H' = 2.50 and D = 0.89). This can be explained by the high conductivity (650.07 µs/cm) and the availability of nutrients (NO_2^-, NH_4^+, Ca^{2+}). In winter, lower temperatures reduce the metabolism of competing microorganisms, which may promote the coexistence of a greater number of diatom species. Additionally, low temperatures increase the solubility of oxygen in water (DO = 4.55), creating more favorable conditions for diatoms sensitive to hypoxia. Similar results were found by Negadi et al., (2021), who observed that the rainy season was the most diverse in the Chott-Chergui wetland, while diversity was high in spring and autumn in Lake Reghaia (El Haouati et al., 2015). Also, due to the movement of nutrients from upstream to downstream induced by runoff during the rainy season. Furthermore, the variability observed in diatom assemblages during the winter season suggests that precipitation is a determining factor in the distribution of diatoms because it plays an important role in the transfer of nutrients in aquatic environments (Olodo et al., 2019).

Annually, our results revealed the dominance of Naviculaceae with a percentage of 27.45%.

These results are similar to those found by Kaddeche et al., (2022) along the central coast of Constantine, with a percentage of 47.87%. There is also a similarity in results from the streams of the Chott-Chergui wetland, with a percentage of 25.71%.

The PCA results demonstrated that the diversity and distribution of diatoms in our reservoir are controlled by several environmental factors, such as pH, temperature, dissolved oxygen, conductivity, and nutrients (NO_2^-, PO_4^{3-}, NH_4^+, and Ca^{2+}). Several studies have revealed the links between diatom communities and these environmental parameters, such as the study by Chaïb et al., (2011) along a North African river, the Kébir East in northeast Algeria, by Kaddeche et al., (2022) along the central coast of Constantine, and by Heramza et al., (2021) on the Aïn Dalia dam in northeast Algeria. Axis Dim1 contrasts different parameters, with dissolved oxygen (DO), conductivity, pH, Ca^{2+}, and NO_2^- being positively correlated on one side. This association is often characteristic of well-oxygenated, mineralized waters with relatively stable pH conditions. The presence of diatoms such as *Meridion*, *Cyclotella*, and *Achnanthes* in this area of the graph suggests that they are adapted to well-oxygenated water conditions, consistent with their status as indicator species of good water quality (Rimet et al., 2007). On the other side, nutrients (NH_4^+ and PO_4^{3-}) are negatively correlated with these parameters and are associated with the genera *Fragilaria*, *Fallacia*, *Amphipleura*, and *Melosira*. This configuration is typical of environments enriched in organic matter, where nutrients promote the growth of certain species tolerant to eutrophication (Lange-Bertalot, 2001). This relationship reflects a potential impact of organic pollution on the composition of diatom communities. Axis Dim2 differentiates genera such as *Achnanthidium* and *Staurosira*, which appear to be influenced by factors not accounted for in Dim1. Their position suggests that they may be sensitive to other environmental variables, such as current velocity or the presence of specific substrates, as observed in other studies on benthic diatoms (Pringle et al., 1984). The results confirm that diatoms respond strongly to physico-chemical variations in the aquatic environment, making their use in bio-indication particularly relevant. The genera *Meridion*, *Cyclotella*, and *Achnanthes*, associated with well-oxygenated waters, are generally considered indicators of good ecological quality. In contrast, the dominance of *Fragilaria*, *Melosira*, and *Amphipleura* in nutrient-rich conditions suggests environmental degradation linked to excessive inputs of organic matter and nutrients. These observations are consistent with studies conducted on other reservoirs and rivers, where water quality directly influences the composition of diatom communities (Stevenson et al., 2010). Thus, PCA not only detects environmental gradients influencing species distribution but also highlights trends related to the potential eutrophication of the Tilesdit Dam. This statistical approach reinforces the relevance of diatoms as reliable biological indicators of water quality. A complementary multi-year analysis and the integration of other abiotic factors (e.g., hydrodynamics, suspended matter) could further refine this interpretation.

The electrical conductivity ranged between 615.23 µS/cm and 650.07 µS/cm. This value falls within the class of good-quality water according to the Algerian standard for dam water quality, indicating a moderate mineralization level.

The pH of the waters of Tilesdit dam is alkaline (7.93 – 8.69). A positive correlation is noted between dissolved oxygen and pH ($r = 0.58$). This result was consistent with that reported by Heramza et al., (2021) at the Aïn Dalia dam, by Draredja et al,. (2019) at the lake Melleh, and by several authors in other studies. The alkalinity of our dam could be due to the increase oxygen levels in the environment resulting from CO_2 consumption through phytoplankton photosynthesis, such as that of diatoms (Heramza et al., 2021). This is why the highest pH, which is more alkaline, is observed in winter (8.69), when the diatom community is larger i.e. the increase in photosynthetic activity.

Taffouo et al., (2017) reported that when the pH is high, ammonium becomes toxic, where as when the pH is below 8, ammonium has little influence on fauna and flora. The highest pH was in winter, where a significant number of diatoms were found. This explains why the level of ammonium at this pH is not toxic and that at lower temperatures in winter, the toxicity of ammonium is reduced. This situation favors a high biodiversity of fauna and flora. The ammonium concentrations measured in the dam water indicate environmental contamination, reflecting excessive nutrient loading. According to the World Health Organization and to Algerian standards, ammonium levels should not exceed 0.5 mg/L. Exceeding this threshold signifies water quality degradation, which may result from organic matter decomposition or anthropogenic inputs.

Orthophosphates (PO_4^{3-}) would come from the decomposition of waste upstream and along the watershed, as well as from the practice of agriculture using chemical fertilizers (Atanle et al., 2012). The decrease in PO_4^{3-} in winter and autumn is due to the absorption of PO_4^{2-} by submerged macrophytes and by algae (El Houati et al., 2015).

In contrast to the study conducted by Heramza et al., (2021) on the Aïn Dalia dam, which demonstrated that the waters of this reservoir are moderately to significantly polluted, as evidenced by the dominance of genus such as*, Thalassiosira, Synedra, Navicula, Nitzschia*, and *Surirella* and *Melosira*. Our study indicates a different water quality, in winter, summer, and autumn, the absence of these genuses and the presence of indicator species of good quality, such as *Achnanthes amphicephala, Meridion circulare, Fragilaria gracilis*, and species of the genus *Achnanthidium*, suggest better water quality. However, in spring, the dominance of *Melosira varians* (33.60%) indicates a state of seasonal pollution. This result is corroborated by the work of Heramza et al., (2021), who found a similar percentage (35%) of this species and consider species of the genus *Melosira* as opportunistic, easily adapting to changes in abiotic conditions and environmental disturbances.

CONCLUSION

The main objective of this study was to characterize the taxonomic diversity of diatoms in the Tilesdit Dam and to assess the influence of physicochemical parameters on their seasonal distribution. This is the first study conducted on this site, where no previous diatom taxonomic inventory had been established. Thus, our work contributes to enriching the Algerian database of diatoms, complementing existing inventories from other regions. Our results reveal significant correlations between diatom community composition and seasonal environmental variations.

By jointly analyzing water physicochemical parameters and diatom biodiversity, we identified key bio-indicator species. The presence of *Meridion circulare, Achnantes amphicephala, Fragilaria gracilis*, and species from the *Achnanthidium* genus suggests good water quality during winter, summer, and autumn. However, the dominance of *Melosira varians* in spring indicates a seasonal decline in water quality, likely due to increased nutrient inputs.

These findings provide valuable insights into the bio-indication role of diatoms in Algerian reservoirs and highlight their sensitivity to environmental fluctuations. More than just a status report, this study represents an initial step toward the sustainable management of water resources. It paves the way for future research to further explore the complex interactions between anthropogenic pressures and aquatic ecosystems. From an applied perspective, our results emphasize the need for strict nutrient input control to mitigate eutrophication in the Tilesdit Dam. Integrating diatoms as a bio-indication tool in environmental monitoring programs would enhance water resource management and help anticipate future ecological imbalances.

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CONFLICT OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript.

LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

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