

## ADAPTATIONS TO THE ENVIRONMENT OF THE LEAF OF THE BRAKENFERN - *PTERIDIUM AQUILINUM* (L.) KUHN

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### Abstract

*Pteridium aquilinum* (L.) Kuhn (Pteridophyta, Filicopsida, Hypolepidaceae) a species known by the common name of brakenfern, vegetates in meadows, on forest outskirts and in deforested plots. The vegetal material studied, i.e. leaves of the brakenfern, was collected in the village of Merișani, in the Argeș district, from specimens belonging to two different populations, one that vegetates in a meadow, in the sunlight (heliophile population), and another one from a forest (sciadophile population), at a distance of cca. 100 m. The different environment of the *Pteridium aquilinum* populations has induced modifications regarding the dimension of the populations, the sexuete reproduction, the anatomy of the leaves. The forest population is numerically smaller; does not reproduce in the sexuete way, and presents smaller thickness of the lamina, of the hypodermic sclerenchyma cells and the stomata; correspondingly, on the lower part of the leaf there are three times fewer stomata than in the individuals vegetating in the meadow. The meadow population is made up of numerous individuals, it reproduces in the sexuete way and has larger dimensions of the lamina thickness, of the hypodermic sclerenchyma cells and the stomata. In order to observe the evolution of the two populations, it is necessary that they be further monitored.

Keywords: population, heliophile, sciadophile, reproduction, lamina, nervure, sclerenchyma, stomata.

### 1. INTRODUCTION

*Pteridium aquilinum* (L.) Kuhn (Pteridophyta, Filicopsida, Hypolepidaceae) [11], a species commonly known as the brakenfern, vegetates in meadows, forest-skirts, and wood-cutting areas (clearings). It is perennial and can reach a height of 50-80 (200) cm. The sporangia grow to maturity during the July to September period. It can be frequently found from the sub-layer of the durmast oak up to the boreal layer, on the outskirts of the forests, in meadows, on sandy and skeletal soils.

It is a mesoxerophile-mesophile, heliophitic-sciadophitic, oligotrophic, moderately acid species. It hinders the natural regeneration of the forest. The species is toxic, and its spreading is cosmopolitan [2]. The data concerning the anatomy of the species can be found in the researches conducted by Dorin [4], [5], on various species of ferns. As far as the adaptation of the individuals of *Pteridium* to the environment is concerned, the researches conducted on the leaf in two populations of *Pteridium aquilinum* in Poland have demonstrated the influence of the environmental (or edaphic) conditions on a

number of morphological-anatomical characters such as the number of primary and secondary divisions, the surface of the lamina and the length of the stomata [7].

### 2. MATERIALS AND METHODS

The vegetal material studied, i.e. leaves from the brakenfern, *Pteridium aquilinum*, was collected in August 2008 in the village of Merișani, in the Argeș county. The leaves were collected from specimens belonging to two different populations, one of which vegetating in a meadow, in the sunlight (so, a heliophilous variety), and the other one growing in a forest (so, a sciadophile variety), at a distance of about 100 m. The leaves were preserved in a solution of 70% ethyl alcohol, and subsequently they were cross-sectioned, dipped in Javel water, and coloured in iodine green. The modifications induced by the different environment of the two populations were evinced through the micrometric measurements conducted on the thickness of the lamina, the median nervure of the segments, on the hypodermic sclerenchyma cells, and the length of the stomata. The lower epidermis of the leaf

was analysed by means of a replica made from a collodion solution. The microscopic examination enabled us to count the stomata per surface unit in the heliophile and the sciadophile specimens, and the length of the stomata was measured. The on-field observations were conducted as to the number of individuals of the two populations and the sporangia.

### 3. RESULTS AND DISCUSSIONS

**The populations of *Pteridium aquilinum* (L.) Kuhn.** In the area under research, the species forms two distinct populations. One of the populations vegetates on the skirt of the forest, in the shade, whereas the other one vegetates in the meadow, in the direct light of the sun. The two populations present differences with regard to the number of individuals that are included. Thus, the population in the meadow is made up of numerous individuals, going into the scores (figure 1). The population on the skirt of the forest is made up of fewer than 10 individuals (figure 2). This population is localised near a very old specimen of beachtree, which has a trunk diameter of over 100 cm [8]. The forest population was probably formed through the expansion of the forest, which caused the individuals of *Pteridium* that had vegetated in the sunny meadow to adjust to the new environment.



Figure 1 *Pteridium aquilinum* in the meadow (orig.).



Figure 2 *Pteridium aquilinum* in the forest (orig.).

**Modifications related to reproduction.** The life cycle of the pteridophytes cannot evolve in the absence of the spores, which are compulsory [6], [10]. In *Pteridium aquilinum*, the spores form in sporangia placed on the lower side of the segments, on their edge, protected by both a ciliate indusium, and the revolute edge of the segments [11]. The sporangia form in the individuals of *Pteridium aquilinum* which vegetates in the sun, on the meadow (figure 3). In the individuals in the forest population the edge of the foliar segments is non-revolute and does not form sporangia (figure 4). The absence of the sporangia and, implicitly, of the spores, makes impossible the sexual reproduction of the individuals in this population. In figures 4-5 one can also observe the different colour of the leaf limbus: light green in the meadow specimen, and dark green in the forest specimen, adaptations which are characteristic of the leaves of the individuals in the same species that vegetate either in the sunlight, or in the shade. Although the mesophile of the shaded leaves has fewer chloroplasts, the latter contain more chlorophyll [9].





Figure 3 *Pteridium aquilinum* in the meadow-leaf with sporangia (orig.).



Figure 4 *Pteridium aquilinum* in the forest-leaf without sporangia (orig.).

### Anatomical peculiarities of the leaf in *Pteridium aquilinum* (L.) Kuhn.

A. Thickness of the lamina. The lamina of the leaf exhibits an assimilatory tissue, or mesophyle, which is differentiated into palisade and lacunose tissue, the latter being made up of ramified cells. The nervures are enclosed in the mesophyle, and they are represented by a vascular bundles [5]. On the outside, the lamina is delimited by the two epidermis, the upper and the lower one, the latter having stomata of an anomocytic, polocytic, rarely desmocytic type [4]. At the level of the median nervure of the segments there are cordons of sclerenchyma, which are protracted sub-epidermically, as is the case of the upper side

of the lamina. The measurements conducted as regards the thickness of the lamina show significant differences between the meadow individuals, whose thickness is of 304  $\mu\text{m}$ , and the forest ones, in which the thickness is of 181  $\mu\text{m}$ . That difference in thickness reflects the morpho-anatomical adaptations of the leaves in the plants growing in the shade (sciadophite) and those growing in the sunlight (heliophite). Indeed, Șerbănescu-Jitariu and Toma [9] mention the fact that “under the forest canopy and in the foliage of individual trees, the light regimen is different from that in open spaces, both through the much smaller quantity, and through quality (more diffuse radiation and less direct radiation), and also through duration (more often than not, not even half of the possible one). In the environment characterized by a denser or a thinner shade, the whole ensemble of biotic and abiotic factors is altered, as those factors condition, at the same time, the humidity and the movement of the air, the temperature, the relationships between the various organisms, etc. A leaf in the shade, in contradistinction to a leaf in the sunlight, in the selfsame plant, is thinner and softer“.

B. The median nervure. The diameter of the median nervure is of 395  $\mu\text{m}$  in the meadow individuals, whereas it is of 241  $\mu\text{m}$  in the forest individuals. Considering the fact that the thickness of the lamina is different, it is normal that the dimensions of the component structures are different, as well. Șerbănescu-Jitariu and Toma [9], Deliu [3], mention the fact that, in the shade leaves, the nervures are smaller and less prominent on the inferior side of the lamina.

C. The dimensions of the cells of the sclerenchyma under the upper epidermis in the meadow plants are of 37  $\mu\text{m}$ , while the cell dimensions of the forest plants are of 22  $\mu\text{m}$ . The smaller dimensions of the sclerenchyma cells, in the forest plants, count among the peculiarities of the leaves growing in the shade [9], [3].

D. The length of the stomata in either types of plant varies only insignificantly, from 49  $\mu\text{m}$  in the meadow plants to 45  $\mu\text{m}$  in the forest plants.

E. The number of the stomata on the inferior side of the leaves is influenced by the environment in which the individuals of the two populations grow. Thus, the meadow individuals exhibit, on the inferior epidermis, 67 stomata per surface unit (figure 5), whereas the forest individuals have only 20 stomata per surface unit (figure 6).

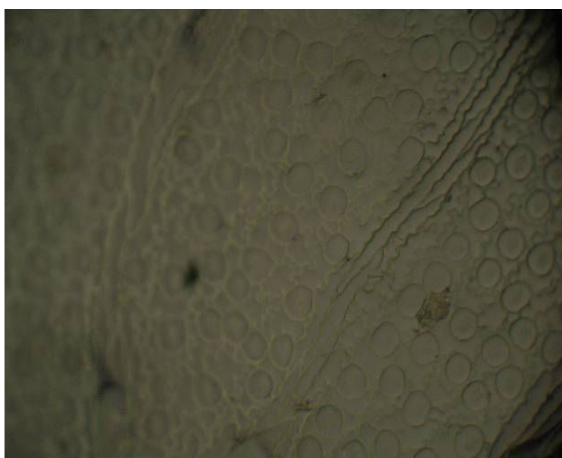


Figure 5 *Pteridium aquilinum* – leaf epidermis with stomata at heliophile individual (orig.).

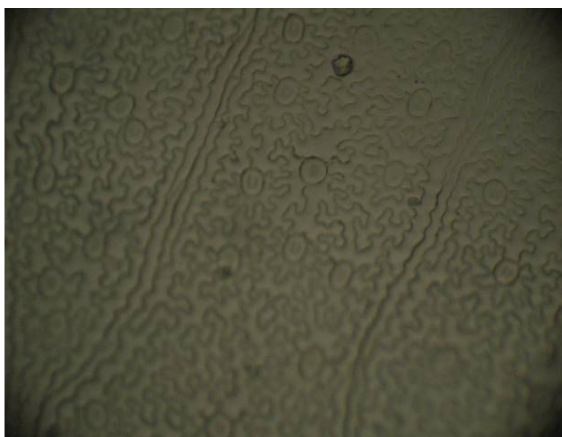


Figure 6 *Pteridium aquilinum* – leaf epidermis with stomata at sciadophile individual (orig.).

The smaller number of stomata is characteristic of the sciadophyte species, in contradistinction to the heliophyte ones [9]. The modification of the foliar limbus structure under the influence of the variations in the environment is mentioned in the papers of several authors so

that using this character is not advisable in the interest of taxonomy [5].

#### 4. CONCLUSIONS

The different environment of the individuals of *Pteridium aquilinum* in the two populations (that in the forest, and that in the meadow, respectively) induced modifications regarding the dimensions of the populations, their sexual reproduction, the anatomy of the leaf. The population in the forest is numerically low, does not reproduce sexually and exhibits a smaller thickness of the lamina, a smaller size of the hypodermic sclerenchyma cells and of the stomata; moreover, on the inferior side of the leaf there are three times fewer stomata than in the individuals vegetating in the meadow. The meadow population is made up of numerous individuals, which reproduce following a sexual way, and the dimensions of the lamina thickness, of the hypodermic sclerenchyma cells and of the stomata are larger. In order to observe the evolution of the two populations, it is necessary that they be further monitored.

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