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Studies of Aquatic Phycomycetes Associated with Wikki Warm Spring, Yankari Game Reserve, Bauchi, Bauchi State, Nigeria

[1]Auwalu Lamido, [2]Rabiu Ibrahim
School of Science and Technology, Abubakar Tatari Ali Polytechnic, Bauchi
[1]Corresponding Author: auwalulamido3@gmail.com.,08035972742

Abstract: Aquatic fungi, particularly phycomycetes, play essential roles in nutrient cycling, organic matter decomposition, and ecosystem health in freshwater environments. This study investigates the diversity of aquatic phycomycetes in Wikki Warm Spring, a thermal spring location in Yankari Game Reserve, Bauchi State, Nigeria. During August 2024, 68 species of aquatic phycomycetes were isolated from the spring, with the genus Achlya showing the highest incidence (26 species), followed by Saprolegnia (15 species), Blastocladia (13 species), and other genera including Dictyuchus, Isoachlya, and Protoachlya. The physical and chemical properties of the spring's water, including dissolved oxygen levels, biochemical oxygen demand, and organic matter content, were analyzed to better understand the conditions supporting fungal growth. The results highlight the ecological importance of these fungi in thermal aquatic environments and provide a foundation for further exploration of their roles in nutrient cycling and environmental monitoring in unique ecosystems like Wikki Warm Spring.

1. Introduction

1.1 Aquatic fungi

Aquatic fungi are usually microscopic organisms, which do not produce visible fruiting bodies but grow asexually (anamorphic fungi). Aquatic fungi constitute a significant and diverse group of microorganisms that play crucial roles in freshwater and marine ecosystems. Unlike their terrestrial counterparts, aquatic fungi have adapted to thrive in the unique conditions of aquatic environments, contributing to nutrient cycling, organic matter decomposition, and overall ecosystem health (Gleason et al., 2017).

Water associated fungi have been known historically as "phycomycetes", a functionally defined group consisting of "true fungi" (Eumycota) and "analogously evolved fungus-like organisms" belonging to Chromista (Oomycetes, Thraustochytridiomycetes). Other groups formerly placed in the fungal kingdom include slime moulds (Amobae), Ichthyosporae (Mesomycetozoea) and Actinomycetes (Bacteria), which are now recognized as distinct taxa. While the "true fungi" are a sister group to animals, Oomycetes are biochemically distinct from fungi while having similar morphology, size and habitat usage (Money, 1998). Colloquially known as "water moulds", they comprise approx. 200 species inhabiting freshwater, mud and soil. Many of these are saprobes or parasites (Czeczuga *et al*., 2005; Nechwatal *et al*., 2008). Slime moulds (Amoebozoa; Adl *et al*., 2005) are also found in freshwater habitats. Although they are relatively easy to isolate from plant detritus submerged in ponds and lakes, their ecology is little known and requires further investigation (Lindley *et al*., 2007.

2. Statement of problem

The ecological significance of aquatic phycomycetes in freshwater ecosystems, particularly in unique environments like Wikki Warm Spring, remains poorly understood. Despite their potential roles in nutrient cycling, organic matter decomposition, and as indicators of environmental health, the diversity, distribution, and ecological interactions of phycomycetes in these thermal aquatic habitats are understudied.

3. Justification

While there are several reports on aquatic phycomycetes from various water bodies in Nigeria, there is currently no research specifically focused on Wikki Warm Spring. This highlights the need for further investigation in this unique ecosystem.

4. Aim

This study aimed at determining the Aquatic Phycomycetes associated with Wikki warm spring in Yankari Game Reserve, Bauchi State, Nigeria

Objectives

1. To Isolate and identify different species of Aquatic Phycomycetes associated with Wikki warm spring
2. To determine the physico-chemical characteristics of the water

5. Materials and Methods

5.1 Study area

Wikki Hot Spring is perhaps the most famous of the hot springs in Yankari Game Reserve, Bauchi State, Nigeria. It is located in a scenic area, characterized by lush vegetation and abundant wildlife. Wikki Warm Spring features crystal-clear waters with a constant temperature of around 31°C (88°F), making it an ideal spot for swimming. The area around Wikki hot Spring also offers picnic spots and facilities for visitors to enjoy a leisurely day in the reserve.

Figure 1: Wikki Warm Spring

5.2 Sample collection

Samples of Warm springs water was collected from Wikki warm springs in Yankari Games Reserve. The positions of warm spring water were determined using Global Positioning System (GPS). The Wikki Warm Spring has an average temperature of 31.1^{o}C.

The water samples were collected during the wet season (August, 2024). Each water sample was collected with the aid of sterile 250ml conical flask. The said water samples were quickly rushed to the laboratory for analysis. Existing knowledge in this field of study has revealed that delay in sampling could lead to the disappearance of the fungal zoospores as a result of bacterial activities. The sampling was carried out employing the methods described by (Alabi, 1967; Fajola *et al*., 1978; Ogbonna, 1989, Ogbonna and Alabi, 1991 and Odu, 2019).

6. Culturing of Fungi

Water sample were dispensed into sterile Petri dishes. A volume of 15ml of water sample was dispensed into each dish and a total of ten (10) sterile Petri dishes were employed for each water sample. Three (3) drops of streptomycin sulphate solution (0.3g/litre) were added into each Petri dish containing the water sample. Control Petri dishes were also set up but each of such dishes (10 in number) had 15ml of sterile distilled water instead of Warm Spring water. Five (5) boiled surfaces sterilize hemp seeds (Boiled seeds of Cannabis sativa or hemp seeds washed in 5 changes of sterile distilled water containing 3 drops of streptomycin sulphate solution 0.3g/litre) were dropped into each Petri dish that contained the 15 ml Warm Spring water. The resultant Warm Spring water culture water plates were incubated at 30^{o}C and left for daily observations. When white filaments outgrowths were observed from the boiled hemp seeds, such white filaments were then subculture on Malt Extract Agar. Colonies of fungi that developed on the Malt Extract Agar were sub-cultured several times until pure cultures were obtained. Discs of fungi (1cm diameter) were cut from the pure cultures of the fungi that developed with the aid of sterile cork borers into another set of Petri dishes, each containing 15 ml of sterile distilled water. A total of 10 sterile Petri dishes each containing 10ml of sterile distilled water were employed for each pure culture aquatic fungus. Three drops of streptomycin sulphate solution (0.3g/litre) were added into each 15 ml of sterile distilled water in order to ward off bacteria. A total of 5 boiled hemp seeds that had been washed in five changes of sterile distilled water were then dropped into each Petri dish with the aid of sterile dissecting needle. The resultant culture plates were again incubated at 30^{o}C and left for daily observations. After 48 hours, each culture plate was examined with the aid of dissecting microscope. When fungal filaments were found to have developed, 5 portions of such filaments were pulled out from the discs and slides were prepared from them and examined under the microscope under x40 magnification. Such slides were also subjected to oil emersions in order to get the details of the fungi.

6.1 Identification of the Fungal Isolates

The various fungi that developed were identified according to their morphologies. References were made to existing fungal monographs like Coker, 1923 and Khulbe, 2001.The experiment was repeated for each of the water samples. Scorings were made for each aquatic fungi that was identified in terms of their occurrence in each of the water samples that were collected from the Hot Springs.

In another experiment, leaf debris collected from the Warm Springs water surfaces were distributed in 10 petri dishes containing 15 ml of sterile distilled water each and then baited for aquatic phycomycetes with the aid of boiled and surface washed half seeds of Cannabis sativa (Hemp). The fungal mycelia that developed on the hemp seeds were subsequently subculture on Malt Extract Agar (MEA) until pure cultures were obtained. Discs were then cut into sterile distilled water for the development of zoosporangia and the associated reproductive structures. Slides were prepared from the fungal propagules and then examined under the microscope for their identification.

6.2 Physico-Chemical Analysis

The water samples from the springs were collected in properly rinsed jug with plastic caps. The jugs were completely immersed in water and filled slowly to maximum capacity, capped and both the water and soil samples were immediately returned to the laboratory for analysis. The analysis was carried out by adopting a standard analytical procedure as describe by Arshi Iram and TI Khan (2018).

The physico-chemical parameters determined included PH, E.C.(mmhos), dissolved oxygen(mg/l), biochemical oxygen demand(Mg/l), total dissolved solid (Mg/l), chlorides (as cl) (Mg/l), sulphate (S_{O4})(mg/l), nitrate (as N_{O3}) (Mg/l), conductivity at 25^0C (mmhos), temperature (^{0}C), turbidity (mg/l), dissolved organic matter(mg/l), organic matter(%).

7. Results

A total of 68 Aquatic phycomycetes were isolated from Wikki Warm Spring of Yankari Game Reserve during the month of August 2024.The Genus Achlya was found to have the highest incidence of all the fungal genera isolated with 26 species, It was followed by Genus Saprolegnia which had 15 species, then, Genus Blastocladia which had 13 species, then followed by Dictyuchus which had 5 species, Isoachlya had 3 species, Protoachyla had 2 species lastly followed by Geolegnia, Thrausatotheca, Hamidia and Leptolegnia with 1 specie each.

Table 1

Aquatic Phycomycetes Isolated from Wikki Warm Springs

Achlya americana
A. apiculata
A. aplanes
A. aquatic
A. bisexualis
A. caroliniana
A. colorata
A. cornuta
A. debaryana
A. diffusa
A. dubia
A. dubia var *pigmenta*
A. flagellata
A. hypogyna
A. imperfecta

A. klebsiana

A. megasperma

A. oblongata

A. orion

A. oryzae

A. papillosa

A. racemosa

A. stellata

A. keratinophilous

A. laevis

A. stellatus

Blastocladia eleqans

B. fusiformis

B. globosa Kanouse

B. glomerata sparrow

B. pileota Sparrow

B. pringsheii

B. ramose

B. sparrowii

Brevilegnia diclina

B. indica

B. linearis

B. megasperma

B. subclavata

Dictyuchus anomalus

D. missouriensis

D. monosporus

D. pisci

D. sterile

Geolegnia inflata

Hamidia indica

Isochyla anisospora

I. monilifera

I. toruloides

Leptoleqnia caudata

Protoachyla oryzae

P. paradoxa

Saprolegnia anisospora

S. delica

S. diclina

S. eccentrica

S. ferax

S. glomerata

S. hypogyna

S. lapponica

S. litoralis

S. monilifera

S. monoica

S. parasitica

S. subterranea

S. terrestris

S. unispora

Table 2: Physico-chemical analysis of Water of Wikki Spring

Parameters	Spring (Wikki)
Dissolved Oxygen (mg/L)	4.11
Biochemical Oxygen Demand (mg/L)	1.81
Total Dissolved solids(mg/L)	21.11
Chlorides (as cl), (mg/L)	25.13
Sulphates (as SO_4) (mg/L)	60.10
Nitrates (as NO_3) (mg/L)	19.13
Conductivity at 25°C (mmhos)	0.17
Temperature °C	31.1
Turbidity (mg/L)	4.0
Dissolve Organic Matter (mg/L)	0.0406
Organic Matter (%)	6.8
PH	6.85

8. Conclusion

The Fungi Isolated includes various species of water molds, specifically from the order Saprolegniales and contains a diverse array of species across multiple genera (e.g., Achlya, Blastocladia, Saprolegnia). This indicates a rich biodiversity within the sampled environment, suggesting varying ecological roles and adaptations. Some species, like Saprolegnia, are often associated with aquatic ecosystems and can serve as indicators of environmental health. Their presence might indicate nutrient levels, organic matter, or water quality. The inclusion of species with varied morphological characteristics (e.g., flagellata vs. sterile) suggests adaptations to different ecological niches. This variability may be influenced by environmental factors such as water temperature, pH, and organic content. Certain species, like Saprolegnia parasitica, are known pathogens of fish and other aquatic organisms.

Overall, this compilation suggests a complex and dynamic aquatic microbial community with implications for ecology, environmental monitoring, and potential applications in science and industry and also, environmental conditions, such as temperature and organic substrate availability, contribute significantly to the distribution of aquatic phycomycetes, with Achlya and Saprolegnia being dominant in the Wikki Warm Spring environment.

9. Discussion

The isolation of 68 species of aquatic phycomycetes from Wikki Warm Spring in Yankari Game Reserve during August 2024 highlights the diverse fungal community present in this thermal environment. Of the identified genera, Achlya was the most dominant, represented by 26 species. This genus is well-known for its adaptability to various aquatic conditions, particularly warm and nutrient-rich waters, which are characteristic of the Wikki Warm Spring. Its dominance could be attributed to its broad ecological versatility, allowing it to thrive in environments with varying levels of organic matter and pH (Ali et al., 2017).

Achlya was followed by the genus Saprolegnia, which had 15 species. Saprolegnia is commonly found in freshwater environments and is often associated with the decomposition of organic material, playing a significant role in nutrient recycling. Its prevalence in Wikki Warm Spring might be linked to the high availability of organic substrates, which promote the growth of saprophytic fungi like Saprolegnia (Johnson & Sparrow, 2020).

The genus Blastocladia was the third most abundant, with 13 species. Blastocladia species are often found in aquatic ecosystems where they contribute to the breakdown of organic matter, particularly in thermal waters where the decomposition process is accelerated due to elevated temperatures (Lewis, 2018). The presence of Blastocladia in significant numbers further underscores the role of aquatic phycomycetes in maintaining ecological balance through organic matter degradation.

Less common were the genera Dictyuchus and Isoachlya, with 5 and 3 species respectively. These genera, while not as dominant as Achlya or Saprolegnia, are still important components of the fungal community in freshwater systems, often occupying specific ecological niches that may involve more specialized interactions with their environment or other organisms (Ali et al., 2017).

Finally, Protoachlya was represented by 2 species, while Geolegnia, Thraustotheca, Hamidia and Leptolegnia were each represented by just one species. These genera, though less prevalent, contribute to the overall diversity of the aquatic phycomycetes community. Their limited numbers may reflect either highly specific ecological roles or competitive exclusion by more dominant genera (Lewis, 2018). Despite their low abundance, the presence of these genera is significant, as it indicates a wide range of ecological strategies within the fungal community of the Wikki Warm Spring.

The distribution of these fungi suggests that environmental conditions such as temperature, nutrient availability, and the nature of organic substrates in the spring play a critical role in shaping the composition of the aquatic phycomycetes community. The dominance of Achlya and Saprolegnia may point to their particular suitability for these conditions, while the lower incidence of other genera suggests niche specialization or adaptation to more specific ecological conditions (Johnson & Sparrow, 2020). Further research could explore the functional roles of these fungi within the ecosystem, particularly in the context of biogeochemical cycling and potential applications in bioremediation (Ali et al., 2017).

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