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Research Article

Holocene Distribution of Boraginaceae Plants in Central Albania.

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Abstract – The Holocene data on fossil pollen reported in this scientific research were obtained from the subsurface investigation of the ancient city of Elbasan, in Central Albania. This study presents information on the evolutionary trajectory that members of the Boraginaceae family have followed throughout time. Based on archaeological research done in the Elbasani underground, the historical era stated corresponds with the New Holocene. The primary goal of this work is to demonstrate a connection between the historical dispersal of ancient pollen from Boraginaceae plants. Information on the fossil pollen of the Boraginaceae family is released for the first time. Between January and March of 2024, the data were examined.

Based on information gathered from the chemical and statistical examination of the fossilized pollen of Boraginaceae plants, we have discovered some intriguing findings. For instance, regardless of the depth to the surface, we have discovered palynomorphs of the Boraginaceae family in all examined soil samples. Furthermore, 815 fossil pollens have been identified and found, demonstrating both a consistent presence and a rising tendency in their amount from the earth's depths towards its surface.

Upon a thorough analysis of both domestic and international literature, no important variables have been identified as influencing the flora of Central Albania. We think that human engagement in the development of plants and fruit trees is required for it, based on the data obtained is mostly to blame for the vegetation's alterations throughout time in the area under study.

Keywords – Fossil Pollen, New Holocene, Boraginaceae, Soil Samples, Elbasan.

I. INTRODUCTION

The scientific work we carried out yielded palynological features of the New Holocene deposits for Elbasani Town, located in Middle Albania, and the findings are displayed below.

Paleopalynology is an interdisciplinary subject with close links to the biological sciences, especially botany, and geology. It has been shown that pollen may be stored for years in underground strata due to the resilience of the exine, or outer wall, of pollen grains [1-2].

It is feasible to ascertain the type and mode of our ancestors' sustenance as well as the history of agriculture through the examination of ancient pollen, which will aid in our comprehension of how plants have been grown and utilized throughout time [3].

Paleopalynology examines both present and ancient palynoforms, although its focus is on pollen and spores deposited in organic sediments [4-5].

Among other things, this work provides vital information that helps recreate the paleoclimate, stratigraphy, and paleoflora of the New Holocene [2,6-10].

Studying Boraginaceae fossil pollen can offer valuable information about the evolutionary history and ecological dynamics of this plant family.

By examining fossil pollen grains preserved in sedimentary rocks or other geological deposits, researchers can reconstruct past environments, track changes in plant distributions, and explore the relationships between Boraginaceae species and their habitats over time.

It's a fascinating field that contributes to our understanding of both plant evolution and Earth's history. By piecing together, the puzzle of ancient plant communities, scientists gain valuable insights into the factors driving plant evolution and ecosystem change over geological timescales [6-11].

We have investigated the distribution of vegetation during the Holocene period, with a continual focus on the evolution of Boraginaceae plants. We have supplied the factors that have impacted the flora change in this scientific study [5-9,11].

We draw attention to the fact that no such studies have been carried out by national or international specialists regarding the fossil spores and pollen data for Boraginaceae plants in the Holocene deposits for the Elbasan area where the study was done. Consequently, no previous studies on the microfossils of these family plants in Elbasan have been conducted. [6-9, 11].

One may argue that the paleopalynological information gathered has significantly advanced our understanding of the evolutionary background and geographic origins of the use and cultivation of these family plants. [6,7,8,9,11].

Using light microscopy, the number of palynomorphs in the Boraginaceae family was counted at 1000x magnification. The major objective of this scientific article was to show how the evolutionary line that has evolved throughout time for plant representatives of the Boraginaceae family is related to the quantitative presence of pollen from prehistoric times.

II. Materials and Method

Because paleopalynological tests are reliable, they are mostly used in research on the Quaternary and, therefore, the paleoclimate and paleoecology of the Holocene period [12-14].

By looking at and evaluating ancient pollen, we may determine how the natural environment has changed and how people have affected this change [15–16].

It is feasible to appropriately preserve and extract pollen from the soil sediments in which it is deposited because of its physics-chemical composition. For processing ancient pollen, almost all methods are based on physically and chemically processing one gramme of soil sediment [2,4, 6,7,8,9].

Following its extraction from the soil strata, the ancient pollen is analyses both qualitatively and quantitatively. For this study, we collected sixteen soil samples in the field in January and March of 2024. The samples varied in depth from 0.25 to 4 meters and were separated by 0.25 meters.

The findings of the paleopalynological test that was performed on each soil sample showed that each sample had a significant amount of organic matter, indicating the importance of fossil pollen study.

A. The Erdtman acetolysis technique.

Soil sampling is based on the Erdtman technique [17–18]. To get the best results, first mix 10 millilitres of 10% KOH with 1 cm^3 of soil. The Erdtman acetolyze technique uses sulfuric acid (H_2SO_4) and acetic anhydride $(CH_3COO)_2$ as an acetolyze combination, treating the material in a 9:1 ratio.

We used distillate water for cleaning and then mixed it with acetolyze solution to produce a neutral environment. Following the emasculation operation, a centrifugal process (3000 rotation/minute) is administered for three minutes.

The acetolyze method is widely used in paleopalynology because it offers better vision over the spores and pollen than other techniques used during the microscopic observation phase [6-9,17,18].

B. *Fixation of the prepared substances.*

The fixture of the manufactured composites was realised by means of the gel-glycerine glue preparation technique, which was based on the Kisser method [19] and made by employing 50 grammes of gelatine, 175 millilitres of distillate water, 150 grammes of glycerine, and 7 grammes of phenol (crystals).

Three days later, the composite was ready for use and storage, having been isolated to the margins of the microscope slide with paraffin or spray.

III. RESULTS

Both the total number of palynoforms and the number of spores for the Boraginaceae family broken down by depth are shown in Table 1.

At a depth of 2.25 metres, the maximum number of spores from the Boraginaceae family 52 spores per sample is acquired, while the least quantity 38 spores are taken at a depth of 4 metres.

Except for sample 9, which shows a decline in number (at precisely 2 m of depth), figure 1 unmistakably shows the overall pattern of continuous numbers of the Boraginaceae Family members from the bottom approaching the surface. Furthermore, the spore count for this family is continuously present almost all the way from the bottom to the surface. In samples 6 and 8, the Boraginaceae spores presence undergoes a significant increase.

Table 1. Boraginaceae palynoforms by deepness.

Sample	Years	Deepness (meters)	Boraginaceae Palynomorphs
1	0	4	38
2	100	3.75	44
3	200	3.5	46
4	300	3.25	42
5	400	3	43
6	500	2.75	48
7	650	2.5	44
8	800	2.25	52
9	950	2	40
10	1100	1.75	44
11	1250	1.5	42
12	1400	1.25	42
13	1550	1	41
14	1700	0.75	42
15	1750	0.5	42
16	2000	0.25	38
The whole count of spores			686

Based on the data in Table 1, the Boraginaceae family has 686 spores' total.

IV. DISCUSSION

The data obtained indicates a consistent trend of Boraginaceae plants moving from the soil's depths towards the surface. This phenomenon suggests that the stability of the family's presence should be attributed to human influence in the cultivation of this plant family.

The way land is used may be impacted by climate change, and human cultures can have complex impacts on the environment [20].

Additionally, there is a noticeable decline in the quantity of fossil pollen in the surface samples, which contradicts the notion that the newest pollen forms may be preserved more successfully than the older ones observed in the deep samples.

It's noteworthy to observe that samples 8, which indicate a depth of 2.25 metres, exhibit an immediate rise in ancient pollen from the Boraginaceae family. Because no information on important climatic circumstances that would have impacted the shift in vegetation during this period, around 800 Years after Our Era, was found while examining the literature, we have relied on Albania's mediaeval history [19].

Allegations suggest that this period is linked to the horrifying extermination conflicts during the Serbian and Bulgarian occupation, leading to a notable reduction in the city's population and the loss of its previous economic prominence [21].

The borage or forget-me-not family, Boraginaceae, is a global family of shrubs, trees, and herbs that has around 2,000 species spread between 146 to 156 genera [22-24].

The Boraginaceae family encompasses a diverse range of plants with various uses and applications [22]:

Medicinal Purposes: Several species within the Boraginaceae family have been traditionally used in herbal medicine. For example, borage *(Borago officinalis)* has been used for its purported anti-inflammatory and diuretic properties, while comfrey *(Symphytum spp.)* has been used to treat wounds and inflammatory conditions.

Ornamental Plants: Some Boraginaceae species are cultivated for their ornamental value due to their attractive flowers. For instance, species like forget-me-nots *(Myosotis spp.)* are popular in gardens for their delicate blue flowers.

Culinary Use: Borage *(Borago officinalis)* is also used in culinary applications. Its leaves and flowers are edible and can be used as a garnish or added to salads for their cucumber-like flavour.

Bee Forage: Many Boraginaceae species, including borage and phacelia *(Phacelia spp.),* are highly attractive to pollinators like bees due to their abundant nectar and pollen. They are often used as cover crops or in wildflower mixes to support pollinator populations.

Soil Improvement: Some species within the Boraginaceae family, such as comfrey, are known for their deep root systems, which can help improve soil structure and nutrient uptake.

Overall, the Boraginaceae family contributes to various aspects of human life, including medicine, horticulture, and ecology.

The Boraginaceae family is dispersed across diverse habitats worldwide, with a broad distribution that spans continents. While the family is most diverse in Mediterranean regions and in temperate climates, it can also be found in tropical and subtropical areas [24-25].

In Mediterranean Regions, many Boraginaceae species are native to the Mediterranean Basin, including countries like Albania. These regions offer favourable conditions for the growth of a wide variety of Boraginaceae plants due to their mild winters and hot, dry summers [25].

Overall, the dispersion of Boraginaceae plants reflects their ability to adapt to a wide range of environmental conditions, from arid deserts to moist woodlands, making them a diverse and globally distributed plant family [24].

The Boraginaceae palynoforms, which are present in all samples and exhibit a stable tendency as they move from samples taken at depths to samples taken at the surface, suggest that human activity has had a significant influence on these plants. This influence is primarily related to the cultivation of these plants over time in the Elbasan area. The fact that these plants are consistently present during this period lends further credence to these phenomena.

Many different types of plants can be found in Elbasan City nowadays, mostly olive plantations, often cultivated fruit trees, and an extraordinarily rich flora and greenery. The role that ecological and human factors play in the pollen grain distribution process cannot be understated.

Overall, Boraginaceae fossil pollen research serves as a valuable tool for reconstructing past environments, tracking plant evolution, and understanding the role of this plant family in shaping Earth's ecosystems over the years. The quantitative data pertaining to ancient pollen from the Boraginaceae family demonstrates the evolutionary changes in the family's plant species across geological time.

V. CONCLUSION

- All the samples that were analysed included members of the Boraginaceae family.

- ❖ The Boraginaceae family palynomorphs demonstrate a consistent inclination for their existence from deep to surface.
- ❖ We believe that human impact is the primary cause of the shift in flora because Elbasan has not seen any notable climate changes throughout time that may have affected it.
- ❖ Overall, Boraginaceae cultivation has evolved over the years in response to changing societal needs, environmental concerns, and advancements in agricultural and horticultural practices.

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