



# ENVIRONMENTAL FACTORS AFFECTING LICHEN DIVERSITY IN BAN NAMRAB MANGROVE FORESTS DURING RAINY AND SUMMER SEASONS

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## Background and Supporting Information

Lichens are composite organisms resulting from a symbiotic relationship between fungi and algae (or cyanobacteria). This mutualistic association allows lichens to thrive in extreme environments where neither partner could survive alone. As small yet vital components of the ecosystem, lichens maintain complex relationships with various other organisms. Furthermore, due to their high sensitivity to environmental changes, lichens serve as excellent bioindicators for assessing forest health and integrity.

Mangrove forests are hotspots of biodiversity, including a wide variety of lichen species. The mangrove forest at Ban Nam Rab, Bang Sak Subdistrict, Kantang District, Trang Province, provides an ideal environment for surveying lichen diversity and investigating the factors influencing it. The area is predominantly characterized by Rhizophora (mangrove trees), which serve as primary substrates for lichen colonization. Seasonal variations in environmental conditions at Ban Nam Rab significantly impact the ecological balance and, consequently, the diversity of these lichen species. Given that lichens can inhabit nearly every ecosystem—ranging from the frigid polar regions to scorching deserts, and from sea level to high-altitude peaks—the research team is interested in conducting this study. This research aims to investigate the relationship between environmental factors and lichen diversity in the mangrove forest of Ban Nam Rab, Bang Sak Subdistrict, Kantang District, Trang Province.

## References

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## Description of Study Site



Our project was conducted in the mangrove forest of Ban Namrab, Village No. 4, Bang Sak Subdistrict, Kantang District, Trang Province (7.3792042, 99.3707290). The general characteristics of the mangrove forest in the Ban Namrab area are predominantly composed of mangrove trees, which serve as important habitats for lichens. The study area experiences both the rainy and summer seasons.

## Data Collection Plan

### Data Types and Sources

This study applies measurements of the Atmosphere, Hydrosphere, and Pedosphere (soil) to collect data for comparing environmental factors affecting lichen diversity in the mangrove forest at Ban Nam Rab, Bang Sak Subdistrict, Kantang District, Trang Province, between the dry season and the rainy season.

### Data Collection Schedule

The study was conducted in the mangrove forest of Ban Namrab, Village No. 4, Bang Sak Subdistrict, Kantang District, Trang Province. Field surveys were carried out by randomly selecting three sampling sites within the study area to collect data on water quality, soil quality, atmospheric conditions, and lichen species diversity. The study was divided into two seasons: the rainy season from November to December and the summer season from December to January. Soil and water samples were collected from areas where lichens were found, with three sampling points at each study site. Sampling was conducted on four occasions, from 1 November 2025 to 16 January 2026, covering a period of 2 months and 15 days.

### Equipment and Tools

CU Smart Lens, Spatula, A4-sized chart, Conductivity, Mobile phone, Soil NPK Meter Thermometer, Laboratory balance, Hygrometer, Glass stirring rod, Universal indicator paper Beaker, Distilled Water, Dissolved oxygen test kit

### Research Methods

The study applied GLOBE investigation protocols as follows:

1. Atmospheric measurement protocols (Atmosphere)
2. Water measurement protocols (Hydrosphere)
3. Soil measurement protocols (Pedosphere/Soil)

The procedures were conducted as outlined below.

**Part 1:** Study of lichen species and density in the mangrove forest of Ban Namrab, Bang Sak Subdistrict, Kantang District, Trang Province

1. Lichen sampling sites were established in accordance with GLOBE principles and divided into two seasonal periods: the rainy season (November–December) and the summer season (December–January) in the mangrove forest of Ban Namrab. An A4-sized sampling frame was used to count the number of lichen species, take photographs, and record the results.

2. CU Smart Lens was used to study the characteristics of different lichen species. Images and descriptive data of lichen morphology were recorded using an A4-sized sampling frame to count each species, photograph them, and document the results.

3. Lichen species found on host trees were identified and classified according to the different sampling periods. The density index of each lichen species was calculated and recorded.

**Part 2:** Study of air quality in the mangrove forest of Ban Namrab, Bang Sak Subdistrict, Kantang District, Trang Province

1. Air temperature was measured using a thermometer, and the readings were recorded.

2. Relative humidity was measured using a hygrometer, and the readings were recorded.

**Part 3:** Study of water quality in the mangrove forest of Ban Namrab, Bang Sak Subdistrict, Kantang District, Trang Province

1. Water temperature was measured using a thermometer at a depth of 10 cm. After waiting 5 minutes, the readings were recorded.

2. Water pH was measured using universal indicator paper, and the values were recorded.

3. Dissolved oxygen was measured by analyzing collected water samples using a dissolved oxygen test kit, and the results were recorded.

4. Water salinity was measured by analyzing collected water samples using a conductivity meter, and the readings were recorded.

5. Water electrical conductivity was measured using a conductivity meter, and the results were recorded.

**Part 4:** Study of soil quality in the mangrove forest of Ban Namrab, Bang Sak Subdistrict, Kantang District, Trang Province

1. Soil pH was measured by weighing 20 g of dried and sieved soil, placing it into a beaker, and adding 20 or 100 mL of distilled water to achieve a soil-to-water ratio of 1:1. The mixture was stirred with a glass rod for 30 seconds and left to settle for 3 minutes until clear water appeared at the top. Universal indicator paper was then immersed in the clear solution (without contacting the sediment), allowed to stabilize, and the pH value was recorded.

2. Soil fertility was measured using an NPK soil tester inserted into the collected soil samples.

3. Soil salinity was measured by mixing 20 g of soil with 20 or 100 mL of distilled water at a 1:1 ratio, stirring for 30 seconds, allowing the mixture to settle for 3 minutes, and analyzing the clear solution using a conductivity meter. The results were recorded.

4. Soil electrical conductivity was measured using the same soil–water extraction method (1:1 ratio), followed by analysis with a conductivity meter, and the results were recorded.

Data collection was conducted on four occasions between 1 November 2025 and 16 January 2026.

## Research Question and Hypothesis

### Research Question

1. How does the species diversity of lichens differ between the rainy and summer seasons in the mangrove forest of Ban Nam Rab, Kantang District, Trang Province?

2. Do relative humidity and air temperature affect lichen species diversity in the Ban Nam Rab mangrove forest during the rainy and dry seasons, and if so, to what extent?

3. Do water quality parameters—specifically temperature, dissolved oxygen, electrical conductivity, pH, and salinity—influence lichen species diversity in the Ban Nam Rab mangrove forest during the rainy and dry seasons?

4. Do soil properties—including fertility, salinity, electrical conductivity, and pH—affect lichen species diversity in the Ban Nam Rab mangrove forest during the rainy and summer seasons?

### Hypothesis

1. The diversity of lichen species differs between the rainy and dry seasons in the mangrove forest area of Ban Nam Rab, Bang Sak Subdistrict, Kantang District, Trang Province

2. Relative humidity and air temperature affect the diversity of lichen species between the rainy and dry seasons found in the mangrove forest area of Ban Nam Rab, Bang Sak Subdistrict, Kantang District, Trang Province.

3. Temperature, dissolved oxygen, pH, salinity, and electrical conductivity of water affect the diversity of lichen species during the rainy and dry seasons found in the mangrove forest area of Ban Nam Rab, Bang Sak Subdistrict, Kantang District, Trang Province.

4. Soil fertility, soil pH, soil salinity, and soil electrical conductivity affect the diversity of lichen species during the rainy and dry seasons found in the mangrove forest area of Ban Nam Rab, Bang Sak Subdistrict, Kantang District, Trang Province.

## Expected Outcomes or Goals

1. The diversity of lichen species between the rainy and summer seasons in the mangrove forest of Ban Namrab, Kantang District, Trang Province can be compared.

2. The effects of relative humidity and air temperature on lichen species diversity between the rainy and summer seasons in the mangrove forest of Ban Namrab, Kantang District, Trang Province can be determined.

3. The effects of water temperature, dissolved oxygen, water electrical conductivity, pH, and salinity on lichen species diversity between the rainy and summer seasons in the mangrove forest of Ban Namrab, Kantang District, Trang Province can be determined.

4. The effects of soil fertility, soil salinity, soil electrical conductivity, and soil pH on lichen species diversity between the rainy and summer seasons in the mangrove forest of Ban Namrab, Kantang District, Trang Province can be determined.

## Result

The study found that during the rainy season, between November and December 2025, the dissolved oxygen content in the water was  $5.63 \pm 1.83$  mg/L, the electrical conductivity of the water was  $30.75 \pm 3.14$  mS/cm, the soil salinity was  $4.885 \pm 0.81$  ppt, the soil pH was  $5.55 \pm 0.46$ , and the relative humidity was  $77.5 \pm 13.56\%$ . These values were higher than those during the dry season. During the summer months of December 2025 January 2026, the water pH was  $6.2 \pm 0.45$ , the water salinity was  $23.6 \pm 0.16$  ppt, the water temperature was  $29.2 \pm 1.09$  °C, the soil nitrogen content was  $855.7 \pm 165.73$  mg/kg, the soil phosphorus content was  $972.3 \pm 187.31$  mg/kg, the soil potassium content was  $1816 \pm 420.73$ , the soil electrical conductivity was  $8.09 \pm 1.79$  mS/cm, and the air temperature was  $30.7 \pm 0.18$  °C, which was higher than the rainy season. The types and diversity of lichens differed between the two seasons 11 species were found in the rainy season, and 21 species in the summer. 2 lichens, *Amandinea punctata* and *Cryptothecia* sp., were found in both the rainy and summer seasons. Water quality, including salinity, was also observed during the summer. Water and electricity consumption, which is higher during the rainy season, results in greater diversity of lichen species in the summer compared to the rainy season. Soil quality, including soil fertility (NPK), which is higher during the rainy season, also contributes to greater diversity of lichen species in the summer. Finally, air quality, such as air temperature, which is higher during the rainy season, also results in greater diversity of lichen species in the summer compared to the rainy season.