Field and Morphometric Studies of *Phyllobotryon* Müell.Arg. (Salicaceae) in the Korup Forest Area of Cameroon

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ABSTRACT
Morphometric analysis of *Phyllobotryon* Müell.Arg. in the Korup Forest Area of Cameroon recognizes three distinct morphospecies (1-3), which show significant variation in several leaf and fruit characters. In order to clarify the taxonomy of *Phyllobotryon*, we conducted univariate and multivariate analyses on sixteen quantitative and four qualitative characters scored from 111 fresh samples. Analysis of Variance revealed nine significant quantitative characters from which the first three Principal Components accounted for 74.6 % of the total variation. Results from Discriminant Analysis strongly support the existence of two groups (96.2 % and 100 %) representing Morphospecies 2 and 3, but morphospecies 2 is only weakly supported (88.9 %) as distinct from morphospecies 1. Characters such as petiole length, fruit surface ornamentation, style & calyx persistence, flower and fruit orientation and leaf shape are of

KEY WORDS
Korup Forest Area,
Morphometric Analysis,
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PCA.

taxonomic importance. A comparison of our three morphospecies to literature descriptions and available herbarium specimens matched up our morphospecies 1 to the published *Phyllobotryon spathulatum* Müell.Arg., while the two other morphospecies did not correspond to validly published taxa. Based on our results, the analyzed morphological variation suggests three morphological entities and one known species in the genus, and therefore a formal taxonomic status of the species rank should be considered for all three morphospecies. An identification key to taxa of the genus is provided.

MOTS CLÉS
région forestière de Korup,
analyse morphométrique,
morphologie,
Afrique,
forêt tropicale,
PCA.

RÉSUMÉ

Étude de terrain et analyse morphométrique de Phyllobotryon *Müell.Arg. (Salicaceae) dans la région forestière de Korup, Cameroun.*

L'analyse morphométrique de *Phyllobotryon* Müell.Arg. dans la région forestière de Korup au Cameroun distingue trois morphospecies (1-3), montrant une variation significative dans plusieurs caractères foliaires et carpologiques. Afin d'élucider la taxonomie de *Phyllobotryon*, nous avons mené des analyses uni- et multivariées sur seize caractères quantitatifs et quatre qualitatifs, relevés sur 111 échantillons frais. L'analyse de variance a mis en évidence neuf caractères quantitatifs significatifs, pour lesquels les trois premières composantes principales rendaient compte de 74,6 % de la variation totale. Les résultats de l'analyse discriminante appuient fortement l'existence de deux groupes (96,2 % et 100 %) correspondant aux morphospecies 2 et 3, cependant la morphospecies 2 n'est que faiblement soutenue (88,9 %) dans sa distinction avec la morphospecies 1. Des caractères tels que la longueur du pétiole, l'ornementation de la surface du fruit, la persistance du style et du calice, l'orientation de la fleur et du fruit, ainsi que la forme de la feuille sont taxonomiquement importants. Une confrontation de nos trois morphospecies aux descriptions publiées et aux spécimens d'herbier disponibles a montré la concordance de notre morphospecies 1 avec le binôme déjà décrit *Phyllobotryon spathulatum* Müell.Arg., alors que les deux autres morphospecies ne correspondent à aucun taxon validement publié. D'après nos résultats, la variation morphologique analysée dans le genre suggère trois entités morphologiques et une espèce connue. Par conséquent, un statut taxonomique formel de rang spécifique devrait être envisagé pour les trois morphospecies. Une clé d'identification des taxons inclus dans le genre est fournie.

INTRODUCTION

Species are a basic functional unit in biology and is a major tool used in forest ecology, biogeography, conservation and evolution biology, but species delimitation is sometimes a difficult and controversial endeavor (Ellis *et al.* 2006), especially in species-rich tropical rainforests. Species delimitation is always controversial due to the many species concepts and the considerably large number of methods of species delimitation (Mayden 1997). Identification of species using molecular markers is a more reliable technique but needs to be tested for congruence with other morphological characters (Hebert *et al.* 2004). A disadvantage of using strictly morphology-based taxonomy is the difficulty with identifying discrete boundaries for cryptic taxa (Padial *et al.* 2010). However, this problem can often be resolved by using a multi-evidence approach that includes

TABLE 1. — Geographical locations of the eight sampled localities including number of individuals measured per locality of *Phyllobotryon* Müell.Arg. in the Korup Forest Area.

Site	Latitude/longitude	Locality	Morpho-species	Collection	Herbarium	No. Ind. Measured	Altitude (m)
I	5°26.716'N/9°10.007'E	Osselle 1	3	*Libalah 103*	To be deposited	12	163
II	5°26.119'N/9°09.972'E	Osselle 2	3	*Libalah et al. 95*	To be deposited	13	160
III	5°25.844'N/9°09.610'E	Osselle 3	3	*Libalah 121*	To be deposited	14	132
IV	5°25.326'N/9°09.295'E	Mbaghatti-Abat	3	*Libalah & Sainge 82*	To be deposited	13	186
V	5°14.719'N/8°88.261'E	Mount Yuham	1 & 2	*Sainge et al. 1968, Sainge M.3068*	MO,YA	18	129
VI	5°03.896'N/8°51.216'E	Chimpanzee Camp trail	1 & 2	*Sainge M.3049, 3050*	MO	5	160
VII	5°03.719'N/8°50.842'E	Lowland trail	2	*Sainge M.3065*	MO	25	122
VIII	5°04.245'N/8°51.659'E	Western-by-Pass	1	*Sainge M.0599*	MO	19	248

all detectable differences in morphology, habitat preference, distributional information, etc. Such approaches may yield similar results as the molecular approach to species delimitation (Sei & Porter 2007; Kenfack 2008; Koffi *et al.* 2010).

Phyllobotryon Müell.Arg. belongs to the tribe Scolopieae (Salicaceae), (Chase *et al.* 2002; APG 2003: Chase & Reveal 2009; Reveal & Chase 2011) but was previously placed under Phyllobotryoneae (Hul 1991). It is a monocaulous treelet, rarely branched and hardly attains 6 m tall and 8 cm in diameter. The plants form a rosette of leaves composed of large green older leaves and small reddish-brown younger leaves. This rosette of leaves collect leaf litters that decompose *in situ* and also serve as hides for ticks and other insects. Bisexual flowers bearing numerous stamens and pink petals are borne along the midrib of the leaves.

Phyllobotryon contains treelets that survive under canopy of tropical forests distributed along the coast from southeastern Nigeria to the Democratic Republic of Congo inland to Angola (Hul 1991). In Cameroon, the genus is confined to primary forests in the South, Littoral and Southwest Regions. This genus is represented in Cameroon by a single species (Hutchinson & Dalziel 1958; see fig. 1 Hul [1991]) although some aberrant forms have been reported (Letouzey *et al.* 1969; Bos 1975). In the Korup Forest Area (KFA), two groups of morphospecies have been consistently observed in allopatry: the first group consists of two distinct subgroups in sympatry, differentiated by the fruits surface ornamentation and length of petiole. One subgroup has wrinkled fruits and a distinct petiole, whereas the other subgroup has smooth fruits and an indistinct petiole. These two taxa are hereafter referred to as morphospecies 1 and 2, respectively. The second group is composed of homogenous individuals whose flowers pierce the lamina and consequently result in the fruits being borne on the abaxial surface of the leaf. This morphospecies also reported by Bos (1975) is hereafter referred to as morphospecies 3.

Here we use sixteen quantitative and four qualitative characters and statistical analyses of morphological, distributional, and habitat data to study the variation in *Phyllobotryon* of KFA. We aim to illustrate that the three morphospecies have differences warranting the recognition of the three as distinct species. The results obtained here will serve as a baseline for an updated revision of *Phyllobotryon.*

MATERIALS AND METHODS

STUDY SITES

This research was carried out within the tropical moist forest zone of Korup National Park and in the Forest Management Unit (FMU 11 001) located *c.* 20 km north of the Park. The above sites, consisting of eight localities (Table 1), hereafter

TABLE 2. — Sixteen quantitative and four qualitative characters examined for variation in morphospecies of *Phyllobotryon* Müell.Arg. Morphological terminology follows Simpson (2006).

Quantitative Character	Code	Quantitative character	Code
Length of longest leaf (cm)	LLL	Width of longest leaf (cm)	LLW
Fruit diameter (mm)	FRD	Petiole length (cm)	PEL
Length of fruit (mm)	FRL	Length of seed (mm)	SDL
Number of mature fruit per leaf	MFN	Number of seeds	SEN
Number of leaves	LEN	Number of lateral veins of the longest leaf	SLN
Diameter of the petiole at point of insertion to main stem (mm)	DIP	Width of smallest leaf (cm)	WSL
Number of teeth	SSN	Petiole length of smallest leaf (cm)	PLS
Number of lateral nerves on smallest leaf	NSV	Number of lateral veins of the longest leaf	NLV
Fruit surface ornamentation	FRN	Wrinkled	1
		Smooth	2
Position of flower or fruit on midrib	IPM	borne from petiole up to of leaf lamina	1
		borne from midway leaf lamina up to acumen	2
		borne along entire leaf lamina	3
Colour of mature fruit	FRC	Deep red	1
		Variegated, cream white & deep red	2
Leaf shape	LES	Oblong-obovate to oblong-lanceolate	1
		Oblanceolate to narrowly elliptic	2

collectively referred to as the Korup Forest Area (KFA). The KFA (Latitude 5°54' to 4°25'N and Longitude 8°42' to 9°9'E) has an elevation of 122-248 m and lies on the western border of Cameroon's Southwest Region. This zone occupies a surface area of *c.* 130 000 ha. Maley (1987) and Letouzey (1985) have elaborately described the vegetation of the area as Atlantic coastal forest and a former Pleistocene refugium.

Morphological characters

Plant sampling was randomly carried out in eight locations where *Phyllobotryon* occurs. Morphological characters were divided into two categories: quantitative and qualitative. Some of the selected characters had shown some degree of significance in separating morphospecies of *Phyllobotryon* in a previous study (Libalah 2012). These characters included leaf width, number of teeth, petiole length, fruit diameter etc. Mounted herbarium specimens deposited in YA and SCA (acronyms follow Holmgren *et al.* 1990) were examined. Measurements could not be made on herbarium specimens because of four main reasons: 1) most herbarium materials had incomplete parts; 2) some materials were badly preserved; 3) leaves are often quite long and do not fit on herbarium sheets and thus were not collected for mounting; and 4) there were not enough collections. Given these limitations, all observations and measurements were alternatively made in the field on 111 fresh samples. Measurements of flowers were not considered for this study because the plants show some variation in their phenology which is under study. Table 2 shows the 20 quantitative and qualitative characters and their states employed during this study.

In addition to qualitative characters, we included presence/absence of characters such as the position of flowers and fruits. Such positions were taken into consideration when nothing more than floral buds or scars were present.

Habitat preference and spatial distribution

According to our field observations and literature, two of the morphospecies (Morphospecies 1 and 2) have been found in sympatry in the 50-ha plot in Korup National Park (Thomas *et al.* 2003; Kenfack *et al.* 2006).

To study microhabitat preference and spatial distribution, we extracted the position of each individual along a 1000 × 20 m rectangular plot within the 1000 × 500 m (50 ha) plot and obtained

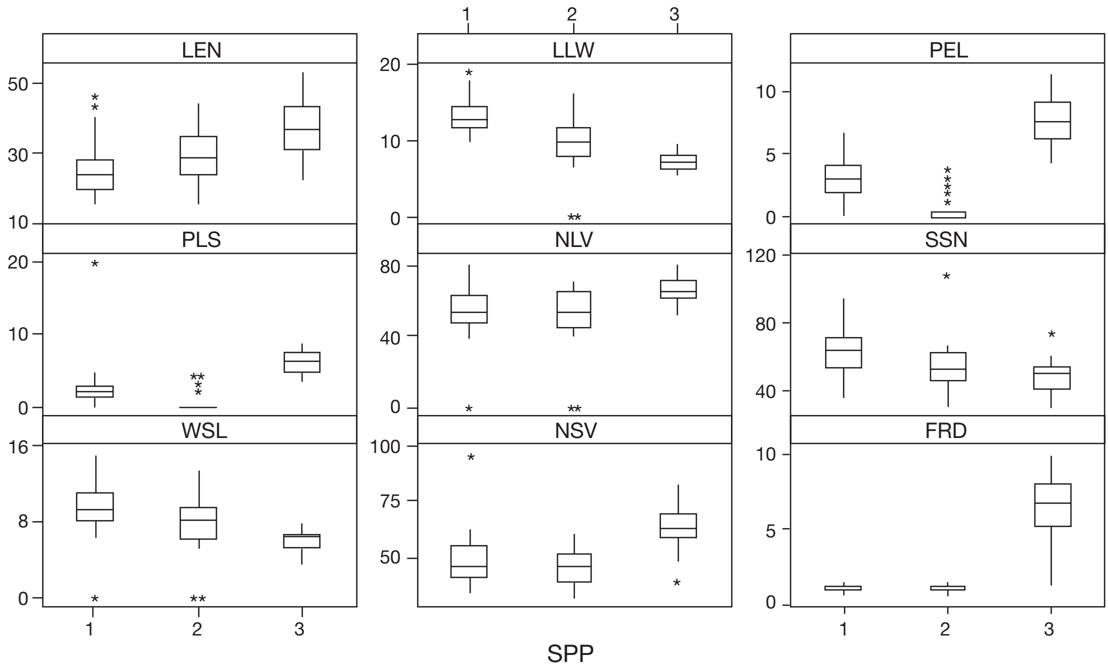

FIG. 1. — Box plots of nine significantly different quantitative characters measured for the three studied morphospecies of *Phyllobotryon* Müell.Arg. (**1**-**3**) used in the Principal Component Analysis (**PCA**) and Discriminant Analysis (**DA**). Median values are shown as lines within the box, and outliers are represented by asterisks. The complete character names for the abbreviations are defined in Table 2.

habitat data from the plot's data base (cf. Kenfack *et al.* 2006; Chuyong *et al.* 2011). The 50-ha plot is characterized by a flat topographical aspect that covers the southern two-thirds of the plot and deeper soils that are wetter and seasonally flooded. The northern one-third of the plot has a steeper slope covered by thinner, drier, stony soils (Thomas *et al.* 2003). A spatial representation plot of microhabitat preference for the morphospecies was produced.

ANALYSES

Morphological data were analysed using both univariate (descriptive statistics) and multivariate statistical approaches. Parameters analysed for the descriptive statistics included arithmetic mean, coefficient of variation, and standard deviation for each morphospecies based on the quantitative data sets. Whisker-box plots were used to show the range of variation amongst selected morphological characters for each morphospecies. In search of significantly different characters, an Analysis of Variance (ANOVA) was conducted; characters were considered statistically significant if $P \leq 0.05$.

To minimize or eliminate error and bias because of differences in measurement units the data were standardized before subsequent multivariate analysis. Principal Component Analysis (PCA) and Discriminant Analysis (DA) were conducted for significantly different morphological characters using Minitab (Minitab Inc. 1991). The DA was intended to bring out similarity and dissimilarity values between the morphospecies.

RESULTS

MORPHOLOGICAL ANALYSIS

Normality Test showed a normal distribution at 95% CI. A one-Way ANOVA (Table 3) revealed that nine out of the 16 quantitative characters were significantly different at $P \leq 0.05$ and could therefore be used for further analyses. Only a single

TABLE 3. — Variation amongst the nine significantly different quantitative characters for the three morphospecies of *Phyllobotryon* Müell. Arg. analyzed in this study (means of morphospecies that do not share the same alphabetic superscripts are significantly different).

	Morphospecies (Mean ± SE)			Significance ($P \leq 0.05$)
Character	1	2	3	
Number of leaves (LEN)	25.603b ± 0.937	29.000b ± 1.40	36.800a ± 1.96	P<0.001
Width of longest leaf (LLW)	12.599a ± 0.462	9.439b ± 0.678	7.310b ± 0.233	P<0.001
Petiole length (PEL)	2.660a ± 0.207	0.268b ± 0.164	7.630c ± 0.454	P<0.001
Petiole length of smallest leaf (PLS)	2.390a ± 0.310	0.500b ± 0.244	6.253c ± 0.380	P<0.001
Number of lateral veins of the longest leaf (SLN)	71.00a ± 2.33	61.18a ± 4.37	46.70b ± 2.97	P<0.001
Number of teeth (SSN)	60.21a ± 2.34	46.07b ± 4.73	47.00b ± 3.26	P<0.002
Width of leaf (WSL)	9.532a ± 0.353	7.389b ± 0.623	6.147b ± 0.271	P<0.001
Number of lateral nerves on smallest leaf (NSV)	47.12b ± 1.71	40.57b ± 3.12	63.26a ± 2.40	P<0.001
Fruit diameter (FRD)	1.080b ± 0.143	1.0243b±0.085	6.425a ± 0.598	P<0.001

TABLE 4. — Loadings of the first three Principal Components showing the contributions of each of the nine significant quantitative and three qualitative characters for the three morphospecies of *Phyllobotryon* Müell.Arg..

Character	**PC1**	**PC2**	**PC3**
Number of leaves (LEN)	0.215	0.004	0.082
Width of longest leaf (LLW)	–0.306	–0.212	0.092
Petiole length (PEL)	0.212	–0.377	–0.350
Petiole length of smallest leaf (PLS)	0.172	–0.382	–0.284
Number of lateral veins of the longest leaf (SLN)	–0.241	–0.248	0.250
Number of teeth (SSN)	–0.170	–0.401	0.296
Width of Leaf (WSL)	–0.233	–0.309	0.297
Number of lateral nerves on smallest leaf (NSV)	0.090	–0.483	0.225
Fruit diameter (FRD)	0.323	–0.187	–0.152
Fruit surface ornamentation (FRN)	0.342	0.120	0.448
Position of flower or fruit on midrib (IPM)	–0.402	0.035	–0.218
Colour of mature fruit (FRC)	0.342	0.120	0.448
Leaf shape (LES)	0.370	–0.227	–0.140
% variance	43.3	21.1	10.1
Cumulative proportion	43.3	64.5	74.6

quantitative character, Petiole length (PEL) showed discrete (i.e. non-overlapping) variation amongst the three morphospecies. The remaining 15 quantitative characters could only be used to differentiate between one of the morphospecies and the remaining pair of morphospecies at a time, depending on the particular analyzed character (Fig. 1).

The first three axes of the Principal Components Analysis (PC1, PC2 and PC3) accounted for 74.5 % of the total variation (loadings across the three components shown in Table 4). The first axis alone accounted for 43.3 % of total variance separating the three morphospecies. The variation along the first axis showed that the highest positive loadings of three quantitative characters were Fruit diameter (FRD), Number of leaves (LEN), and Petiole length (PEL). The highest negative loadings were from Leaf width (LLW) and Number of teeth (SLN). However, qualitative characters also made a significant contribution to variation along this axis with the largest positive and negative loadings coming from Leaf shape (LES). The second axis (21.1 % of the total variation) had the highest loadings for Number of leaves (LEN) and the highest negative

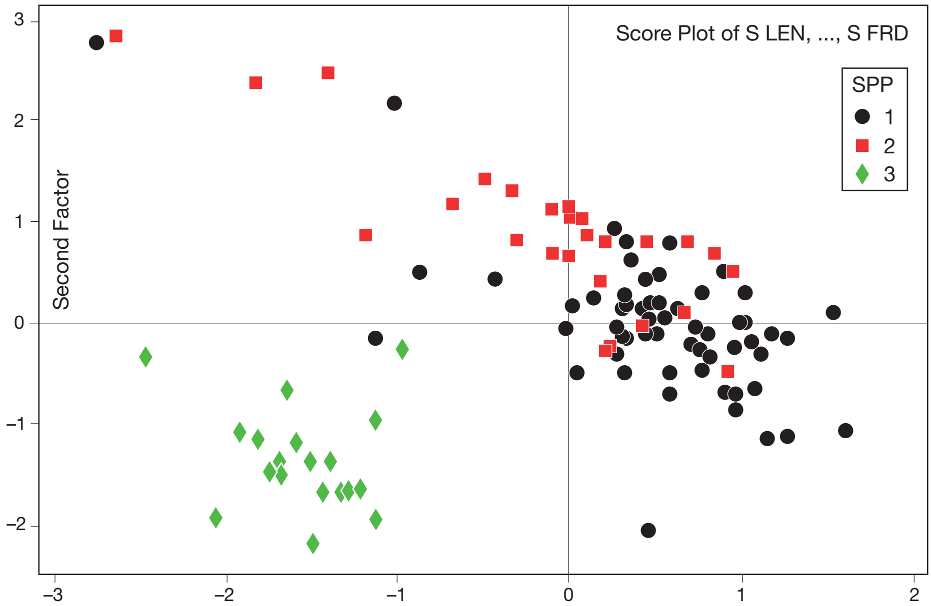

FIG. 2. — Scatter plot showing the contribution of the first three Principal Components.

loading with the Number of lateral nerves (SLN) and Number of teeth (SSN). Qualitative characters that load heavily on the second axis are Fruit colour (FRC), Fruit surface ornamentation (FRN), and Leaf shape (LES). The third axis only explained 10.1 % of total variation with highest loadings contributed by two quantitative characters [Number of teeth (SSN) and Width of leaf (WSL)] towards the positive axis. The Fruit surface ornamentation (FRN) and Fruit colour (FRC) loaded positively for the qualitative characters. This third axis separated the morphospecies with numerous teeth, larger leaves, wrinkled and reddish fruits from those with fewer teeth, narrow leaves, smooth and whitish fruits.

The scatter plot (Fig. 2) of PC1, PC2 and PC3 for the 13 significantly different characters of *Phyllobotryon* yielded a group of points corresponding to morphospecies 3, which was clearly separated from a nebulous cloud of points in multivariate space from morphospecies 1 and 2, but the plot failed to show a clear separation between morphospecies 1 and 2.

The Discriminant Analysis (DA) shown in Table 5 supports the distinctiveness of the three morphospecies. The DA discriminates three groups made of 88.9 %, 96.2 % and 100 %, representing morphospecies 1, 2 and 3, respectively. The DA, however, did show weak support for distinction between morphospecies 1 and 2. As in the PCA, the DA also revealed some clustering between Morphospecies 1 and 2, which is because of the continuous overlapping between these two morphospecies.

Within the 50-ha plot in the park, the sympatrically distributed morphospecies 1 and 2 showed some microhabitat preference (Fig. 3). The spatial representation plot shows that the two morphospecies occur in sympatry but are not completely merged-up populations. Furthermore, individuals of morphospecies 1 are restricted to the low wet areas within the 50-ha plot, while those of morphospecies 2 are confined to the lower, wetter, and higher elevation

DISCUSSION

The use of morphometrics in the identification of species and delimitation of taxa provides a rapid and reliable means in resolving taxonomic prob-

Table 5. — Discriminant Analysis (DA) for individuals of the three morphospecies of *Phyllobotryon* Müell.Arg.). 108 individuals (sample value) were used for the DA of which 8 individuals (correct value = 100) were common to both of morphospecies 1 and 2 giving a correct pecentage of 92.6 (Proportion correct).

Put into Group	Morphospecies 1	Morphospecies 2	Morphospecies 3
1	56	1	0
2	7	25	0
3	0	0	19
Total value	63	26	19
Correct value	56	25	19
% Proportion	88.9	96.2	100
	Sample value = 108	Correct value = 100	Correct proportion = 92.6%

Table 6. — Comparison of morphological characters for the three morphospecies of *Phyllobotryon* Müell.Arg. analyzed in this study.

	P. spathulatum	Morphospecies 2	Morphospecies 3
Fruit shape	Ovate, beaked	Ovate, beaked	Slender oblong
Fruit surface ornamentation	Wrinkled	Smooth	Smooth
Style persistence	Persistent and vestigial	Persistent and pronounced	Persistent and pronounced
Style length (mm)	< 1	< 2	*c.* 2
Petiole length (cm)	1.5-5.5	<1	6 – 12
Calyx persistence	Caducous	Caducous	Persistent
Flower and fruit orientation	Permanently on adaxial surface of leaf blade	Permanently on adaxial surface of leaf blade	Perforate and projecting through the abaxial surface of leaf blade

lems even in cryptic species complexes (Jimenez-Perez & Lorea-Hernandez 2009; Sharma & Pandit 2011; Ceolin & Miotto 2011). The multivariate analysis of nine significant characters confirm that there is continuous and overlapping variation in *Phyllobotryon*. A scatter plot of the significant characters revealed two clusters corresponding to three morphospecies. Contrary to previous literature (Hutchinson & Dalziel 1958; Letouzey *et al.* 1969; Hul 1991), which showed that *Phyllobotryon* of Cameroon is monospecific, the variation displayed in this study suggests that there is more than one morphological entity in the genus. The variations mentioned by previous authors (Letouzey *et al.* 1969; Bos 1975; Hul 1991), were based on field and herbarium observations without further quantitative analysis.

After matching our morphospecies 1 to herbarium specimens deposited at YA and SCA and comparing it to descriptions in taxonomic literature (Hutchinson & Dalziel 1958; Hul 1991, 1995), morphospecies 1 corresponded to the validly published *Phyllobotryon spathulatum* Müell.Arg and will be referred to by its legitimate name hereafter. This species was found between sites V-VIII (Table 1). Morphospecies 2 has fruits that are smooth and ovate with early caducous pubescence. It has a very short petiole resulting in subsessile leaves. The style is very pronounced and persistent on the fruit. This morphospecies usually occur in similar habitats with *P. spathulatum*, but shows some microhabitat preference (Fig. 3). In contrast to *P. spathulatum*, morphospecies 2 usually occurs in areas characterized by a flat topographic aspect, wetter, deeper and seasonally flooded soils while *P. spathulatum* mostly occurs at areas typified by a steeper slope, covered by thinner, drier, stony soils. In addition to their microhabitat preference however, these two morphospecies can be distinguished in other features such as Width of leaves (LLW & WSL), Number of teeth (SSN), Petiole lengths (PEL & PLS) (Table 3), Fruit surface ornamentation (FRN) and Petiole length (PEL) (Table 6).

Unlike morphospecies 1 [*P. spathulatum* sensu stricto] and morphospecies 2, morphospecies 3

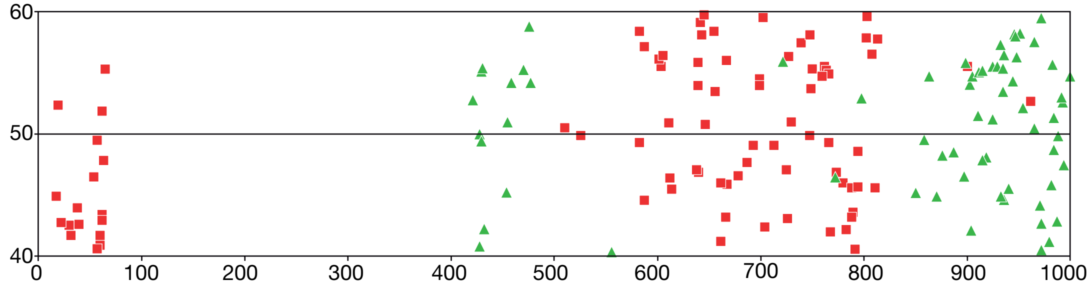

FIG. 3. — Spatial representation plot to illustrate microhabitat preference for the two sympatric Morphospecies of *Phyllobotryon* Müell. Arg. The information on the spatial representation plot (1000 × 20) is extracted from the 1000 × 500 m database of the 50-ha plot in Korup. Symbols: ▲, morphospecies 1; ■, morphospecies 2.

has a distinct petiole. The later is distinguishable from *P. spathulatum* and morphospecies 2 in that the flowers and fruits are produced only after the inflorescence pierces the lamina completely, thereby producing flowers and fruits on the lower surface of the leaf. The fruit is slender, oblong with persistent calyx as opposed to a fruit that is ovate and beaked with caducous calyx of *P. spathulatum* and morphospecies 2 (Table 6). In the field, plants of this taxon superficially appear sterile because of their hidden fertile organs. The scatter plot shows morphospecies 3 separated from *P. spathulatum* and morphospecies 2 (Fig. 2). The distribution of morphospecies 3 in a separate location (sites I-III) from the other morphospecies (Table 1) supports its ecological uniqueness, as was also observed at Kribi in the southern region of Cameroon (Bos 1975).

Important differentiating characters

Based on field observation of some previous authors (Letouzey *et al.* 1969; Bos 1975) and the statistical analysis used in this study, the leaf and fruit characters are important in distinguishing between species of *Phyllobotryon*. According Letouzey *et al.* (1969) and Bos (1975), leaf characters such as leaf dimensions, petiole length, and the presence or absence of indumentum are less diagnostically important.

Taxonomic implication

The continuous but consistent patterns of morphological variation observed here between *Phyllobotryon spathulatum*, morphospecies 2 and 3 reveals more than "mere ecological variants" as proposed by Letouzey *et al.* (1969) and supported by Bos (1975). The unpublished form *P.* "*verecundum*" highlighted in Bos (1975) is yet another morphospecies that was not observed during

Identification key to taxa of *Phyllobotryon* Müell.Arg. of Cameroon

1. Flowers and fruits piercing the lamina and borne on the abaxial surface of the leaf; petiole 6-12 cm long; calyx persistent; fruit oblong .... Morphospecies 3
— Flowers and fruits not piercing the lamina and remaining on the adaxial surface of the leaf; petiole shorter than 6 cm; calyx caducous; fruit ovate 2

2. Leaves petiolate; petiole 1.5-5.5 cm long; fruit wrinkled ...... *P. spathulatum* Müell.Arg.
— Leaves subsessile; petiole < 1 cm long; fruit smooth 3

3. Leaves subsessile; petiole <1 cm; fruit smooth, variegated green/deep red .... Morphospecies 2
— Flowers and fruits situated exclusively on the apical part of the midrib, leaf tip sharply recurved .... *P.* "*verecundum*"

our field studies, and still may only be known from a single collection made by Letouzey (*Letouzey 9390*). This suggests the possibility of a fourth distinct morphospecies necessitating further collections and study. It should be noted that Hul (1991) took a broader view of *P. spathulatum* by merging characters patterning to *P. spathulatum* and *P.* "*perforans*". The later is a form previously noted by Letouzey *et al.* (1969) and Bos (1975) respectively. In order to bring attention to the differences in *Phyllobotryon* of Cameroon and to aid in the identification of new collections a taxonomic key for *Phyllobotryon* is proposed.

CONCLUSION

Based on descriptions in floras, herbarium studies, field observations and morphometric analyses, there is a consistent pattern of overlapping variation between *Phyllobotryon spathulatum* and morphospecies 2 in the KFA but morphospecies 3 is unique in the fact that its fruits are borne on the abaxial surface of the leaf. *Phyllobotryon* "*verecundum*" is different from the later in having its flowers and fruit on the apical portion of the leaf tip as illustrated by Bos (1975). Compared to Morphospecies 2, *P. spathulatum* has relatively broader leaves, a well-developed petiole, and a wrinkled, reddish ovate fruit borne on the adaxial leaf surface along the midrib. Morphospecies 2 has relatively broad and sessile or subsessile leaves. The fruits are smooth, ovate, with variegated cream white and deep red. Morphospecies 3 differs from morphospecies 1 and 2 in having the longest petioles (6-12 cm), and an inflorescence that pierces the lamina leading to the flowers and fruit being on the abaxial surface of the leaf along the midrib. Its fruit is smooth, slender, and oblong.

A molecular phylogenetic study will clarify the species boundaries of this genus. This is possible through the sequencing of *rbcL*, the plastid gene encoding for ribulose bisphosphate carboxylase. This will help in explaining the genetic connection and relationship between the various morphospecies. As such an updated revision of *Phyllobotryon* and description of the new taxa will be justifiable.

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