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Desiccation Stress and the Effect of Humidity in Mosses

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Abstract

Mosses show fair degree of structural adaptations to different environmental conditions. The effects caused by desiccation were determined in the shoots of six moss species, collected from various locations of the Obafemi Awolowo University Ile-Ife campus, Osun State, Nigeria. Using 0.1 g of fresh weights, desiccation of moss species over time at 0%, 52%, and 100% relative humidity, were determined by putting the shoots into desiccators and reweighing at intervals of 15 min, 30 min, 1 hr and on the 8th day. It was concluded that the locations of the moss species, and the fact that the cell walls of all the mosses were thick, were regarded as the adaptations which helped these mosses survived desiccation stress.

Keywords: *Bryophytes*, desiccation stress, environment and relative humidity

Introduction

Bryophytes are less independent of their environment and are more limited in their ecological range than the angiosperms (Muller, 1979). The ability of many species to survive periods of severe drought and relative lack of competition from higher plants enable bryophytes to colonize apparently a wide range of inhospitable surface of gravel, rocks, sand and back of insect (Gradstein *et al.*, 1984; Richards, 1984). The water retention capabilities, and relatively thicker cell walls are adaptations that help mosses retain their viability for a long period of time (Makinde and Fajuke, 2009).

During periods of prolonged water deficit it may not be possible for plants to avert the loss of tugor in the cells, resulting in mechanical stress concomitant with membrane damage, metabolic disruption and damages due to free radicals (Smirnoff, 1993; Bohnert, 1995; Pammenter and Berjak, 1999). Desiccation tolerant mosses however, have the ability to tolerate severe water loss and resume normal physiological functioning on rehydration (Gaff, 1989).

Materials and methods

The moss species used for this investigation were collected from various locations of the Obafemi Awolowo University Main Campus, Ile-Ife, Nigeria.

The six moss species selected for the investigation are: *Archidium ohioense* Schimp ex. C. Mull, *Bryum coronatum* Schwaegr, *Fissidens subglaucissimus* Broth and *Octoblehparum albidum* Hedw, *Racopilum africanum* Mitt and *Thuidium gratum* (P. Beauv.) Jacq.

Using freshly collected mosses, within 12 hours, 0.1 g of the shoot mosses were weighed and put into desiccators where kept in the dark at 25^{0}C and 100%, 52% and 0% relative humidity, obtained with deionized water, saturated solution of magnesium nitrate and silical gel respectively. Specimen of the mosses were removed from the desiccators at interval of 15 minutes, 30 minutes, 1 hour and on the 8th day and then reweighed.

Results

The weights of the mosses recorded in Fig. 1 after 15 minutes of desiccation shown *Racopilum africanum* and *Thuidium gratum* to have the highest weights with distilled water. This was followed by *Fissidens subglaucissimus* and then *Bryum coronatum* which was closely followed by *Archidium ohioense* while *Octoblepharum albidum* came last.

With Magnesium nitrate after 15 minutes of desiccation, *Racopilum africanum* had the highest weight and was closely followed by *Thuidium gratum* then came after *Bryum coronatum* and *Fissidens subglaucissimus. Archidium ohioense* came up next in weight, while *Octoblepharum albidum* had the lowest weight in the series.

The weight with silica gel after 15 minutes of desiccation showed *Racopilum africanum* and T*huidium gratum* as having the highest weight, followed by *Fissidens subglaucissimus*. This was closely followed by *Archidium ohioense*, while *Bryum coronatum* and *Octoblepharum albidum* came last.

Fig. 1 showes the recorded weights of the six mosses after 30 minutes of desiccation. *Racopilum africanum* noted the highest weight with distilled water and was followed by *Thuidium gratum*. *Fissidens subglaucissimus* came next and was followed by *Bryum coronatum.* Coming next after this was *Archidium ohioense* while *Octoblepharum albidum* came last in it weight.

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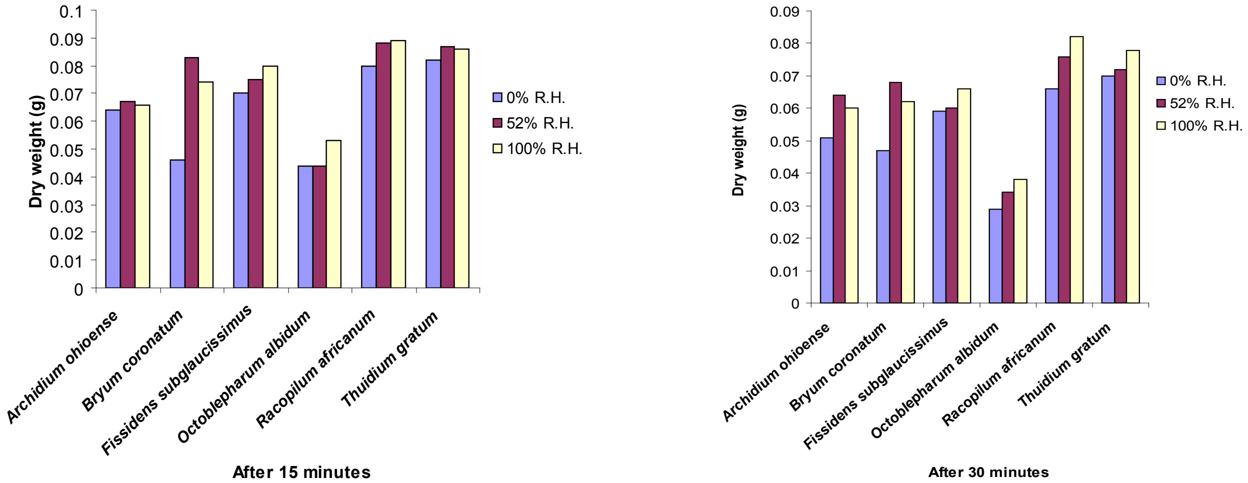

Fig. 1. Desiccation resistance in selected mosses

The desiccation of the mosses after 30 minutes with magnesium nitrate showed *Racopilum africanum* having the highest weight and was followed by *Thuidium gratum*. *Bryum coronatum* came next in weight and following this was *Archidium ohioense*. *Fissidens subglaucissimus* came next to this while *Octoblepharum albidum* came last.

In the same Fig. 1, after 30 minutes of desiccation with silica gel, *Thuidium gratum* recorded the highest weight and was followed by *Racopilum africanum*. Coming next to this was *Fissidens subglaucissimus* which was then followed by *Archidium* ohioense. *Bryum coronatum* came up next while *Octoblepharum albidum* came last.

The desiccation after 1 hour as seen in Fig. 2, shows further decrease in weights. Both *Racopilum africanum* and *Thuidium gratum* recorded the highest weights with distilled water. This was followed by *Fissidens subglaucissimus*, *Bryum coronatum* and *Archidium ohioense* while *Octoblepharum albidum* recorded least.

The desiccation with magnesium nitrate after 1 hour marked *Fissidens subglaucissimus* with the highest weight followed by *Racopilum africanum* and coming next to this was *Thiudium gratum* and then *Bryum coronatum*. *Octoblepharum albidum* was next while *Archidium ohioense* was last.

The result of the weight after 1 hour desiccation with silica gel gave *Thiudium gratum* the highest weight while *Fissiden subglaucissimus* and *Bryum coronatum* followed closely and was followed by *Archidium ohioense* and *Octoblepharum albidum* came last.

Desiccation on the 8th day with distilled water from Fig. 2 recorded the weight of *Thuidium gratum* as the highest. Coming next was *Fissidens subglaucissimus* and *Bryum coronatum*. *Racopilum africanum* followed and after come

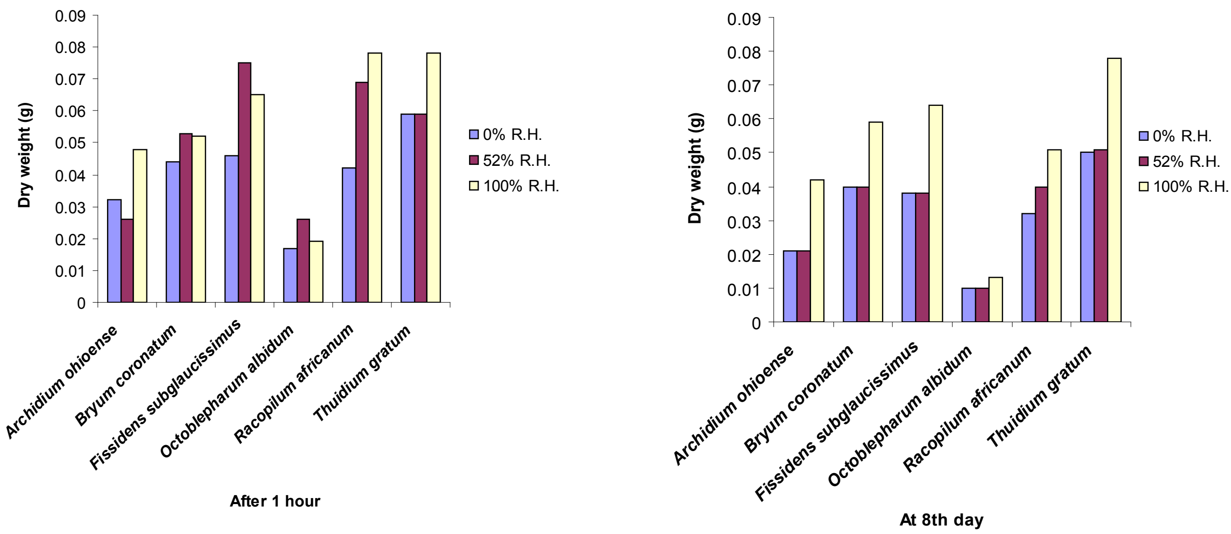

Fig. 2. Desiccation resistance in selected mosses

Archidium ohioense while *Octoblepharum albidum* came last.

With Magnesium nitrate on the 8th day, *Thuidium gratum* had the highest weight and was closely followed by *Fissidens subglaucissimus* and *Bryum coronatum*. Then came next *Archidium ohioense* leaving *Octoblepharum albidum* as the last.

On the 8th day the desiccation with silical gel revealed *Thuidium gratum* with the highest weight and was followed by *Fissidens subglaucissimus* and *Bryum coronatum*. Coming next was *Racopilum africanum* and was followed by *Archidium ohioense* while *Octoblepharum albidum* came last.

The summary from Fig. 1 and Fig. 2 show that there was a decrease in the dry weights more in the savanna species (*Archidium ohioense, Bryum* coronatum and *Fissidens subglaucissimus*) than those of the forest species, except for *Octoblepharum albidum* that showed great decrease in its weight from 15 minutes interval to the 8th day. At 0% relative humidity, a decrease in the rate of water loss was observed in all six mosses, but while *Thuidium gratum* a forest species lost about 50% of its weight, *Octoblepharum albidum* also forest species lost about 80% by the 8th day. At 52% relative humidity, there was a general decrease in the rate of water loss for all six mosses, although the water loss was more in *Octoblepharum albidum*. The loss of water at 0% and 52% relative humidity by the 8th day was equal in all the mosses except *Thuidium gratum* and *Racopilum africanum*.

Discussion and conclusions

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 (Clausen, 1952; Ochi, 1952; Abel, 1956). The current study in agreement is with this, as all the mosses studied except *Racopilum africanum* lost equal amount of water on the 8th day at 0% and 52% relative humidity (Fig. 2). Makinde (1981), noted that forest mosses lost water than the derived savanna species. In this study, this was true of *Octoblepharum albidum* but not in *Racopilum africanum* and *Thuidium gratum*.

Bryophytes generally have no mechanism for water retention, especially at low humidities (Clausen, 1952). The study confirms this theory in Figs. 1 and 2, especially with *Thuidium gratum* which did not lose more than 50% of its water content.

As reported by Egunyomi (1978; 1979), in Western Nigeria *O. albidum* is annually subjected to a prolonged dry season (November-March) alternating with a predominantly rainy season (April-October). During dry season the moss losses most of its water content, ceases growing, and survive in a quiescent dry state thus exhibiting a high tolerance to desiccation. This study agreed with this assertion (Figs. 1 and 2).

In this study, the results show a relationship between the mosses with the rate of water loss and the relative humidity, as less water was lost at higher relative humidity.

In conclusion, it was realized that the variation of the location of the moss species and the thick cell walls noticed in all the selected mosses, are adaptations which must have helped them survived desiccation stress.

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