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Inventaire des lichens dans le Parc National du Djurdjura (accompagné d'une carte de localisation)

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General introduction

General introduction

Biodiversity, or biological diversity, is a concept that encompasses the variety and diversity of life on Earth, at all levels of organization, from genes to ecosystems.**(Rawat & Agarwal, 2015)**.it includes the multitude of animal, plant, fungal, and microbial species, as well as the complex interactions between these different forms of life and their environment**(Wilson, 1988)**. biodiversity is facing unprecedented threats due to human activities such as habitat destruction, pollution, overexploitation of resources, and climate change **(Pereira et al., 2012)**. These threats not only endanger countless species but also threaten the stability and resilience of entire ecosystems, upon which human well-being ultimately depends **(Elisha & Felix, 2020)**. In the face of these challenges, understanding, conserving, and restoring biodiversity has become a global priority. By recognizing the importance of biodiversity and taking concerted action to protect it, we can safeguard the intricate tapestry of life on Earth for future generations **(Onoh et al., 2024)**.

The biodiversity of the Djurdjura National Park is truly remarkable. Its varied ecosystems, from rocky peaks to steep-sided valleys, are home to a multitude of plant and animal species, many of which are endemic to the region **(Meddour & Sahar, 2021)**. From oak and cedar forests to alpine meadows, steep cliffs and refreshing waterfalls, every corner of the park offers a unique habitat for a diversity of living organisms **(Chaker et al., 2021)**. The deterioration and disappearance of habitats represent the main threat to biodiversity in general and particularly for lichens **(Scheidegger & Werth, 2009).**Habitat loss leads to a decrease in local population sizes, similarly affecting saxicolous, terricolous, and epiphytic species. This habitat loss is identified as the most widespread threat to lichens, with clear-cutting in old or natural forests accounting for 63% of lost sites **(Wolseley, 1995).**Deforestation and degradation of lichen habitats due to the replacement of natural forests with plantations both have a significant impact on the richness and specific composition of lichen communities**(Ellis, 2012)**. These trends are also observed along a continental gradient encompassing different bioclimatic regions **(Stofer et al., 2006)**. It should be noted that crustacean lichens, with low exchanges and slower growth than foliose and fruticulose lichens, seem to be less affected by air pollution and more resistant to the industrial and urban environment. Thus, during an initial observation of the lichen flora of an environment, an initial diagnosis of air quality can be advanced according to the types of thalli mainly present on tree trunks **(LA QUALITÉ, s. d.)**.

In the most remote corners of our planet, where conditions are sometimes unsuitable for life, a strange alliance between fungi and algae or cyanobacteria thrives. These enigmatic organisms, known as lichens, defy expectations and reveal the extraordinary diversity of the fungal kingdom **(Klepzig et al., 2001).** Until the 18th century, lichens were considered simple beings **(Honegger, 2000)**. In 1867, Schwendener recognized the dual nature of lichens by showing that their green cells belonged to genera of algae and their other cells to fungi. These two types of cells form two partners that live intimately linked **(Honegger, 2000).** Lichens, intriguing organisms, emerge from a symbiotic partnership between fungi and algae or cyanobacteria **(Honegger, 1998).** In terms of ecology, lichens are true pioneers **(BENDAkHA et al., 2022)**. They are extremely versatile in terms of habitat, allowing them to colonize a wide variety of environments, from polar regions to deserts and urban areas **(V. Shukla et al., 2014)**. In polar regions, lichens can form colorful mats on frozen tundra, while in deserts, they find refuge on rocky and sandy surfaces by utilizing moisture from the air **(Mallen-Cooper et al., 2021)**. Even in urban environments, lichens can be found on building walls and sidewalks, demonstrating their ability to adapt to often harsh conditions **(Lundholm, 2011).**

Lichen growth varies significantly depending on environmental factors**(Armstrong, 2013)**. Consequently, these lichens have no means of defense against environmental aggressions , which results in a direct dependence on the atmosphere and a high accumulation capacity, adding to other structural and physiological characteristics **(Grube, 2010)**.

Lichens are extremely sensitive to air pollution**,** which positions them as bioindicators for assessing air quality **(Nash, 2008)**. Their ability to accumulate harmful substances present in the atmosphere, such as heavy metals and volatile organic compounds, makes them particularly effective in this role **(Garty, 2001)**.

In addition, lichens possess significant therapeutic properties, including antiviral, antioxidant, antifungal, antibacterial, and cytotoxic effects **(WA et al., 2021)**. These properties have drawn increasing attention from researchers exploring their potential applications in pharmaceuticals and traditional medicine **(Ureña-Vacas et al., 2022)**.

The study of lichenology in Algeria dates back more than a century**(Amrani et al., 2015)**, but it remains relatively marginal compared to other scientific disciplines **(Rebbas et al., 2011)**. In the past, lichens have frequently been overlooked, but in recent decades, they have garnered renewed interest from the scientific community. Regrettably, in Algeria, where much of the territory remains unexplored and likely harbors numerous undiscovered species, research on lichen diversity has failed to capture the attention of Algerian scientists. In an effort to revitalize lichenological research in Algeria, which has been hindered by the absence of an up-to-date lichen flora, catalogue, or even a checklist **(Amrani et al., 2015)**.

Some lichenological studies in Algeria have focused on the distribution of lichen species in different regions of the country, as well as their response to environmental factors such as climate, geology, and pollution. These studies have contributed to a better understanding of lichen biodiversity in Algeria and their role in local ecosystems **(Hamralaine et al., 2019)**.

Despite the progress made, there is still much to be done to deepen our knowledge of lichens in Algeria. Further studies are needed to assess the impact of human activities on lichen populations, identify threatened species and develop effective conservation strategies **(Kerboua et al., 2021)**.

The lack of work in the field of lichenology in Algeria prompted us to undertake the study of the lichens of national park of Djurdjura to enrich our knowledge of the country's lichen flora and to contribute to the development of the inventory of lichens in Tikjda. Our study aims to comprehensively identify the lichens present in the Tikjda region and map their geographical distribution using GIS, which are essential tools to study the distribution of lichens at different spatial scales. With its ability to integrate, analyze, and visualize complex geographic data, GIS allows researchers to accurately map the distribution of lichen species. This includes modelling their habitat, detecting environmental factors influencing their presence, and identifying areas with high potential for lichen population conservation or restoration.

Chapter I: Bibliographical section

1. Definition:

The word "lichen" comes from the Greek "leikhen" which means "lick," as the lichen seems to lick its support **(Kularatne, 2012)**. It is also composed of a borrowing from the Latin word lichen and the Greek leichên, which meant "leprosy" and "rash" **(Chevalier, 2003).** Historically, lichens were considered to be intermediate beings between algae and fungi. However, they are among the first organisms to have colonized the earth. Lichens are symbiotic plants consisting of an alga or a cyanobacterium, called the phycobiont, and a fungus called the mycobiont **(DERVELLE, 1983)**. In symbiosis, the fungus provides the alga with a humid environment and the necessary mineral salts, while the alga supplies the fungus with organic products through photosynthesis **(Watkinson, 2016)** .

2. Biology of Lichens:

Lichens are organisms that differ from higher plants by several unique characteristics. Unlike higher plants, lichens do not have a vascular system to transport water and mineral salts. They absorb them passively from the atmosphere and rain, which explains their cyclical activity. When hydrated, they photosynthesize actively but dehydrate and enter dormancy in dry weather. This adaptation allows them to survive extreme drought conditions that higher plants cannot tolerate. Lichens are characterized by a slow metabolism, resulting in slower growth compared to higher plants. They also have a high capacity to accumulate substances, including atmospheric pollutants. They do not possess an impermeable cuticle like flowering plants, allowing direct exchange with the atmosphere. Additionally, they lack stomata, structures that regulate the opening and closing of leaves in plants. Finally, their reproduction occurs through aerial structures, the spores, directly exposed to pollutants **(Deruelle & Lallemant, 1983).**

3. Morphology of Lichens:

The fungus is responsible for the morphology of lichens **(Deising, 2009)**. The body of a lichen, called a thallus, is formed by a network of filaments called hyphae, among which the algae are found. The thallus, which ensures the nutrition, survival, and growth of the lichen, has a specific morphology different from that of free algae and fungi **(Grube, 2010)** . The morphology of the lichen thallus, characteristic and diverse, can be crustose, lobed or non-lobed, foliose, umbilicate, complex, or fruticose. Depending on the internal organization of the hyphae and the algae, the structure of the thallus can be homoiomerous or heteromerous **(Notov, 2014)**. This remarkable diversity of forms and structures reflects the adaptation of lichens to various environments and is a key element of their classification. Thus, several types of thalli are distinguished:

a) **Crustose thalli:** Tightly attached to the substrate (rock, wood, etc.), they cannot be separated from it. Their surface can be smooth, cracked, or verrucose. Examples: Lecanora, Rhizocarpon.

Figure.1 Crustose thalli

b) **Foliose thalli:** Resembling small leaves, they spread out on the substrate and attach more or less firmly by structures called rhizines. The underside of the thallus can be smooth, hairy, or have hairs. Examples: Parmelia, Xanthoria.

Figure.2 Foliose thalli

c) **Squamulose thalli:** Composed of small scales or squamules, often overlapping, they adhere to the substrate by their underside. Examples: Squamarina, Toninia.

Figure.3 Squamulose thalli

d) **Fruticose thalli:** Erect on the substrate, they are only attached by their base. They can have various shapes: branched, tubular, ribbon-like, etc. Examples: Anaptychia, Evernia.


Figure.4 Fruticose thalli

e) **Gelatinous thalli:** When hydrated, they form translucent gelatinous masses that contract and harden when drying. Examples: Collema, Lathagrium.

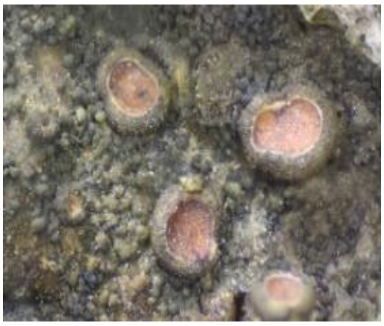



Figure.5 Gelatinous thalli

f) **Filamentous thalli:** Consisting of thin, branched filaments, they spread out on the substrate forming a loose mat. Examples: Usnea.

Figure.6 Filamentous thalli

g) **Composite thalli:** Resulting from the association of two distinct types of thalli: a primary thallus, usually crustose or foliose, and a secondary thallus, erect and fruticose. Example: Cladonia.

Figure.7 Composite thalli

This diversity of thallus forms in lichens demonstrates their ability to adapt to varied environmental conditions. This morphological diversity is also an important element in their identification and classification **(Ahmadijian, 2012)** .

4. Structure of Lichens:

At the heart of lichens lies an astonishingly complex and elaborate structure, the result of a symbiotic association between a fungus and a microscopic alga. This unique organization, invisible to the naked eye, ensures the survival and development of these remarkable organisms.

According to Asta (1994), the hyphae, fungal filaments, constitute the framework of the thallus, the body of the lichen. Representing 90% of the total biomass, they form a dense and branched network that envelops and protects the algae **(Debras, 2022)**. The shape of the lichen, whether foliose, crustose, or fruticose, is determined by the arrangement and growth of these hyphae **(Jahns, 1973)**.

The distribution of algae within the lichen thallus defines two main types of structures:

- Homoiomerous structure: Here, algae and hyphae are intimately intertwined, evenly distributed throughout the thallus. This organization is often found in crustose lichens and some foliose lichens **(Jahns, 1973)**.
- Heteromerous structure: In this case, the thallus presents a more complex organization with distinct layers specialized in specific functions. There are two types of heteromerous structures **(BOOK, s. d.).**
- Stratified heteromerous structure: This organization is characteristic of most foliose lichens and some fruticose lichens. From the surface inward, one can observe an upper

cortex, a gonidial layer rich in algae, a medulla formed of loose hyphae, and a lower cortex **(Honegger, 1991) .**

- Radiate heteromerous structure: Found in most fruticose lichens, this structure features a continuous gonidial layer surrounding the cross-section of the thallus. The medulla can vary, ranging from a dense axial cord in Usnea to a hollow structure in Alectoria **(Clauzade & Ozenda, 1970).**

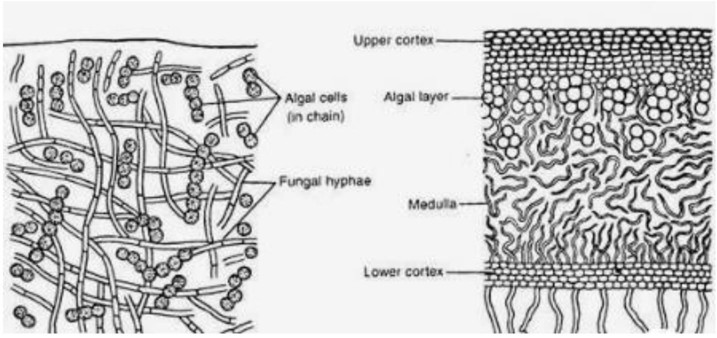


Figure.8 Internal structure of lichen thallus.

5. **Reproduction in Lichens:**

Two main modes of reproduction coexist in lichens: asexual reproduction and sexual reproduction.

a) **Asexual reproduction:**

Soredia and isidia: These specialized structures, consisting of both fungi and algae, easily detach from the thallus, the body of the lichen. Transported by wind, animals, or rain, they allow for effective and rapid dispersion to new habitats **(Warren et al., 2019)**.

Fragmentation of the thallus: Pieces of the thallus, broken off by natural factors or humans, can also develop and give rise to new lichens **(V. Shukla et al., 2014)**.

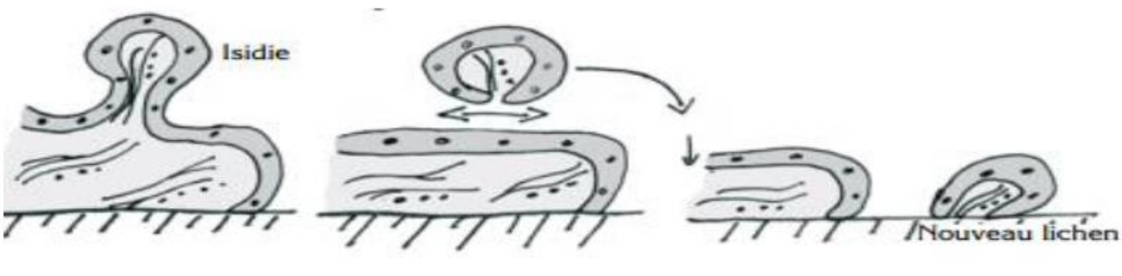


Figure.9 Asexual reproduction by isidia

b) Sexual reproduction:

Apothecia: These cup-shaped structures produce sexual spores of the fungus. These spores, dispersed by the wind, germinate and give rise to fungal filaments that must then capture a compatible alga to form a new lichen **(Hurley, 2024)**.

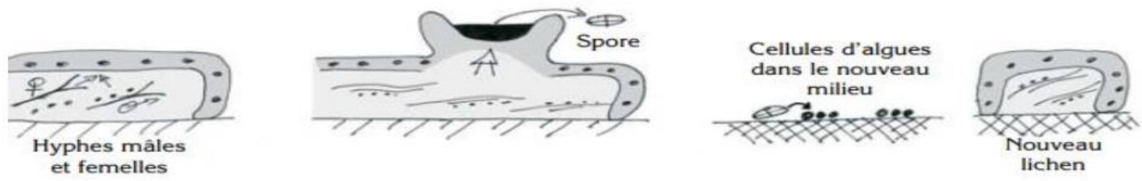


Figure.10 mechanism of sexual reproduction.

6. Ecology of Lichens:

Lichens, true pioneers, adapt to extremely varied environments, colonizing habitats ranging from lush forests to sanitized urban landscapes. They are even found in some aquatic environments, and their presence extends across the planet, including the poles and high altitudes, at the edge of perpetual snow **(Roux & lichénologie, 2014).** This exceptional adaptability results in remarkable morphological and ecological diversity, allowing them to thrive in extreme conditions of temperature, humidity, and light. The distribution of lichens is influenced by a complex set of interacting factors **(Boruah et al., 2024)**:

a. Substrate factors:

Nature of the support, pH, texture, porosity, water and mineral content. These elements determine the lichens' ability to adhere and draw the necessary resources for their survival **(R. S. Shukla & Chandel, 2010)**. Three main types of communities are distinguished based on the nature of the support they colonize:

a) Saxicolous lichens: Masters of rocks, they thrive on the most inhospitable surfaces.
b) Terricolous lichens: They cover bare soil, rocks, and integrate into grasslands, heaths, and open woods.
c) Epiphytic lichens: Acrobats of the plant world, they colonize the bark of trees and shrubs, both coniferous and deciduous.

b. Climatic factors:

Temperature, humidity, sunlight, wind. These parameters directly influence the physiological processes of lichens, such as photosynthesis and growth **(Lechowicz, 1982)**.

c. Biological factors:

Competition among lichens and other organisms, predation by animals, anthropogenic action. These interactions alter environmental conditions and create microclimates favorable or unfavorable to colonization **(Asplund & Wardle, 2017)**.

7. Uses of Lichens:

Beyond their crucial ecological role, lichens possess remarkable properties that make them valuable to humans. These fascinating symbioses offer a range of uses **(Lawrey, 1986)**

a) Food and feed use:

While direct human consumption of lichens remains marginal, they have been a survival food source during times of famine, particularly in northern regions. Rich in carbohydrates and proteins, certain species like Cetraria islandica have nourished both human and animal populations **(Huss-Ashmore & Johnston, 1997)**.

Even today, lichens are an important part of the diet for reindeer and caribou, providing essential nutrients in harsh environments.

b) Cosmetic and pharmaceutical uses:

Lichens offer perfumers a palette of subtle and persistent scents, used in the creation of unique perfumes and essences. Also, Lichens contain an arsenal of compounds with remarkable properties. Natural antibiotics, powerful anti-inflammatory agents, and photoprotective agents, their therapeutic applications are the subject of promising research. Usnic acid, derived from Usnea, is noted for its activity against a variety of bacteria, including the formidable Escherichia coli **(Elkhateeb et al., 2022)**.

c) Environmental bio-monitoring:

True environmental sentinels, lichens are valuable indicators of air quality. Their sensitivity to atmospheric pollutants makes them formidable allies in monitoring the state of our environment. The presence or absence of certain species, as well as their health status, provides information on pollution levels and alerts to the dangers faced by ecosystems **(Ristić et al., 2021)**.

Chapter II: Inventory of lichens in the Djurdjura National Park

1. Introduction

Nestled within Djurdjura National Park, the Tikjda region boasts a breathtaking tapestry of landscapes. Towering, glacier-carved peaks give way to slopes teeming with life, while lush forests and vibrant meadows provide a haven for diverse wildlife. Beyond these grand vistas lies a hidden world—the realm of lichens.

Lichens, often overlooked, add an intricate layer of beauty to the Tikjda environment. Their diverse forms, ranging from delicate crusts to colorful fronds, adorn rocks, branches, and soil with a unique palette. Beyond their aesthetic appeal, lichens play a crucial ecological role by contributing to biodiversity and serving as sensitive indicators of air quality.

Despite their significance, knowledge about lichens in Tikjda remains limited. The small size of lichens, the need for microscopic or chemical analysis for accurate identification, and the sheer variety of species pose considerable challenges to comprehensive study.

To address this knowledge gap, we propose a comprehensive lichen inventory project within Djurdjura National Park, with a specific focus on the Tikjda region. This project aims to document the rich lichen habitats of the area, including rocky outcrops, ancient forests, alpine meadows, and riverbanks. By doing so, we hope to uncover the hidden diversity of lichens, potentially including species new to science or previously unrecorded in Algeria.

The findings from this inventory will be invaluable for understanding the overall health of the Tikjda ecosystem. The baseline data collected will facilitate future monitoring efforts, allowing scientists to track changes in lichen communities over time and identify potential environmental threats. Moreover, this information will enhance resource management within Djurdjura National Park, enabling informed conservation decisions to protect this irreplaceable natural treasure.

This work presents the initial steps and methodologies for conducting a lichen inventory in the Tikjda region, highlighting the importance of such an endeavor for ecological research and conservation.

2. Materials and methods

2.1.Study site

2.1.1. Description and location

Tikjda region is located within the Djurdjura National Park (DNP), initially established on 18 September 1925 as a protected area during Algeria's colonial period, spans 16,550 hectares, originally dedicated solely to leisure and recreation. With Algeria's independence, a significant transformation occurred **(Meddour & Sahar, 2021).**

By Presidential Decree No. 83-460 on 23 July 1983, the park attained official status as a public institution under the oversight of the DGF (Direction Générale des Forêts) and the Ministry of Agriculture. Its administrative framework expanded, now encompassing approximately 18,550 hectares, integrating territories from two wilayas (Arar et al., s. d.)**.** Of this, 10,340 hectares reside on the northern slope within the wilaya of Tizi Ouzou, and 8,210 hectares on the southern slope within the wilaya of Bouira.

In 1997, the DNP garnered further recognition as a UNESCO MAB biosphere reserve, solidifying its commitment to biodiversity preservation under the auspices of the MAB program **(loukkas, 2006).**

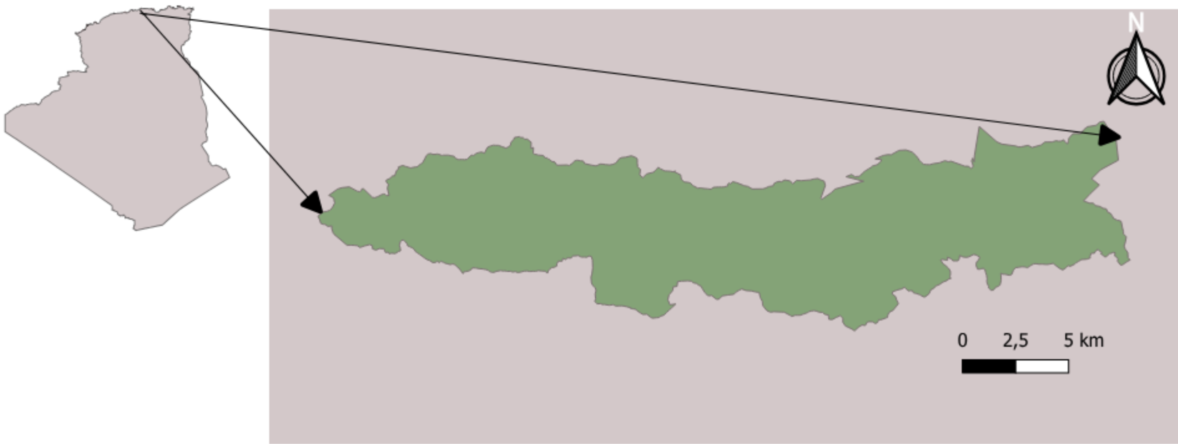


Figure 11: **Map of the geographical location of Djurdjura National Park.**

The Djurdjura National Park (DNP) is located in the north of Algeria, in the Greater Kabylia region, 140 km southeast of Algiers and 50 km from the Mediterranean Sea.

The territory of this park is laid out according to an arch trunk, oriented from east to west over 50 km long and 03 to 10 km wide It is considered a biodiversity basin. Occupying the central region of Tellien **(loukkas, 2006)**, the Djurdjura National Park is an important ecosystem.

It is divided into five sectors, including the Tikjda sector on which our study focuses**.**

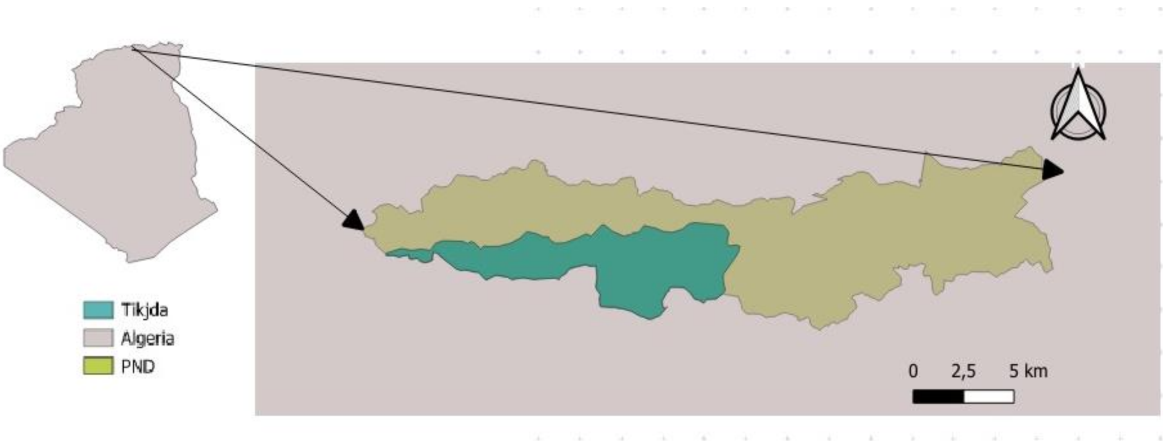


Figure.12 Map of the geographical location of Tikjda Park Sector.

2.1.2. Climate:

The Tikjda region is located in the humid bioclimate with a cool variant, due to its location on the southern slope of the Djurdjura, the region is directly influenced by warm winds (siroco) and the snow period can reach four months in the best years. The lack of weather stations in the reserve makes it difficult to characterize the climate **(Ouyed & Begriche, 2020)**.

It has a dry period of 4 months (June to September) and an estimated average rainfall of 719.7 mm/year as for the monthly temperatures, they vary from 7.7 °C to 24.5 °C **(Roudjiat, 2020).**

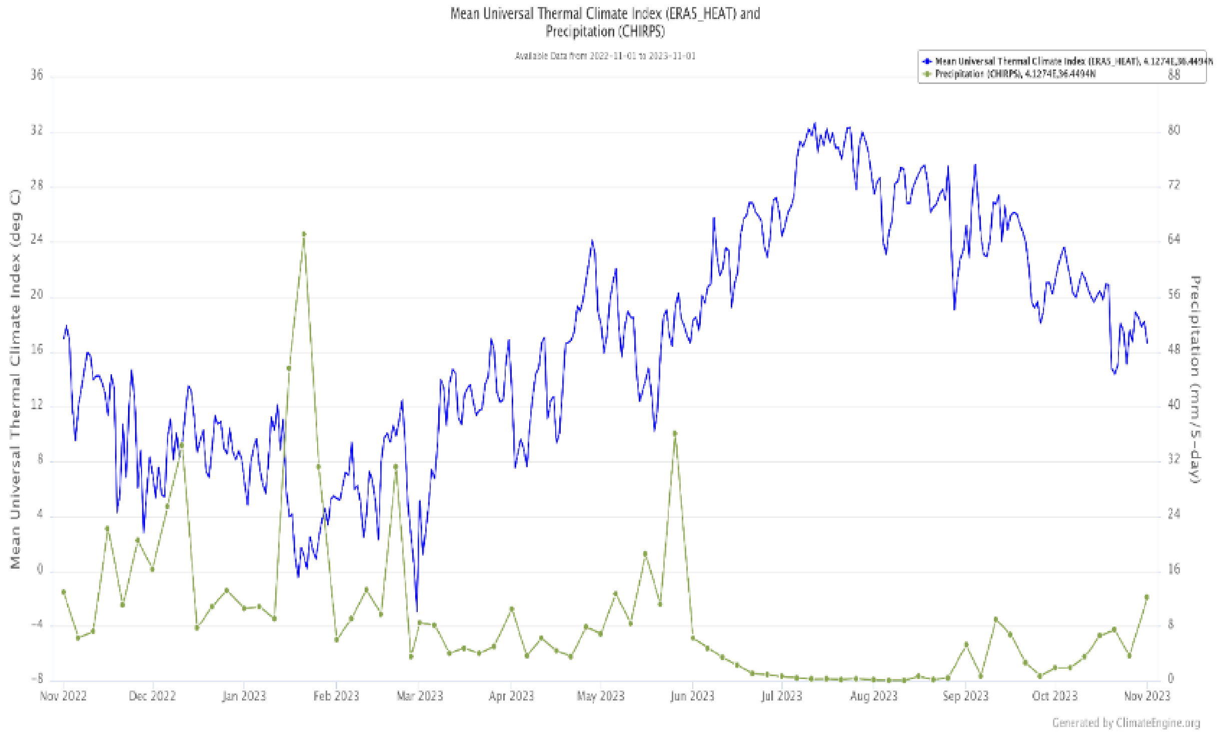


Figure.13 Embrothermic Diagram.

2.2.Field Sampling

Several field trips were carried out between April and June. The choice of stations is conditioned not only by ecological factors, i.e. the homogeneity of the vegetation formations and the abundance of the substrate, but also by physical factors such as topography and accessibility.

Figure.14 Map of sampling site.

The DNP is a favorable environment for the propagation and development of lichens. Several surveys have been carried out on different substrates, either on bark (epiphyte), rock (Saxicole), or on land (soil). For each station, a technical sheet is developed where we note the Lambert coordinates of the station using a GPS, the nature of the substrate, location and the date.

These surveys are divided into three parts, depending on the nature of the substrate. For epiphytes, crustacean species are very adherent to the substrate (bark) where they are attached, in this case it is necessary to also remove the substrate with a sharp knife. We noticed in the field that the most abundant lichens in the study area are those that grow on rocks. With the help of a hammer, the rocks are broken, hence the lichen samples that go with them. These are kept in paper envelopes and then put in bags and preserved.

As for the soil and muscicolous species, they are generally harvested easily with a good knife/cutter or simply by hand, taking care to remove the base. If the lichens are very dry and brittle, it is sometimes useful to moisten them before removing them.

2.3.Technique for the determination of lichen samples

Identifying lichens can be an exciting and complex challenge due to the diversity of species and the subtle morphological variations between them. Here are some general steps to identify lichens:

2.3.1. Macroscopic observation:

Start by observing the macroscopic characteristics of the lichen, such as its shape, size, color, and texture. Also note its habitat and substrate (rock, tree bark, soil, etc.).

Figure.15 The Thallus.

2.4.Examination of the thallus:

The thallus is the main body of the lichen. Observe its shape (foliose, crustacean, fruiting) and texture (smooth, rough, scaly). Also note if it is attached to the substrate by specific structures such as rhizines or spikes.

Figure.16 Complex thallus *Cladonia fimbriata.*

2.5.Examination of reproductive structures:

Lichens usually reproduce by specific structures such as apothecia (for ascomycete lichens) or pycnidia (for some crustacean lichens). Observe their shape, color, and arrangement on the thallus.

Figure.17 Magnifying glasses.

2.6.Chemical reaction:

Some species of lichens react characteristically to certain chemical reagents such as sodium hypochlorite (rated C), Potash(K), Paraphenylenediamine(P), The Lugol (I) and Nitric acid (N). These reactions can help distinguish between different species.**(Rebbas et al., 2011).**

Figure.18 Chemicals used in lichen identification.

2.7.Using Determination Keys:

Determination Keys are guides that help you identify lichens by asking a series of questions about their characteristics. Such as: **italic7.0 - Lichenologie.fr.**

The determination of the lichen samples was made at the laboratory of the Bouira University. Several floras have been used for the determination of DNP lichens.

The determination of lichens is first done with the aid of a pocket magnifying glass and a binocular magnifying glass to see the general physiognomic appearance, then by consulting the different floras, the species or genus is noted, and there, if difficulties are found which are expressed by differences between two genera or two species, the use of chemical reagents is performed **(Rebbas et al., 2011b)**

It is not always sufficient to rely solely on the morphological characteristics of lichen thalli to identify it. Thus, we have to carry out chemical tests with certain reagents that, in contact with the thallus, produce particular stains.

Figure.19 Thallus.

The identification of lichens is confirmed by colorimetric reactions, which shows deferential reactions depending on the species. The reagents are applied directly to the fronds, on a surface free of impurities **(Lindsay, 1869).**

Colored reactions are carried out by directly applying the reagent onto the thallus, after exposing the medulla by scraping or scratching the upper cortex.

Figure.20 Chemical test on Xanthoria parientina K+.

The results are noted:

- If no reaction is observed, the sign '-' is noted on the sheet.
- In case of a positive reaction, the sign '+' is indicated.

When the reaction produces a coloration, we refer to the floras to determine the species. If the chemical reagents do not allow for exact identification, a final manipulation is performed, consisting of a microscopic preparation based on a section of the fruiting bodies (apothecia). This is necessary to determine the characteristics of the spores, such as their shape, color, dimensions,andseptation **(Gavériaux, 2003)**

Réactions colorées				Un exemple de substance présente
K+	K+ violet			pariétine
K+	K+ jaune brunâtre			acide fumarprotocétrarique
K+	K+ jaune ou orange	P+ jaune		atranorine
K+	K+ jaune ou orange	P+ rouge brique		acide physodalique
K+	K+ jaune ou orange	P+ orange		acide stictique
K+	K+ jaune puis rouge	P+ jaune pâle		acide hyostictique
K+	K+ jaune puis rouge	P+ rouge		acide salazinique
K-	C+	C+ rouge		acide gyrophorique
K-	C+	C+ rose		acide olivétorique
K-	C-	KC+	KC+ jaune	acide usnique
K-	C-	KC+	KC+ rouge	acide lobarique
K-	C-	KC+	KC+ jaune orange	acide barbatique
K-	C-	KC+	KC+ rose	norlobaridone
K-	C-	KC-	P+ rouge	acide alectorique
K-	C-	KC-	P+ jaune soufre	acide psoromique

Figure.21 the use of microchemical reagents in the search for lichen substances.(from lichenologiste)

3. Results and Discussion:

The results regarding the lichen flora of Djurdjura National Park in the Tikjda sector are expressed according to the type of substrate (Corticolous and saxicolous lichens); according to the physiognomy (type of thallus: foliose, crustose, etc.); and according to systematic classification (orders and families,). we identified 50 species classified alphabetically (Table1).

Table 1 . List of lichens species inventoried in Tikjda National Park

Name	Ordre	Family	Thallus type	Substrate
Amandinea punctata	Caliciales	Caliciaceae	Crustaceous	Corticolous
Anaptychia ciliaris	Teloschistales	Physciaceae	Fruticose	Corticolous
Aspicilia calcarea	Pertusariales	Megasporaceae	Crustaceous	Saxicolous
Aspicilia contorta	Pertusariales	Megasporaceae	Crustaceous	Cor/Sax
Aspicilia radiosa	Pertusariales	Megasporaceae	Crustaceous	Saxicolous
Botryolepraria lesdainii	Lecanorales	Lecanoraceae	Leprose	Saxicolous
Calogaya pussila	Teloschistales	Teloschistaceae	Crustaceous	Saxicolous
Caloplaca cerina	Teloschistales	Teloschistaceae	Crustaceous	Corticolous
Caloplaca ferruginea	Teloschistales	Teloschistaceae	Crustaceous	Corticolous
Caloplaca flavorubescens	Teloschistales	Teloschistaceae	Crustaceous	Saxicolous
Caloplaca holocarpa	Teloschistales	Teloschistaceae	Crustaceous	Corticolous
Candelariella aurella	Candelariales	Candelariaceae	Crustaceous	Saxicolous
Cladonia fimbriata	Lecanorales	Cladoniaceae	Complex	Corticolous
Collema furfuraceum	Peltigerales	Collemataceae	Foliose	Corticolous
Diplotomma chlorophaeum	Caliciales	Caliciaceae	Crustaceous	Saxicolous
Evernia prunastri	Lecanorales	Parmeliaceae	Fruticose	Corticolous
Flavoparmelia caperata	Lecanorales	Parmeliaceae	Foliose	Corticolous
Haematomma ochroleucum	Lecanorales	Haematommaceae	Crustaceous	Saxicolous
Hypogymnia physodes	Lecanorales	Parmeliaceae	Foliose	Saxicolous
Lecanora chlarotera	Lecanorales	Lecanoraceae	Crustaceous	Corticolous
Lecanora conizaeoides	Lecanorales	Lecanoraceae	Crustaceous	Corticolous
Lecanora dispersa	Lecanorales	Lecanoraceae	Crustaceous	Saxicolous
Lecanora muralis	Lecanorales	Lecanoraceae	Crustaceous	Saxicolous

Lecanora polytropa	Lecanorales	Lecanoraceae	Crustaceous	Corticolous
Lecidella elaeochroma	Lecideales	Lecideaceae	Crustaceous	Corticolous
Lecidella stigmatea	Lecideales	Lecideaceae	Crustaceous	Saxicolous
Lepraria finkii	Lecanorales	Stereocaulaceae	Leprose	Corticolous
Lepraria incana	Lecanorales	Stereocaulaceae	Leprose	Corticolous
Pachnolepia pruinata	Arthoniales	Arthoniaceae	Crustaceous	Corticolous
Parmelia conspersa	Lecanorales	Parmeliaceae	Foliose	Saxicolous
Parmelia pulla	Lecanorales	Parmeliaceae	Foliose	Saxicolous
Parmelia sulcata	Lecanorales	Parmeliaceae	Foliose	Corticolous
Parmelina tiliacea	Lecanorales	Parmeliaceae	Foliose	Corticolous
Pertusaria pertusa	Pertusariales	Pertusariaceae	Crustaceous	Corticolous
Physcia adscens	Lecanorales	Physciaceae	Foliose	Corticolous
Physcia aipolia	Lecanorales	Physciaceae	Foliose	Corticolous
Physcia caesia	Lecanorales	Physciaceae	Foliose	Saxicolous
Physcia tenella	Lecanorales	Physciaceae	Foliose	Corticolous
Physconia distorta	Caliciales	Physciaceae	Foliose	Corticolous
Physconia perisidiosa	Caliciales	Physciaceae	Foliose	Saxicolous
Pleurosticta acetabulum	Lecanorales	Physciaceae	Foliose	Corticolous
Porpidia macrocarpa	Lecideales	Lecideaceae	Crustaceous	Saxicolous
Pseudevernia furfuracea	Lecanorales	Parmeliaceae	Fruticose	Corticolous
Rhizocarpon geographicium	Rhizocarpales	Rhizocarpaceae	Crustaceous	Saxicolous
Tephromela atra	Lecanorales	Tephromelataceae	Crustaceous	Saxicolous
Varicellaria hemisphaerica	Pertusariales	Varicellariaceae	Crustaceous	Corticolous
Verrucaria calciseda	Bagliettetalia	Verrucariaceae	Crustaceous	Saxicolous
Verrucaria nigrescens	Verrucariales	Verrucariaceae	Crustaceous	Saxicolous
Xanthoria elegans	Teloschistales	Teloschistaceae	Foliose	Saxicolous
Xanthoria parientina	Teloschistales	Teloschistaceae	Foliose	Cor/Sax

Our lichen inventory identified 18 families in the Tikjda region. Lecanoraceae, Parmeliaceae, Physciaceae, and Teloschistaceae were dominant, each comprising over 10% of the total species found (42). Parmeliaceae had the highest species richness (8 species, 19.05%). Further studies are needed to investigate the distribution and abundance of these lichen families across different habitats within the PND.

Table 2. Lichens classified by family in the PND

Famiy	Number of Species	Percentage
Arthoniaceae	1	2
Caliciaceae	2	4
Candelariaceae	1	2
Cladoniaceae	1	2
Collemataceae	1	2
Haematommaceae	1	2
Lecanoraceae	6	12
Lecideaceae	3	6
Megasporaceae	3	6
Parmeliaceae	8	16
Pertusariaceae	1	2
Physciaceae	8	16
Rhizocarpaceae	1	2
Stereocaulaceae	2	4
Teloschistaceae	7	14
Tephromelataceae	1	2
Verrucariaceae	2	4
Varicellariaceae	1	2
Total: 18	50	100

This table highlights the dominance of **crustose and foliose lichens** within the Tikjda lichen community. These growth forms are well-suited to various environments and can tolerate a wide range of conditions. The lower abundance of fruticose and leprose lichens might be due to specific habitat requirements within the tikjda that are less prevalent.

Table 3. Physiognomic Types of Lichens in the PND

Categories	Number of species	percentage proportions %
Complex	1	2
Crustaceous	26	52
Foliose	17	34
Fruticose	3	6
Leprose	3	6
Total	50	100

The table suggests that the PND environment provides more suitable conditions for **corticolous lichens**. This could be due to factors like:

- Higher availability of suitable tree bark compared to exposed rock surfaces.
- Specific bark characteristics (texture, moisture retention) favoring lichen growth.

The presence of a few **Sax/Cor lichens** indicates some degree of adaptability within the lichen community.

Table 4. Types of lichens defined according to substrate nature in the PND

Substrate	Number of species
Corticolous	26
Saxicolous	22
Sax/Cor	2

After collecting and identifying the samples, we identified 50 lichen species spread across 18 families, with the most dominant being the Physciaceae and Parmeliaceae (8 species each), Teloschistaceae (7 species), Lecanoraceae (6 species), Lecideaceae and Megasporaceae (3 species each). The remaining families—Caliciaceae, Stereocaulaceae (2 species each), and Cladoniaceae, Collemataceae, Haematommaceae, Rhizocarpaceae, Tephromelataceae (1 species each)—were less represented (Table 2). In terms of thallus type, crustose lichens were dominant, constituting 52% of the total species, followed by foliose lichens at 34%. Fruticose and leprose lichens each accounted for 6% (Table 3).

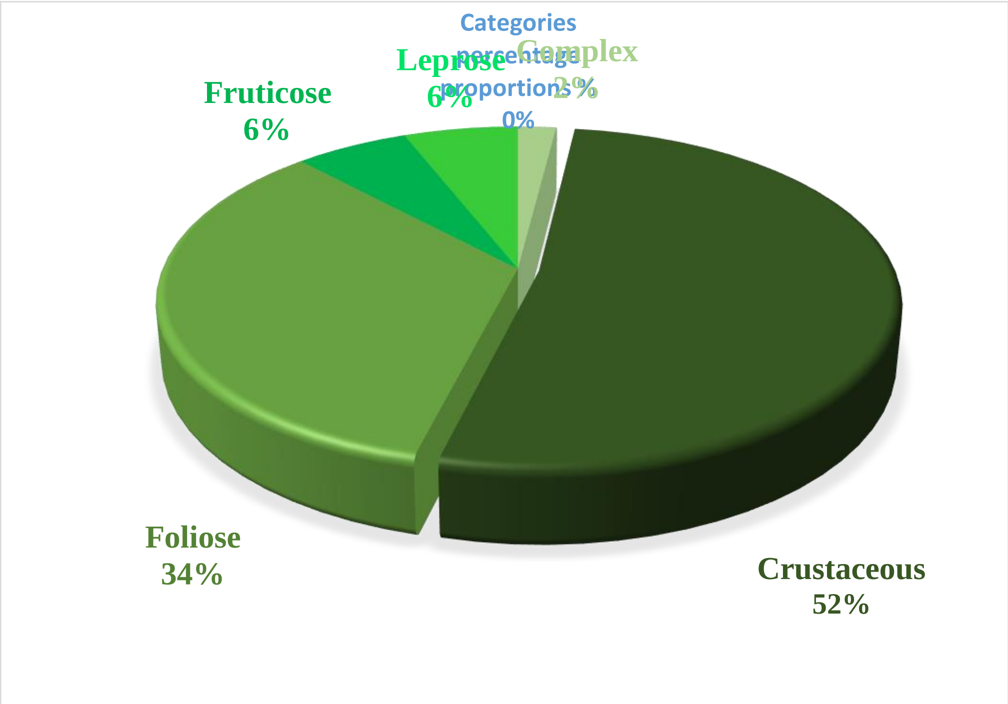


Figure.22 Physiognomic types of lichens in the PND.

The thalli of the lichens studied differed in their substrate preferences and shapes. Sixteen taxa were foliose, with 9 being corticolous: Collema furfuraceum, Flavoparmelia caperata, Parmelia sulcata, Parmelina tiliacea, Physcia adscendens, Physcia aipolia, Physcia tenella, Physconia distorta, and Pleurosticta acetabulum. The remaining 7 foliose taxa were saxicolous: Hypogymnia physodes, Parmelia conspersa, Parmelia pulla, Physcia caesia, Physconia perisidiosa, Xanthoria elegans. Additionally, one foliose species, Xanthoria parietina, was found on both saxicolous and corticolous substrates.

Nineteen crustose taxa were identified, with 7 being corticolous: Amandinea punctata, Caloplaca cerina, Caloplaca ferruginea, Lecanora chlarotera, Lecanora conizaeoides, Lecidella elaeochroma, and Pachnolepia pruinata. Eleven crustose species were saxicolous: Aspicilia calcarea, Aspicilia radiosa, Caloplaca flavorubescens, Diplotomma chlorophaeum, Haematomma ochroleucum, Lecanora dispersa, Lecanora muralis, Lecidella stigmatea, Porpidia macrocarpa, Rhizocarpon geographicium, Tephromela atra. One crustose species, Aspicilia contorta, was found on both saxicolous and corticolous substrates.

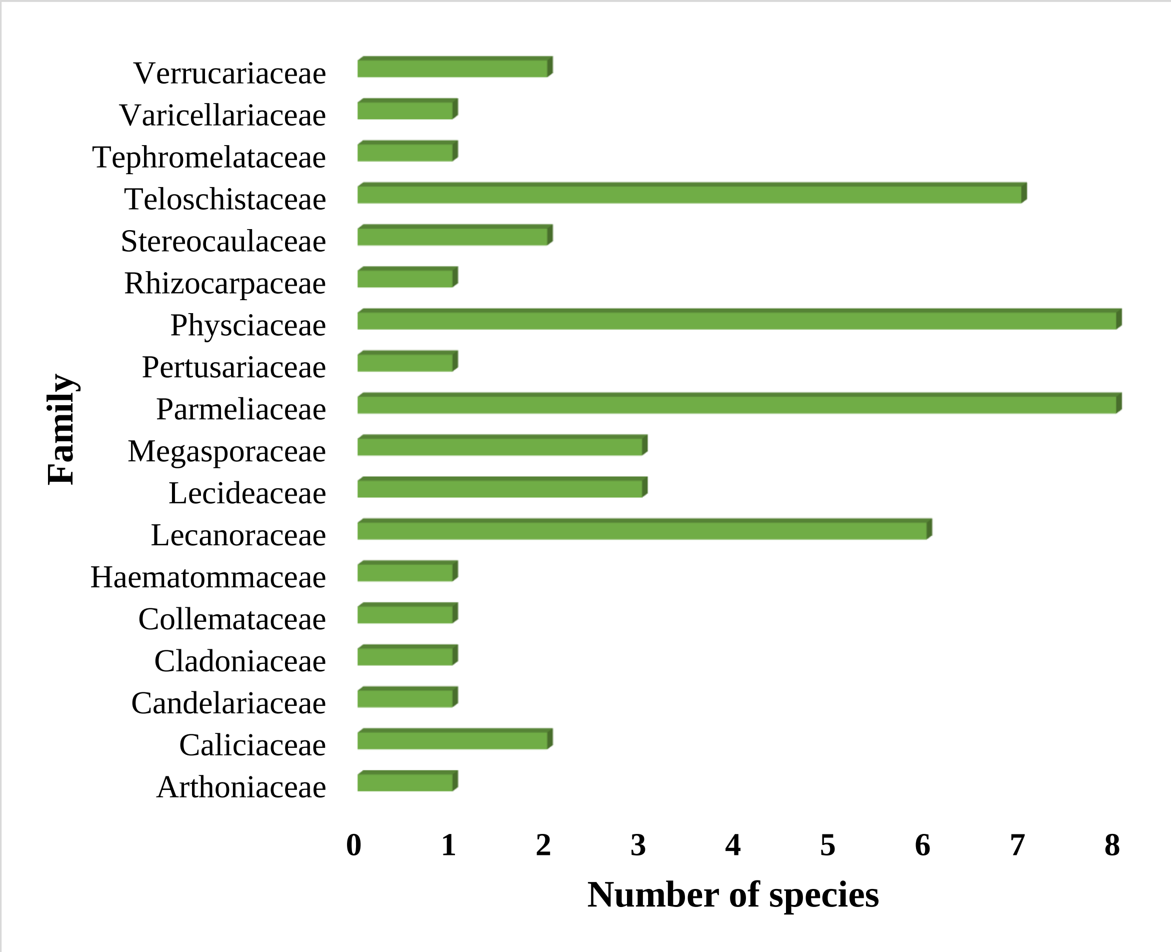


Figure.23 Distribution of recorded taxa in Djurdjura National Park by families.

Three species had fruticose thalli: Anaptychia ciliaris, Evernia prunastri, and Pseudevernia furfuracea.

Pseudevernia furfuracea is present in environments with an atmosphere devoid of nitrogen input and pollution, as is the case in Tikjda. It was collected from very acidophilic phorophytes, namely large and old cedars. This species often characterizes valley bottom areas where fog frequently forms, corresponding to the conditions at Tikjda. Pseudevernia furfuracea is photophilic and located in the canopy of trees, disappearing completely in the understory (Stations 1 and 2).

Anaptychia ciliaris is corticolous on deciduous trees, often found solitary in open situations and rarely on calcareous rocks. This species thrives in well-lit areas, on isolated trees exposed to the sun, or in very open forests, requiring good air quality for development. It is a common species, ranging from the littoral and meso-Mediterranean to the subalpine stage, with an optimum in the supra-Mediterranean (Station 1).

We also inventoried three leprose lichens, two of which are corticolous: Lepraria finkii and Lepraria incana, with one species found on a rocky substrate: Botryolepraria lesdainii. Additionally, we found one species with a complex thallus: Cladonia fimbriata.

4. Conclusion

This study conducted a comprehensive lichen inventory within Tikjda National Park, Algeria. The analysis revealed a rich and diverse lichen community encompassing 50 species distributed across 18 families. Notably, the Physciaceae and Parmeliaceae families were the most dominant, with a significant contribution to the overall diversity. The investigation of thallus morphology identified crustaceous lichens (45.24%) as the most prevalent growth form, followed by foliose (38.09%) and fruticose/leprose lichens (7.14% each). Further examination of the corticolous and saxicolous preferences within these growth forms provided detailed insights into the lichen-substrate relationships in Tikjda.

The presence of specific indicator species, such as Pseudevernia furfuracea and Anaptychia ciliaris, suggests good air quality and specific microclimatic conditions within the park. Pseudevernia furfuracea's preference for acidic environments and its presence on old cedars in valley bottoms with frequent fog highlight the unique ecological characteristics of Tikjda. Similarly, Anaptychia ciliaris thrives in open, well-lit habitats on isolated trees, indicating its dependence on light availability.

Overall, this lichen inventory provides a valuable baseline for understanding the biodiversity and ecological health of Tikjda National Park. The documented lichen diversity, along with the presence of specific indicator species, offers valuable data for future monitoring and conservation efforts. Further studies exploring the distribution patterns of these lichens across different habitat types within the park would provide deeper insights into the complex relationships between lichens and their environment in Tikjda.

Chapter III : Geographic Distribution of Lichens in the Study Area

1. Introduction

Despite the ecological significance and fascinating biology of lichens, knowledge regarding their distribution within Djurdjura National Park, particularly at the Tikjda Station, remains fragmented. Previous studies have documented individual lichen species present in the park. However, a comprehensive understanding of how lichen communities are distributed across the landscape is lacking. This knowledge gap hinders our ability to effectively assess the overall health and resilience of this high-altitude ecosystem.

This part aims to address this knowledge gap by analyzing existing data on the geographic distribution of lichen families within Djurdjura National Park's Tikjda Station. While acknowledging the limitations of current knowledge due to incomplete surveys, this investigation offers valuable insights into the spatial distribution of these ecologically important life forms. By analyzing lichen family distribution patterns, we can gain a broader understanding of the overall lichen diversity and potential ecological dynamics at play.

This research has the potential to significantly improve our understanding of the Djurdjura National Park ecosystem. Mapping lichen family distributions can inform conservation efforts by identifying areas with high lichen diversity and potential vulnerability. This knowledge can also guide the development of sustainable management practices within the park, ensuring the long-term health and resilience of this unique and ecologically significant region.

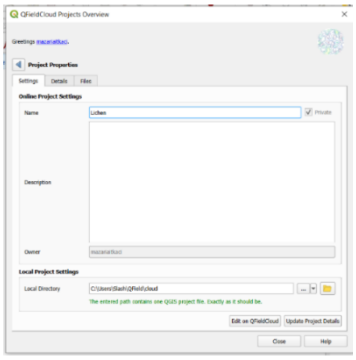
2. Materials and Methods

2.1. Data Acquisition and Coordinate Collection:

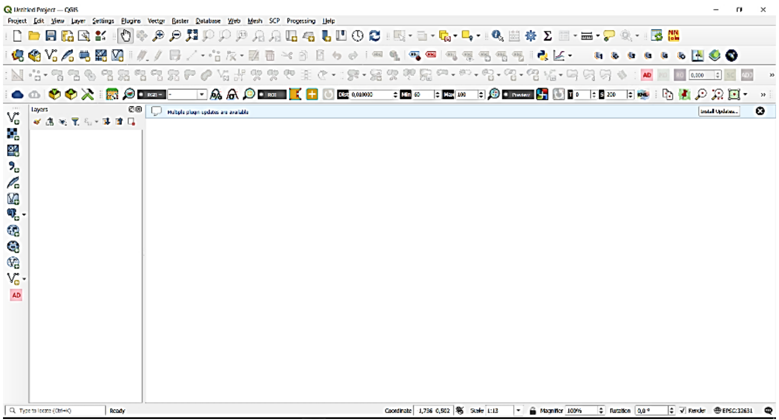
This study utilized a combination of field sampling and spatial analysis software to map the geographic distribution of lichen families within Djurdjura National Park's Tikjda Station.

- **Field Sampling:** Building upon previous lichen inventories conducted in the park, additional targeted field surveys were undertaken to collect data on the occurrence of various lichen families. During these surveys, precise location coordinates of each sampled lichen specimen were recorded using a handheld Global Positioning System (GPS) device.

- **Software Selection:** To manage and analyze the spatial data collected during field surveys, two open-source Geographic Information System (GIS) software packages were employed: QField and QGIS.
    - **QField:** This user-friendly mobile application, specifically designed for field data collection, was utilized during field surveys. QField allows for the seamless capture of GPS coordinates along with other relevant field observations for each lichen sample.

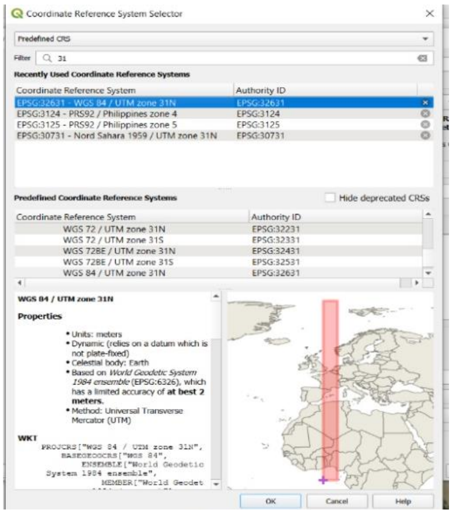


    - **QGIS:** This powerful desktop GIS software served as the central platform for data processing, analysis, and visualization. The GPS coordinates collected through QField were imported into QGIS for further analysis and map creation.



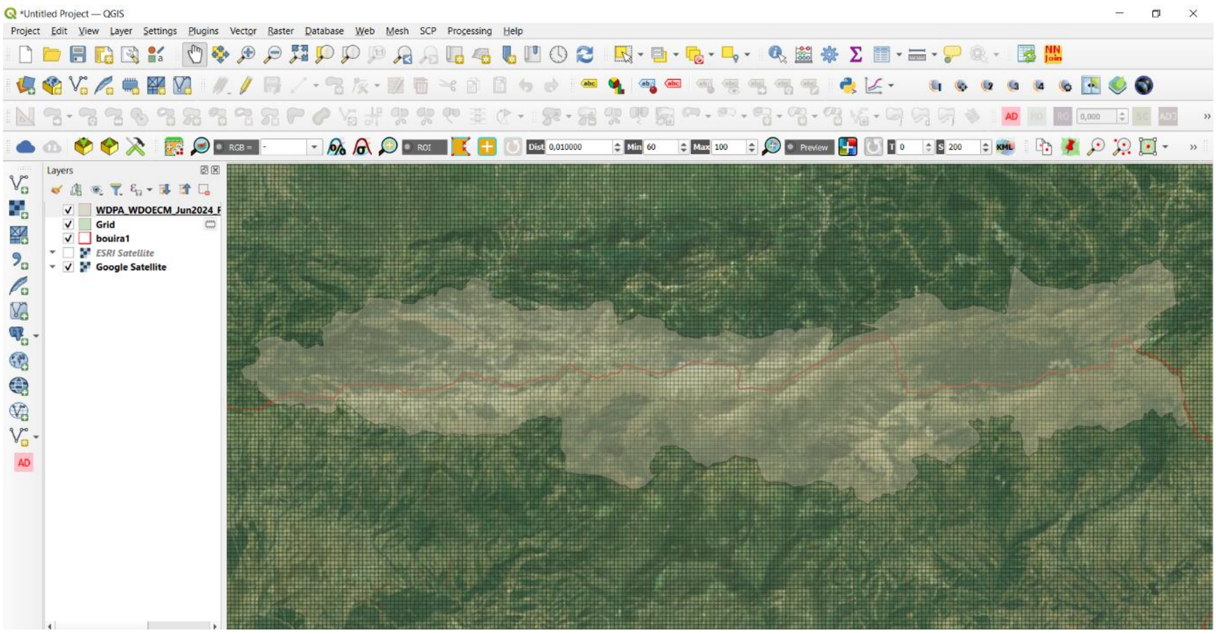
3. **Spatial Reference System (SRS):**

To ensure accurate spatial representation and compatibility with existing geospatial data, the World Geodetic System 1984 (WGS84) was adopted as the reference system for this project. Specifically, the Universal Transverse Mercator (UTM) projection, Zone 31 North, was used within the WGS84 framework. This projection system provides a standardized and accurate representation of the earth's surface, facilitating data integration and analysis within the broader geographic context.



4. **Data Processing and Map Generation:**

The GPS coordinates collected in the field were imported into QGIS. Following data cleaning and validation procedures, the point data representing individual lichen family occurrences were symbolized based on family classification. This facilitated the creation of thematic maps illustrating the geographic distribution patterns of lichen families across Tikjda Station.



5. Result and discussion

The geographic distribution of lichen families within Djurdjura National Park's Tikjda Station reveals intricate patterns that offer valuable insights into the ecological dynamics of this high-altitude ecosystem. Through a combination of field sampling and spatial analysis using QField and QGIS, we have mapped the occurrence of various lichen families across the study area. This analysis not only highlights areas of high lichen diversity but also identifies potential ecological niches and environmental factors influencing lichen distribution. The following sections present the key findings from our study and discuss their implications for conservation and sustainable management practices within the park.

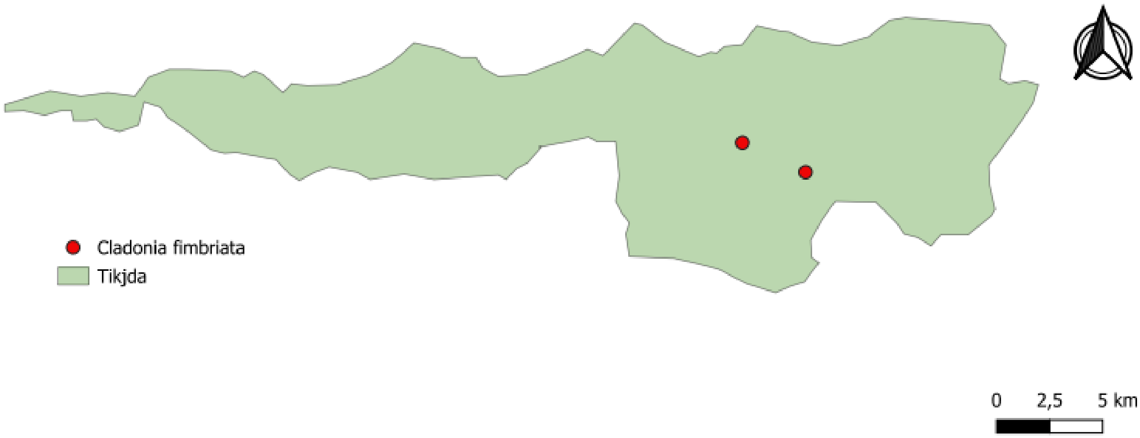


Figure.24 The distribution of the cladoniaceae family in the tikjda region

The map (Figure.24) illustrates the spatial distribution of the Cladoniaceae family within the Tikjda region of Djurdjura National Park. This family is particularly notable for its diverse and widespread presence, with clusters of occurrence observed in specific areas. The distribution patterns suggest a strong correlation with environmental factors such as altitude, substrate type, and microclimatic conditions. Understanding the spatial dynamics of the Cladoniaceae family is crucial for assessing the overall health and resilience of the lichen communities in this high-altitude ecosystem.

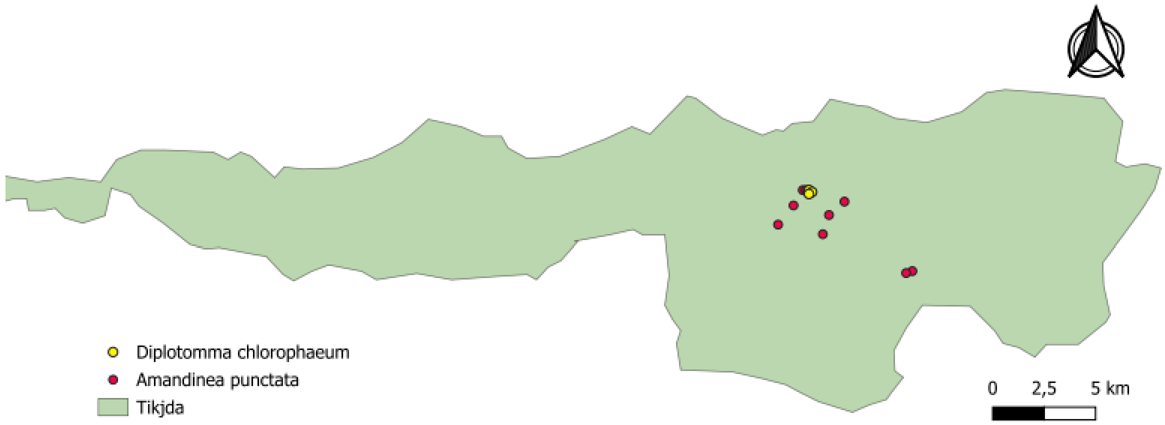


Figure.25 The distribution of the caliciaceae family in the tikjda region

The map **Figure.26** depicts the geographic distribution of the Caliciaceae family within the Tikjda region of Djurdjura National Park. This family exhibits a distinct spatial pattern, with notable concentrations in certain areas. The distribution of Caliciaceae lichens appears to be influenced by specific habitat characteristics, such as tree bark, rock surfaces, and soil types. These patterns provide insights into the ecological preferences and potential environmental drivers affecting the distribution of this lichen family. Understanding the spatial dynamics of the Caliciaceae family is essential for targeted conservation efforts and the development of effective management strategies within the park.

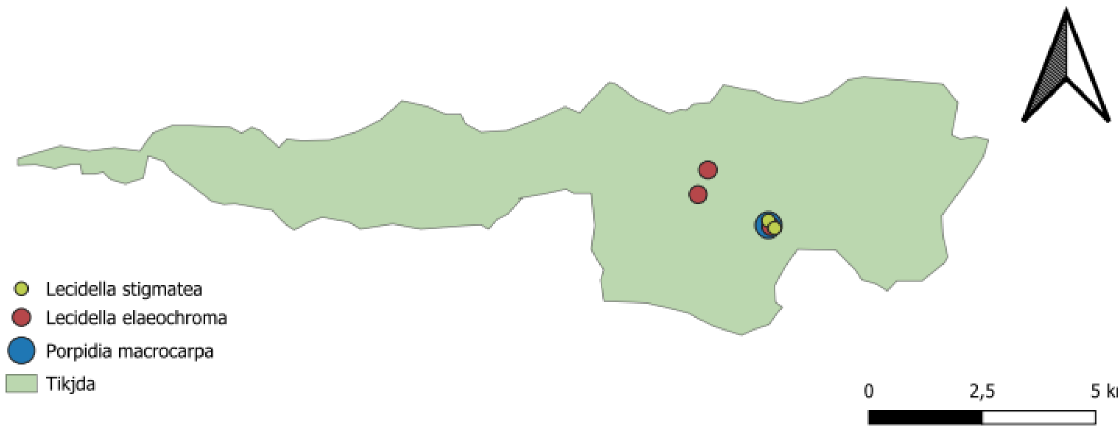


Figure.27 The distribution of the lecediacea family in the tikjda region

The map (**Figure.28)** showcases the spatial distribution of the Lecanoraceae family within the Tikjda region of Djurdjura National Park. This family is characterized by a varied and extensive distribution pattern, with significant clusters observed in different parts of the study area. The Lecanoraceae family's presence appears to be influenced by a range of environmental factors, including sunlight exposure, moisture levels, and substrate types. These distribution patterns offer valuable insights into the ecological adaptability and resilience of this lichen family. Understanding the spatial dynamics of the Lecanoraceae family is crucial for comprehensive conservation planning and the implementation of sustainable management practices within the park.

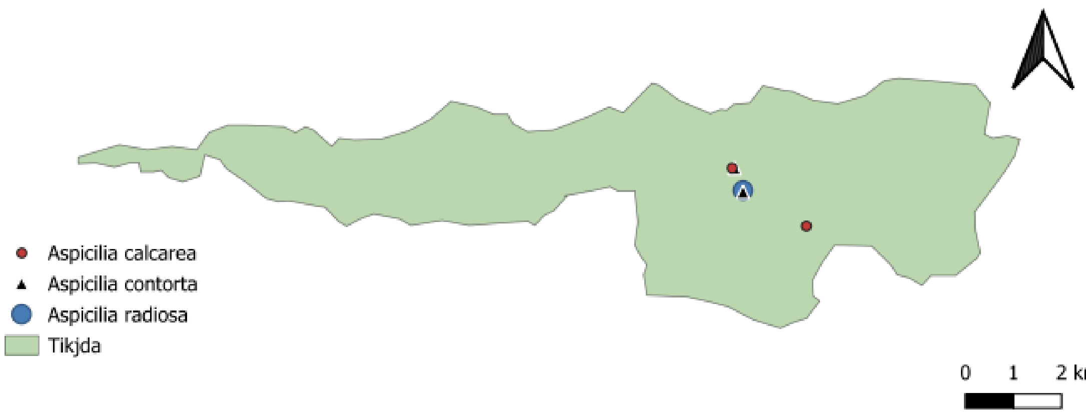


Figure.29 La distribution de la famille Megasporaceae dans la region de tikjda

The map (**Figure.30*)*** illustrates the spatial distribution of the Megasporaceae family within the Tikjda region of Djurdjura National Park. This family exhibits a unique and somewhat localized distribution pattern, with specific areas showing higher concentrations of Megasporaceae lichens. The distribution appears to be influenced by specialized habitat requirements, such as particular microclimates and substrate preferences. Understanding the spatial dynamics of the Megasporaceae family is essential for identifying key habitats and developing targeted conservation strategies to protect this ecologically significant lichen group within the park.

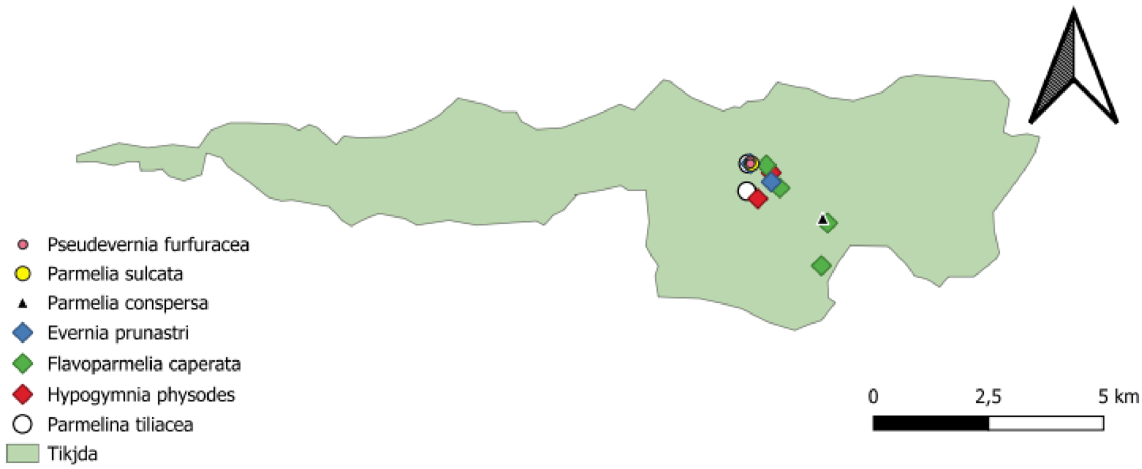


Figure.31 The distribution of the Parmeliacea family in the tikjda region

The map illustrates the widespread distribution of the Parmeliaceae family within the Tikjda region of Djurdjura National Park. This family is notable for its diverse presence, influenced by factors such as altitude, substrate type, and climatic conditions. Understanding these patterns is crucial for effective conservation and management strategies within the park.

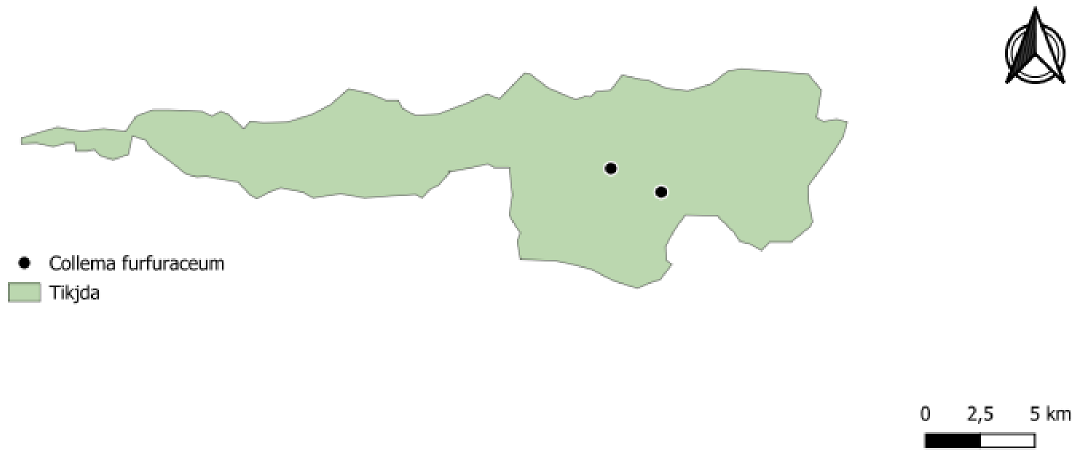


Figure.32 The distribution of the collematacea family in the tikjda region

The maps **Figure.33 and 30** presents the geographic distribution of the **the collematacea and haemmatomacea** family within the Tikjda region of Djurdjura National Park. This family is notable for its widespread and diverse presence, with significant clusters observed across various parts of the study area. The distribution of collematacea and **haemmatomacea** lichens appears to be influenced by a range of environmental factors, including altitude, substrate type, and climatic conditions.

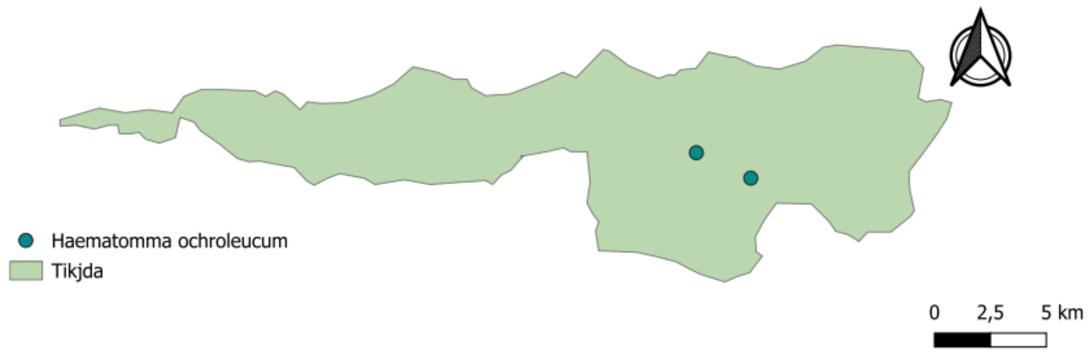


Figure.34 The distribution of the haemmatomacea family in the tikjda region

These patterns provide valuable insights into the ecological adaptability and resilience of this lichen family. Understanding the spatial dynamics of the collemataceaand **haemmatomacea** family is crucial for comprehensive conservation efforts and the development of effective management strategies within the park.

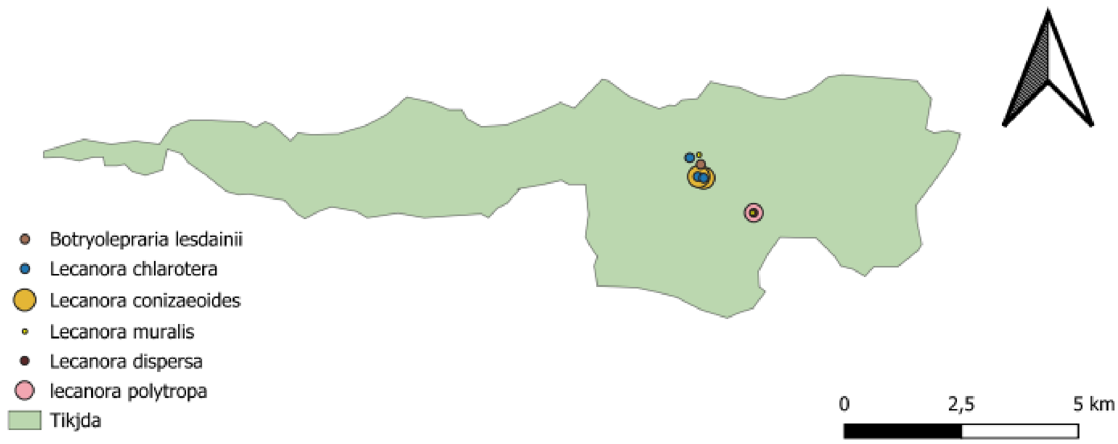


Figure.35 The distribution of the lecanoracea family in the tikjda region

The maps (**Figure.36 and 32) The** illustrate the distribution of the Lecanoraceae and Teloschistaceae families within the Tikjda region of Djurdjura National Park. The Lecanoraceae family is characterized by a varied and extensive distribution pattern, with significant clusters observed in different parts of the study area.

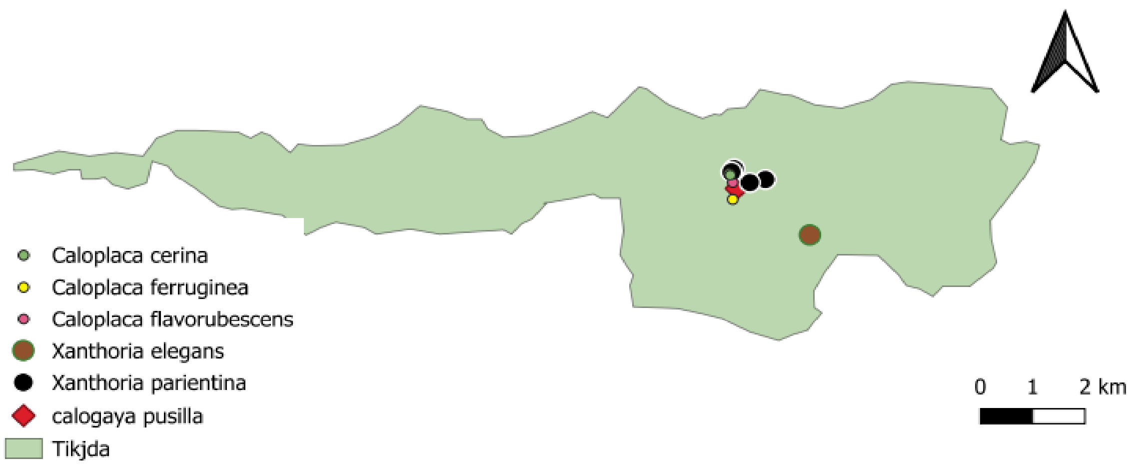


Figure.37 The distribution of the teloschistaceae family in the tikjda region

Similarly, the Teloschistaceae family exhibits distinct spatial patterns, with notable concentrations in specific areas. We identified 6 species within each family, highlighting their ecological adaptability and resilience. Understanding these distribution patterns is crucial for comprehensive conservation planning and the development of effective management strategies within the park.

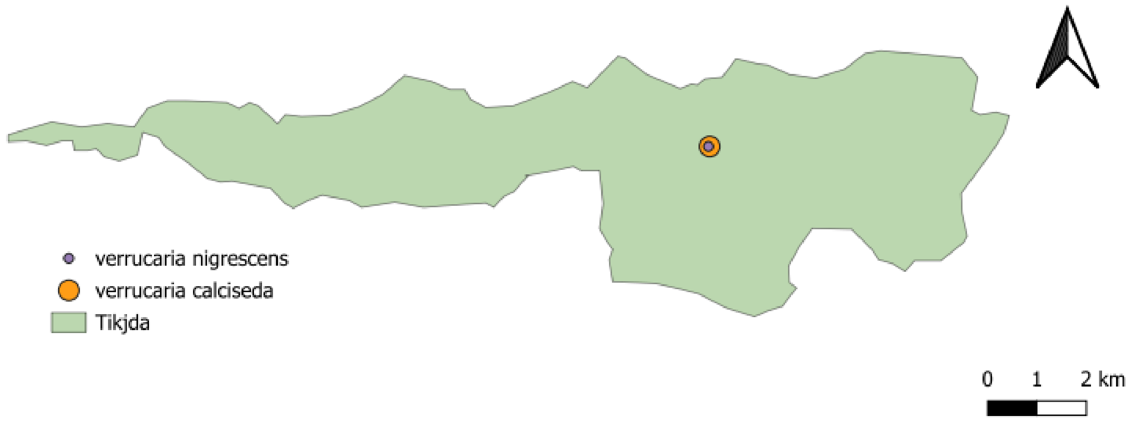


Figure.38 The distribution of the verrucariaceae family in the tikjda region

The maps Fig 33,34 and 34 illustrate the distribution of the Verrucariaceae, Rhizocarpaceae, and Stereocaulaceae families within the Tikjda region of tikjda National Park.

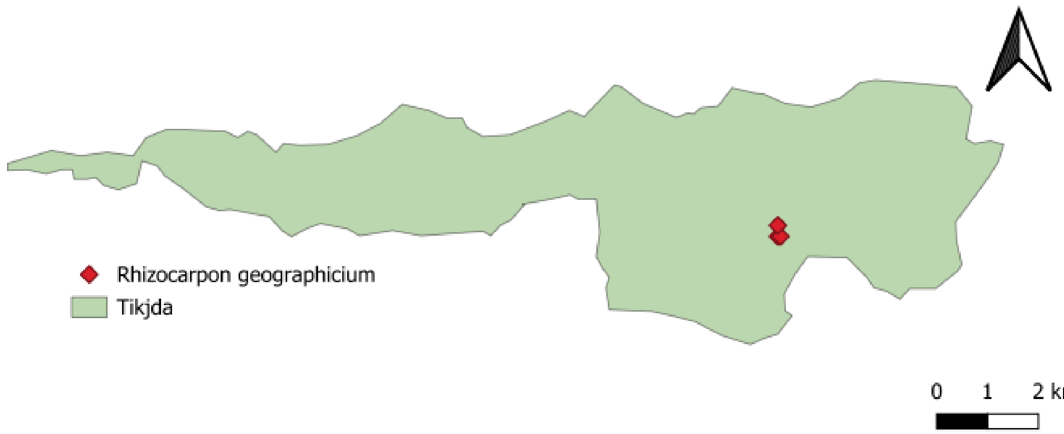


Figure.39 The distribution of the rhizocarpaceae family in the tikjda region

The Verrucariaceae family exhibits a unique distribution pattern, with clusters observed in specific areas. Similarly, the Rhizocarpaceae family shows distinct spatial patterns, influenced by specialized habitat requirements.

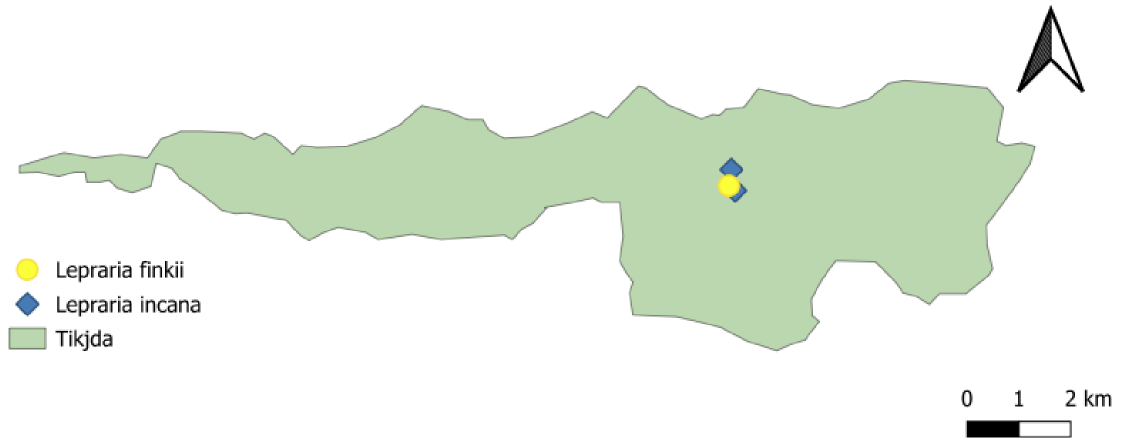


Figure.40 The distribution of the family stereocaulacea in the tikjda region

The Stereocaulaceae family is characterized by a varied distribution, highlighting its ecological adaptability. Understanding these distribution patterns is crucial for comprehensive conservation planning and the development of effective management strategies within the park.

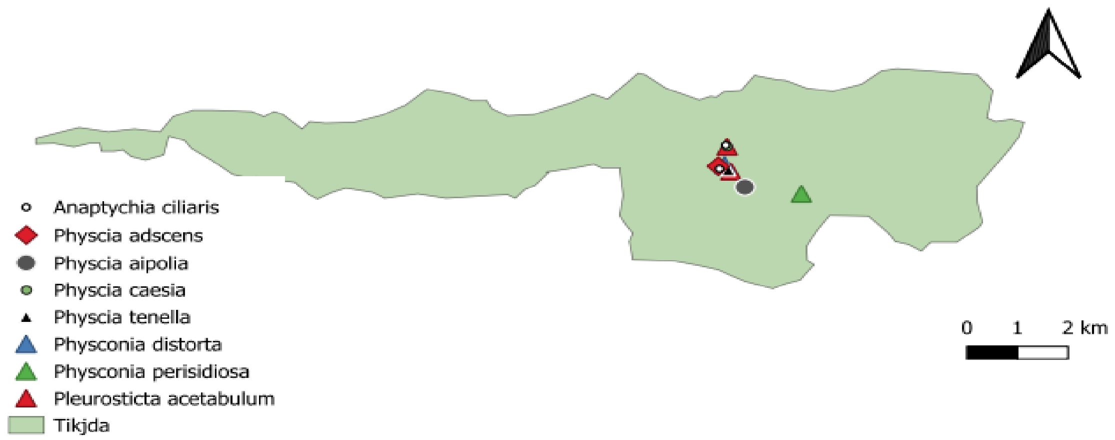


Figure.41 The distribution of the physciaceae family in the tikjda region

The map (fig. 36) illustrates the distribution of the Physciaceae family within the Tikjda region of Djurdjura National Park. This family is notable for its extensive and diverse distribution pattern, with significant clusters observed across various parts of the study area. We identified the largest number of species within this family, totaling 8 species. The widespread presence of Physciaceae lichens highlights their ecological adaptability and resilience. Understanding these distribution patterns is crucial for comprehensive conservation planning and the development of effective management strategies within the park.

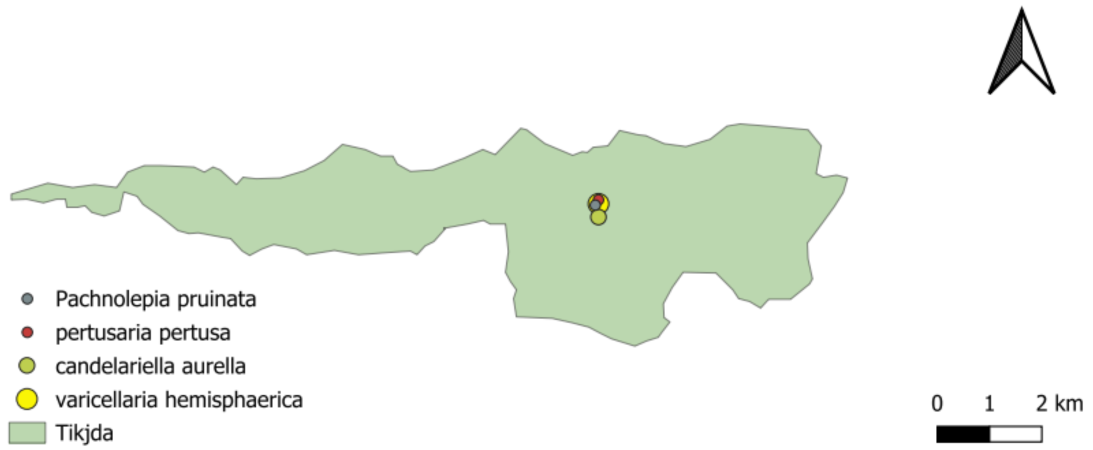


Figure.42 The distribution of various families in the Tikjda region.

The map (Fig 37) illustrates the distribution of various lichen families within the Tikjda region of Djurdjura National Park. This comprehensive overview highlights the diverse and extensive distribution patterns of multiple families, Each family exhibits same spatial patterns influenced by specific environmental factors and habitat requirements. Notably, we identified one representative species for each family, showcasing the adaptability of these lichens. Understanding these distribution patterns is crucial for comprehensive conservation planning and the development of effective management strategies within the park

6. **conclusion**

This study employed spatial analysis techniques to map the geographic distribution of lichen families within Djurdjura National Park's Tikjda Station. By leveraging field data collected using GPS devices and open-source GIS software (QField and QGIS), we were able to generate thematic maps depicting the spatial patterns of lichen family occurrence. While acknowledging the limitations of incomplete surveys, this investigation provided valuable insights into the distribution of these ecologically important life forms across the landscape.

The resulting maps offer a valuable tool for understanding the overall diversity and potential ecological dynamics within the park. Areas with high lichen family diversity, identified through this analysis, can be prioritized for further research and potential conservation efforts. Furthermore, this study demonstrates the effectiveness of open-source GIS tools in analyzing and visualizing ecological data. By continuing to build upon this knowledge base, we can gain a deeper understanding of Djurdjura National Park's unique ecosystem and implement sustainable management practices for its long-term health and resilience.

General Conclusion

Conclusion

The biodiversity of Djurdjura National Park is exceptionally rich in lichens, playing a crucial role in its diverse ecosystem. The aim of this study was to update the Algerian lichen flora and create a checklist of lichen species in the National Park (PND) located in the Tikjda region, which includes pure cedar forests and a reserve of Pinus nigra sp. Mauretanica, an endemic species of black pine. Additionally, it aimed to map their geographical distribution using GIS, essential tools for studying lichen distribution at different spatial scales.

The results show the presence of 50 taxa distributed across 18 families. The richest families are Parmeliaceae and Physciaceae, each with 8 taxa. The combined studies on lichen diversity in Djurdjura National Park's Tikjda Station revealed a rich and varied community comprising 50 species across 18 families. Physciaceae and Parmeliaceae were particularly prominent, contributing significantly to overall diversity. The predominant growth forms were crustaceous (45.24%), foliose (38.09%), and fruticose/leprose (7.14% each), with detailed examination showing preferences for corticolous and saxicolous substrates.

Indicator species like Pseudevernia furfuracea and Anaptychia ciliaris highlighted specific environmental conditions within the park, including good air quality and particular microclimatic niches such as acidic environments and well-lit habitats. These findings establish a fundamental understanding of biodiversity and ecological health in Tikjda National Park, providing essential insights for future conservation strategies and suggesting avenues for further research.

This study employed spatial analysis techniques to map the geographic distribution of lichen families within Djurdjura National Park's Tikjda Station. By leveraging field data collected using GPS devices and open-source GIS software (QField and QGIS), we were able to generate thematic maps depicting the spatial patterns of lichen family occurrence. While acknowledging the limitations of incomplete surveys, this investigation provided valuable insights into the distribution of these ecologically important life forms across the landscape.

The resulting maps offer a valuable tool for understanding the overall diversity and potential ecological dynamics within the park. Areas with high lichen family diversity, identified through this analysis, can be prioritized for further research and potential conservation efforts. Furthermore, this study demonstrates the effectiveness of open-source GIS tools in analyzing and visualizing ecological data. By continuing to build upon this knowledge base, we can gain a deeper understanding of Djurdjura National Park's unique ecosystem and implement sustainable management practices for its long-term health and resilience.

In enhancement, this research not only updates the existing knowledge on Algerian lichen flora but also sets a foundation for future studies on the ecological significance and conservation of lichens in Djurdjura National Park. The insights gained from this study can guide the development of targeted conservation strategies and inform sustainable management practices, ensuring the preservation of this rich and diverse ecosystem for future generations.

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Abstract :

The biodiversity of the Djurdjura National Park is exceptionally rich in lichens, playing a crucial role in its diverse ecosystem. The aim of this study is to update the Algerian lichen flora and create a checklist of lichen species in the National Park (PND) located in the Tikjda region, which includes pure cedar forests and a reserve of Pinus nigra sp. Mauretanica, an endemic species of black pine. Additionally, it aims to map their geographical distribution using GIS, essential tools for studying lichen distribution at different spatial scales. The results show the presence of 50 taxa distributed across 18 families. The richest families are Parmeliaceae and Physciaceae, each with 8 taxa.

Résumé :

La biodiversité du Parc National du Djurdjura est exceptionnellement riche en lichens, jouant un rôle crucial dans son écosystème varié. Le but de ce travail est de mettre à jour la flore lichénique algérienne et de créer une "checklist" des espèces de lichens du Parc National (PND) présentes dans la région de Tikjda, qui comprend des forêts de cèdres purs et une réserve de Pinus nigra sp. Mauretanica, une espèce endémique de pin noir. De plus, il vise à cartographier leur répartition géographique à l'aide des SIG, outils essentiels pour étudier la répartition des lichens à différentes échelles spatiales. Les résultats montrent l'existence de 50 taxons répartis en 18 familles. Les familles les plus riches sont les Parmeliaceae et les Physciaceae, avec 8 taxons chacune.

ملخص :

يتميز تنوع الحياة النباتية في الحديقة الوطنية لجبال جرجرة بغناها الاستثنائي في الحزازيات، حيث تلعب دوراً حاسماً في النظام البيئي المتنوع للمنطقة. هدف هذا العمل هو تحديث قائمة النباتات الحزازية الجزائرية وإنشاء "checklist" لأنواع الحزازيات في الحديقة الوطنية (PND) في منطقة تيكجدة، التي تضم غاباتٍ من أشجار الأرز النقي ومحمية لأنواع الصنوبر الأسود (Pinus nigra sp. Mauretanica) ، وهو نوع نادر من الصنوبر. بالإضافة إلى ذلك، يهدف هذا البحث إلى رسم خريطة توزيعهم الجغرافي باستخدام أنظمة المعلومات الجغرافية، وهي أدوات أساسية لدراسة توزيع الحزازيات على مقياسات مختلفة من التناوب المكاني. تظهر النتائج وجود 50 نوعاً موزعة في 18 عائلة، العائلات هي و بـ 8 أنواع لكل منهما.