

## Are The Fruiting And Non-Fruiting Acrocarpous Moss *Barbula indica* (Hooker) Sprengel in Nigeria Distinct Species?

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**Abstract:** *Barbula indica* (Pottiaceae), a dioecious acrocarpous moss had never been found with sporophytes in Nigeria. The occurrence of fruiting *B. indica* from two populations in the Nigerian forest and derived savanna is reported for the first time. Aspects of the morphological characters of fruiting and non-fruiting plants were compared to ascertain if they are distinct species or not. The leaf and costa length were not significantly different in both types of plants. The ratios mean leaf length : mean leaf width, costa length : leaf length and apical cell size were higher in non-fruiting than in fruiting shoots. However basal and median cell lengths were higher in fruiting than non-fruiting samples. Mean shoot lengths in fruiting plants were  $8.8 \pm 2.946$  mm and  $9.6 \pm 2.330$  mm in non-fruiting samples. Non-fruiting shoots produced more axillary gemmae than fruiting ones. As all of these vegetative differences are within the morphological range of *Barbula indica* the fruiting and non-fruiting shoots are not distinct species.

**Keywords:** *Barbula indica* moss, fruiting, non-fruiting, Nigeria.

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### I. Introduction

Pottiaceae is an acrocarpous moss family recognized by its papillose, filamentous single ring of 16 peristome teeth (haplolepidous), which could be either erect or spirally twisted and laminar cells being quadrate papillose [1] [2]. The Pottiaceae family is widely distributed almost throughout the whole world – Africa, North America, Asia, Colombia Japan, Korea, Madagascar, Malaysia, Mexico, Philippines and Seychelles, ranging from low to high altitude areas. They are well adapted to varying climatic conditions and topographic features. In fact, [3] described the Pottiaceae as “mosses of harsh environments”. *Barbula Hedw.* represents the largest genus of the Pottiaceae and recently suggested to be polyphyletic [4]. Although *Barbula* is dioecious and many species are known to produce sporophytes, many other species have been reported as not having been seen with sporophytes. As an example, in South Africa, whereas *Barbula crinita*, *B. calycina*, *B. microcalycina* and *B. rehmannii* produce sporophytes or are fruiting species, [5] reported that sporophytes were unknown in *Barbula acutata* and *B. horschuchiana*. Also *B. eubryum*, which produced sporophytes in Uganda, was non-fruiting in South Africa [5]. The foregoing examples show that variations occur in the fruiting and non-fruiting habits of *Barbula* species. In Nigeria, *Barbula indica* (formerly *B. lambarenensis*) is an urban moss found in open and partially shaded habitats on road side concrete gutters, rock crevices, moist concrete blocks and rotten logs. It often shares niches with *Bryum*, *Hyophila* and *Cyathodium* (liverwort). In all previous gatherings of *Barbula* in Nigeria fruiting shoots were never encountered. Indeed, [6] reported that *Barbula lambarenensis* (synonym: *B. indica*) a species widely distributed in West Africa, did not produce sporophytes but spreads by means of gemmae. Recently, fruiting *Barbula* was first collected on the campus of Obafemi Awolowo University, Ile-Ife, Nigeria (Oyesiku 40). The second fruiting collection was fortuitously made at the campus of Olabisi Onabanjo University Ago-Iwoye Nigeria. (Oyesiku 41). Although the two fruiting samples were tentatively identified as *B. indica*. They could in all probability be a different *Barbula* species such as *B. consanguinea*, which [7] claimed to be found in Nigeria, but reduced to the synonymy of *B. javanica* a species not growing in Africa [8]. On the other hand, the fruiting samples might be the same species as *B. indica*. In the light of this, aspects of the morphological features of the fruiting and non-fruiting *Barbula indica* were comparatively studied. This was with a view to ascertaining whether they are distinct species or not.

### II. Materials And Methods

#### 2.1 Collection and identification of samples

Fruiting and non-fruiting populations of *Barbula indica* were collected from Obafemi Awolowo University (Lat 7°31' 15"N, Long 4° 31' 49"E) derived savanna zone and Olabisi Onabanjo University (Lat 6°57'

18°N, Long 3° 54' 16"E) rainforest zone. Samples were growing on concrete crevices under tree along footpath to hill top in Obafemi Awolowo University and on the concrete gutter side and moist concrete floor under decking roof in partial shade in Olabisi Onabanjo University. The identification of moss samples were made by the second author and confirmed by the first author. Voucher specimens (Oyesiku 40 and 41) were deposited in the University of Ibadan Herbarium and Elkaf Herbarium of Olabisi Onabanjo University. With the aid of a dissecting microscope and a light compound microscope the fruiting and non-fruiting samples were morphologically studied and compared.

## 2.2 Statistical analysis

The ratio of maximum leaf length maximum leaf width and ratio of maximum costa length; maximum leaf length were calculated. Paired t-test was used to compare mean differences between the cell sizes in leaves of fruiting and non-fruiting samples.

## III. Results

Descriptive morphology of *Barbula indica* (Hook.) Sprengl. Plants small to medium size (5-10 mm) yellowish green to dark green in loose or dense tufts. Stem erect, simple or irregularly (sympodial) branched Fig. 1 (1). Leaves crisped when dry, erect spreading when moist, ovate-spathulate-lanceolate to narrowly ligulate (1.2 mm - 1.6 mm) with rounded obtuse apex, margins entire or incurved, plain towards the base Fig. 1 (2-3). Costa stout, percurrent or ending in tiny excurrent with dorsal surface papillose towards apex. Apical cells thin walled, obscure, multi-papillose, small, rounded-quadrate to hexagonal (2.6 - 4.0  $\mu\text{m}$  x 0.8-3.1  $\mu\text{m}$ ) (Fig. 1 (4); median leaf cells round to quadrate, thickly packed and papillose (8.4 - 9.4  $\mu\text{m}$  x 5.7 - 5.9  $\mu\text{m}$ ) Fig 1 (5); basal cells are rectangular/polygonal, thickly packed and smooth (16 - 44  $\mu\text{m}$  x 6-12  $\mu\text{m}$ ), smooth, hyaline (17.7 - 21.1  $\mu\text{m}$  x 4.0 - 4.6  $\mu\text{m}$ ) Fig 1 (6). Gemmae in leaf axils, brownish, globose irregularly sub-spherical, pluricellular and non-seriate Fig 1 (7-9). Seta 3-10 mm long; capsules erect, oblong-ovoid to cylindrical, peristome teeth linear, erect, densely papillose; operculum conic-rostrate, with long oblique beak Fig 1 (1). Spore (7.17 - 9.81  $\mu\text{m}$ ) Fig 1 (10). Figure 2 shows that at 5% CI the leaf width of the fruiting gametophyte was significantly higher than the non-fruiting ones, whereas the leaf length and the costa length were not significantly different in both the fruiting and non-fruiting gametophytes. The ratio of maximum leaf length : maximum leaf width was higher in non-fruiting (4.395  $\mu\text{m}$ ) than fruiting (3.783  $\mu\text{m}$ ) gametophyte. The ratio of maximum costa length : maximum leaf length was higher in non-fruiting (0.048  $\mu\text{m}$ ) than in fruiting (0.046  $\mu\text{m}$ ) gametophyte. Figure 3 shows that basal and median cell lengths were higher in fruiting sample than non-fruiting and apical cell in non-fruiting sample was higher than fruiting samples. The mean difference between the cells of the apical cell length of non-fruiting was significantly higher than the fruiting ones ( $t(20)$ .  $T_{\text{cal}} = 39.195$ ,  $t_{\text{tab two tail}} = 2.093$  ( $p < 0.05$ ). The mean difference between the cells of the basal length of fruiting was significantly higher than the non-fruiting sample ( $t(20)$ .  $T_{\text{cal}} = 58.843$ ,  $t_{\text{tab two tail}} = 2.093$ , ( $P < 0.05$ ). The mean shoot length of fruiting shoots was  $8.8 \pm 29.46$  mm and  $9.6 \pm 2.330$  mm for non-fruiting plants. Axillary gemmae were found to be profusely produced, hence more commonly found in non-fruiting shoots, but rather scanty in fruiting plants. Sizes of gemmae were length 32.01-97.95, width 20.47-35.19  $\mu\text{m}$  in non-fruiting and length 53.41-98.90  $\mu\text{m}$ , width 12.22-33.56  $\mu\text{m}$  in fruiting plants. The matured asexual propagules were similar in both types of *Barbula*.

## IV. Discussion

The collection of fruiting *Barbula indica* in Nigeria for the first time is quite significant as it will enhance phenological study of the moss. Aspects of morphological study revealed that the features measured were not significantly different in both the fruiting and non-fruiting *Barbula*. The differences are within the morphological range of the moss, which thrives in different microhabitats. [9] was of the view that owing to morphological plasticity of vegetative parts of plants especially bryophytes, for any taxonomic purpose, there must be a distinction between morphological aberrant populations, which are environmentally evoked and those that are genetically different. [10] attested to the phenotypic plasticity of West African mosses at species level. That many bryologists did not take cognizance of this fact, has led to multiplicity of new species, merely based on minor vegetative differences and inadequate collection of samples over a wide range of habitats. As an example, [8] listed 18 previously described *Barbula* species all of which are now reduced to the synonymy of *Barbula indica*. [11] proposed a scheme of life strategies of bryophytes. *B. indica* fits into this scheme as a perennial for it is always found in dry or wet conditions in open or shaded habitats throughout the seasons in Nigeria. In the opinion of [12] such a putatively primitive strategy involves dioecious gametophytes, and rarity or absence of sporophytes. The rarity of fruiting and relatively few sporophytes observed in the present study may be ascribed to *B. indica* being a dioecious moss. [13](1982) studied sporophytes production and sexuality of mosses in two habitats of Michigan, USA. He reported that mean percentage of moss populations with sporophytes in an aspen forest were 75.9 for monoecious and 19.3 for dioecious species. In a contrasting wet coniferous forest, the means were 84.1 for monoecious and 12.3 for dioecious species.

The present study reveals that axillary gemmae were relatively abundant in non-fruiting and few in fruiting *B. indica* shoots. The widespread nature of the moss in harsh environments may be due to effectiveness of the gemmae for propagation. On the importance and effectiveness of propagules, [6] reported that the gemmae of an acrocarpous moss, *Octoblepharum albidum* retained viability after 6 months of storage and spores for 8 months. This demonstrates that the propagules would most probably survive the dry season (*ca.* 4 months) in Nigeria and germinate when the wet season sets in. Also, [14] ascribed the wide distribution of *Philonotis hastata* a pantropical moss, which fruits elsewhere [15] but not in Nigeria, to its brood branches (asexual propagules), which show high regenerative capacity. [16] claimed that asexual reproduction in mosses is related to dioecism and to xeric habitats where sexual reproduction is particularly difficult to achieve. This may be applicable to *Barbula indica* in Nigeria.

## V. Conclusion

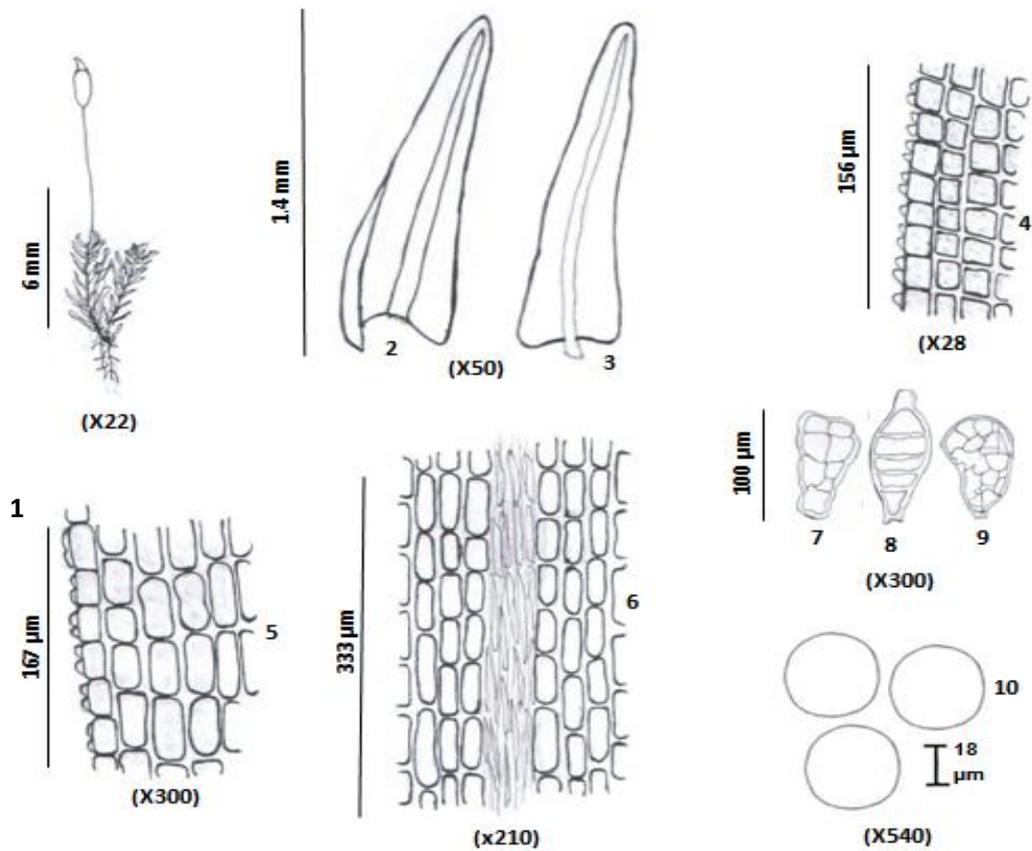
The observed fruiting *B. indica* in Nigeria for the first time is an advantage to enhance phenological study of the moss. The wide distribution and survival of the *B. indica* in wet and dry seasons can be largely ascribed to asexual reproduction and to a lesser extent to sexual reproduction. Based on morphological study fruiting and non-fruiting *Barbula* in Nigeria are not distinct species.

## Acknowledgements

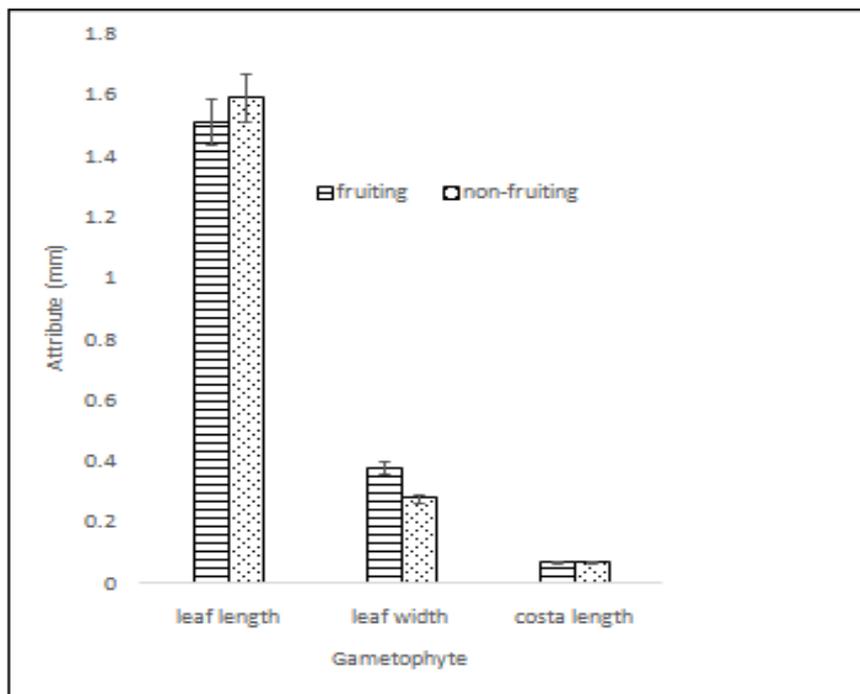
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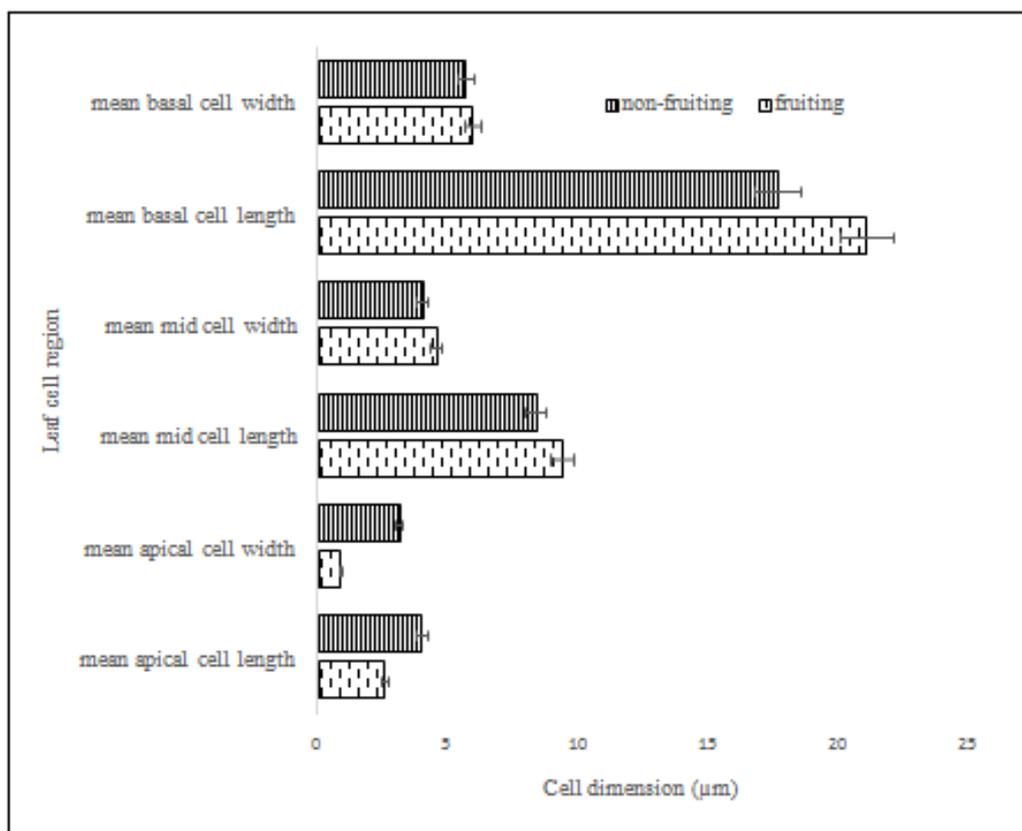
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**Figure 1.** Fruiting *Barbula indica*. 1, habit. 2-3, leaves. 4, apical cells adjacent to margin. 5, median cells adjacent to margin. 6, basal hyaline cells on either side of midrib. 7-9, gemmae. 10, spores.



**Figure 2.** Comparison of leaf attributes of “fruiting” and “non-fruiting” *B. indica*. Bar=5% Confidence interval (CI=5%)



**Figure 3.** Comparison of different leaf cells of “fruiting” and “non-fruiting” *B. indica*.  
Bar=Confidence Interval (CI=5%)

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