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Adaptive Strategies of Mosses to Desiccation

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Abstract

Adaptive features of six selected mosses – *Octoblepharum albidum, Racopilum africanum, Thuidium gratum* (forest species) and *Archidium ohioense, Bryum coronatum* and *Fissidens subglaucissimus* (derived savanna species) were investigated with the view to evaluating water retention capabilities, high desiccation resistance and adaptations that help mosses retain their viability for a long period of time. Shoots of the six moss species collected from three locations; Biological Garden, Parks and Garden and Base of Hill II all of the Obafemi Awolowo University Campus were subjected to shoot viability tests using staining method of wetting and staining with neutral red on fresh samples and those stored for 20yrs. Samples were exposed to 1.0M – 10.00M molar concentration of KNO3 in order to show plasmolysis levels. Of all the species A. *ohioense and* B. *coronatum* were the most viable, while O. *albidum* was the least viable. *Racopilum africanum* and T. *gratum* had lost their viability after 20 years of desiccation. Cells of 1986 desiccation recorded high molar concentrations when plasmolysed than those of 2006 desiccation.

Keywords: mosses, desiccation, viability, plasmolysis

Introduction

Bryophytes comprise one of the simplest forms of terrestrial plant groups. They are small in size and many are indeed microscopic but in spite of their small size, bryophytes form the dominant elements of the vegetation under a number of different ecological conditions (Tallis, 1964). He further reported that oceanic climates in the north temperate zones favour the development of mire dominated by the mosses e.g. *Sphaghum* species.

Bryophytes are abundant in many different types of plant communities and have a substantial and distinctive influence on the functioning of ecosystem where they occur most especially in moist areas possessing adaptive mechanisms to survive periods of water stress (Dilks and Proctor, 1974).

Bryophyte mats on trees, retain water and thus serve as seed beds for vascular epiphyte (Salaam and Egunyomi, 2007). They are often among the few colonizers on cleared land. After rains, they can reduce or prevent erosion through soil stabilization by their rhizoids. Bryophytes are useful even in undisturbed sites where they retain a layer of organic material at the soil surface thereby providing a conducive habitat for microorganisms involved in organic decomposition (Salaam and Egunyomi, 2007). This work aimed at investigating some of the adaptive features in some selected mosses.

Materials and methods

The moss species use for this study were collected from three locations (Fig. 1) at Obafemi Awolowo University, Ile-Ife, main campus (07°.30`N, 04° 40`E). Site 1 is the Biological gardens of the university, site 2 is a regrowth forest of Parks and Garden while site 3 is a typical derived savanna vegetation zone which is burnt annually between November and January.

Three species namely: *Archidium ohioense* Schimp ex. C. Mull, *Bryum coronatum* Schwaeg, *Fissidens subglaucissimus* Broth were collected from sites 3, a derived savanna zone while *Octoblepharum albidum* Hedw, *Racopilum africanum* Mill and *Thuidium gratum* (P. Beauv.) Jacq. were collected from sites 1 and 2 the regrowth forest vegetation zones.

Shoots of these moss species collected in 1986 and stored for 20 years by Dr A.M. Makinde were also used for the analysis and comparison with the fresh samples.

Simple tests of viability was carried out on the shoots of mosses stored at room temperature for 20 years using staining method of Dinola *et al*. (1983) described as follows: Dried materials wetted and stained with neutral red to view accumulation of the dye in all vacuoles usually scored by microscopic examinations revealed indication that some samples of s hoots were still viable.

The determination of Osmotic potential of the mosses was carried out in ascertaining any correlation of the osmotic potential with the resistance of the plant to water stress. The plasmolytic method of Hosokawa and Kubota (1957) was used in which potassium nitrate (KNO3) of molarities 1.0, 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, 9.0 and 10.00 were prepared in sterile distilled water. Freshly collected samples and dried samples collected in 1986 were used. The mosses were placed first in deionised water for 10 seconds and then transferred into each of the molar solutions in

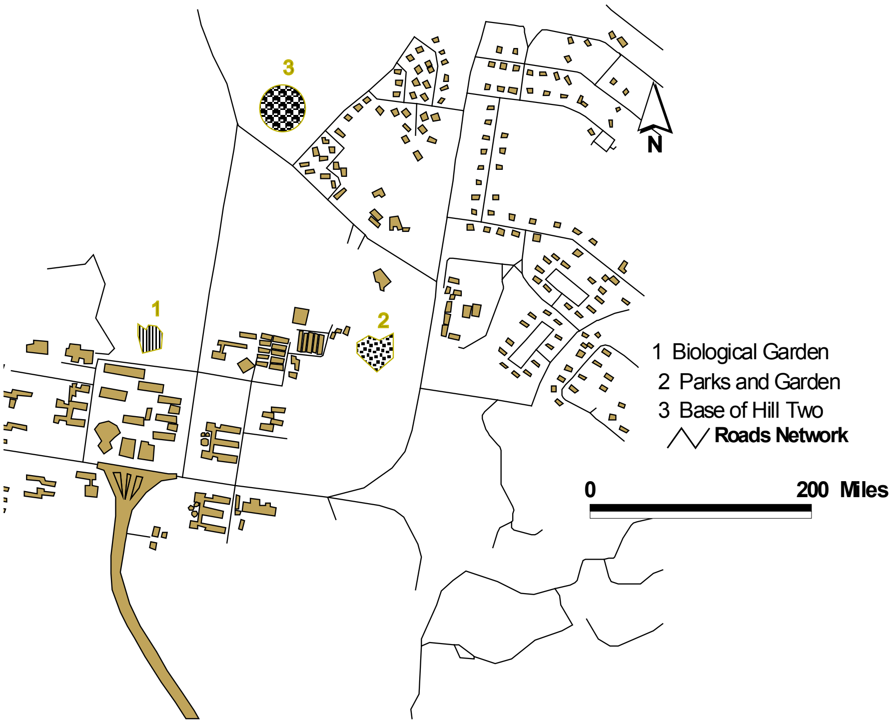

Fig. 1. The location of collected species used for this study

watch glasses for 25 minutes at room temperature (26.0 ± 2.0°C). The number of cells that were just starting to plasmolyse were counted. The KNO3 solution in which about half the cells were plasmolysed was regarded as incipient plasmolysis when the internal and external solutions were considered isotonic.

Results and discussion

Both *Archidium ohioense* and *Bryum coronatum* were highly viable after 20 years desiccation, *Fissidens subglaucissimus* followed showing viability too but the forest species *Racopilum africanum* and *Thuidiumm gratum* were not viable again through *Octoblepharum albidum* another forest species was partially viable (Tab. 1).

Octoblepharum albidum showed plasmolysed cells at 2M with the desiccated shoots collected in 2006 while those desiccated for 20 years displayed plasmolysed cells at 4M. *Fissidens subglaucissimus* cells collected in the year 2006 showed plasmolysed cells at 4M while those desiccated since 1986 showed plasmolysed cells at 8M. *Racopilum* africanum and *Thuidium gratum* became plasmolysed at 5M with the desiccated shoots of 2006 collections while the shoots desiccated 20 years revealed plasmolysis at 6M (Tab. 2).

Tab. 1. Viability Test on 20-year desiccated mosses (n =20)

Species	Viability	Positive/Negative
Archidium ohioense	Highly viable	++++
Bryum coronatum	Highly viable	++++
Fissidens subglaucissimus	Viable	++
Octoblepharum albidum	Partially viable	+
Racopilum africanum	Not viable	-
Thuidium gratum	Not viable	-

Archidium ohioense and *Bryum coronatum* that were collected in the year 2006 for desiccation displayed their plasmolysed cells at 6M while those desiccated since 1986 showed plasmolysed cells at 10M.

Several workers have shown that the ability of bryophytes to withstand desiccation is correlated with the relative humidity of the atmosphere in which they grow (Clause, 1952; Ochi, 1952 and Abel, 1956). Many species can survive long periods of desiccation whereas others cannot (Irmscher, 1912). This study also agreed with these observations as *Archidium ohioense*, *Bryum coronatum* and *Fissidens subglaucissmus* that were from the derived savanna were all viable again after desiccation of 20 years while *Racopilum africanum* and *Thuidium gratum* forest species were no longer viable.

Makinde (1981), noted that forest mosses lose water more than derived savanna species. In this study, this was true of *Octoblepharum albidum* but not of *Racopilum africanum* and *Thuidium gratum*.

The physiological state of bryophytes and hence desiccation tolerance varies with the season. Physiological adaptations may permit the bryophytes to retain water or to recover from loss of water and to change its strategies with the season. Most mosses seem to be sensitive during autumn and early winter the season when most bryophytes resume growth (Dilks and Proctor, 1976). This study tallied well with this ascertion as the derived savanna mosses; *Archidiu0.ohioense*, *Bryum coronatum* and *Fissidens sub-*

Tab. 2. Anhydrobiosis using various molar concentrations of potassium nitrate (KNO3) solutions as 1M. 2M, 3M, 4M, 5M, 6M, 7M, 8M, 9M and 10M respectively. Plants collected in 1986 was represented as I while those collected in 2006 as II

Molar concentration		Archidium ohioense	Bryum coronatum	Fissidens subglaucissimus	Octoblepharum albidum	Racopilum africanum	Thuidium gratum
1M	I	-	-	-	-	-	-
	II	-	-	-	-	-	-
2M	I	-	-	-	-	-	-
	II	-	-	-	√	-	-
3M	I	-	-	-	-	-	-
	II	-	-	-	√	-	-
4M	I	-	-	-	√	-	-
	II	-	-	√	√	-	-
5M	I	-	-	-	√	-	-
	II	-	-	√	√	√	√
6M	I	-	-	-	√	√	√
	II	√	√	√	√	√	√
7M	I	-	-	-	√	√	√
	II	√	√	√	√	√	√
8M	I	-	-	√	√	√	√
	II	√	√	√	√	√	√
9M	I	-	-	-	√	√	√
	II	√	√	√	√	√	√
10M	I	√	√	√	√	√	√
	II	√	√	√	√	√	√

glaucissmus that were still viable after 20 years of desiccation will be able to resume growth.

Ochi (1952) examined the effects of season on drought tolerance and concluded that mosses with active buds at the beginning of the growing season were generally more drought resistant than in other seasons. Ochi concluded that these seasonal fluctuations in osmotic values, high values in summer (dry season) lower in winter (wet season). This study supports the view as the plasmolysed cells of the 2006 desiccation in all the mosses had their cells plasmolysed at the lower molar concentration.

Conclusively, this study showed that the water retention capabilities, and relatively thicker cellwalls are adaptations that help mosses retain their viability for a long period of time.

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