

Reappraisal and identification of *Olinia rochetiana* (Oliniaceae) in South Africa

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ABSTRACT

A numerical phenetic analysis of data obtained from populations of the *Olinia rochetiana* A.Juss. complex occurring in South Africa (Mpumalanga and Limpopo Provinces) revealed the existence of two forms: 1, a shrubby form (up to 2.5 m tall), with thick terminal branches, coriaceous leaves with a tinge of red on margins (towards the apices), short inflorescence axes, peduncles and deeply red pedicels and floral tubes/hypanthia; and 2, a slender tree form, measuring more than 4 m tall with slender terminal branches, glossy and slightly thin, papery leaves, margin colour the same as the entire lamina, and the inflorescence axes, peduncles, pedicels and hypanthia pale green to creamy white. Differences in floral features between the two forms correlate with differences observed in vegetative features. The two forms occupy distinct ecological niches and show tolerances and preferences for different environmental conditions such as soil type, elevation and humidity. An identification key for the two forms is presented.

INTRODUCTION

Olinia rochetiana A.Juss. *sensu lato* is a morphologically variable and widespread forest species occurring on foothills and mountain ravines in Angola, Zambia, Zimbabwe, South Africa, Mozambique, Malawi, Tanzania, Kenya, Rwanda, Burundi, Democratic Republic of the Congo, Uganda, Sudan and Ethiopia. The plants prefer moist habitats at the foot of mountains, often along ravines. In this kind of habitat plants often reach quite considerable heights (\pm 4–6 m), whereas in exposed areas the plants are associated with rocky outcrops and quartzitic soils, and mostly measure just less than 3 m tall. The description of *O. rochetiana* by Jussieu (1846) was based on *Rochet d'Héricourt 18*, collected during his voyage in Abyssinia (Ethiopia). The current taxonomic concept of *O. rochetiana* s.l. includes *O. aequipetala* Gilg, *O. discolor* Mildbr., *O. huillensis* Welw., *O. ruandensis* Gilg, *O. usambarensis* Gilg and *O. volkensii* Engl., all of which Verdcourt (1975, 1978) and Verdcourt & Fernandes (1986) treated as conspecific in their regional treatments of Oliniaceae. Commenting on the nature of the morphological variation, Verdcourt (1975, 1978) remarked that South African populations of *Olinia* from the northern and eastern parts of the former Transvaal (now split into four provinces: Gauteng, Limpopo, Mpumalanga and some eastern parts of North-West) with short, broad petals could be recognized as a variety of *O. rochetiana*. Since then material collected from the escarpment in Mpumalanga and Limpopo has been referred to *O. rochetiana*, despite Burt Davy's (1926) recognition of the plants collected from the mist belt forests in Graskop and Pilgrim's Rest, Mpumalanga, as *O. usambarensis*. Gilg (1895) described this latter species based on *Holst 9115*, collected from the elevated forests of Usambara in Tanzania. Cufodontis (1960) and Fernandes & Fernandes

(1962) recognized *O. usambarensis*, but their concepts did not include the South African populations, which represent the most southern limits of the present distribution of the *O. rochetiana* complex in Africa. Thus, the confusion between *O. rochetiana* and *O. usambarensis* has persisted in South Africa. Information gleaned from herbarium sheets of material collected from Usambara, Tanzania, consistently indicates *O. usambarensis* to be a medium to large tree with large and broadly elliptic leaves, and sparsely pubescent hypanthia, as opposed to the shrubby form with shorter obovate leaves, robust and glabrous hypanthia that occurs in misty heights and windswept outcrops in Graskop and within the Pilgrim's Rest area in Mpumalanga.

During October/November to March/April it is possible to observe significant morphological variation in floral and fruit characteristics among populations of *Olinia rochetiana* occurring in Mpumalanga and Limpopo. In undertaking field studies on populations of *O. rochetiana* in South Africa, as part of an Africa-wide revision of this species complex, it became apparent that what is currently referred to *O. rochetiana* in South Africa shows considerable discontinuities in morphological variation between populations. It was therefore decided to study and analyse the morphological variation within and between populations of *O. rochetiana* occurring in South Africa, and determine whether the variation is sufficiently discrete to justify splitting the populations into species or infraspecific taxa. Population level data are often preferred over other kinds of data, and have the potential to provide useful information on the extent and distribution of variation within and between sympatric taxa (Balfour & Linder 1990; Wiltshire *et al.* 1991; Astholm & Nyman 1994; Chandler & Crisp 1998; Hong *et al.* 1998). Most populations of *O. rochetiana* in South Africa are allopatric, separated by mountain blocks of varying elevation/altitudes, rainfall and different soil formations. However, in the Pilgrim's Rest area, some of the populations occur in close proximity to each other, suggesting that the observed morphological variation may have a genetic basis and that the populations are maintained possibly by some sexual reproductive system.

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In this paper, only results from studies on morphological variation among populations of *Olinia rochetiana* in South Africa are presented. The study focused on comparing morphological variation among populations of the *O. rochetiana* complex occurring in Limpopo and Mpumalanga in order to examine to what extent the patterns of morphological variation between populations can be related to environmental factors. A comprehensive taxonomic treatment of the *O. rochetiana* species complex over its entire range of distribution is currently being prepared, and will be published shortly.

MATERIAL AND METHODS

Morphological variation within and between populations was assessed during their flowering (December/January) and fruiting periods (March/April) from 1997 to 2001. A total of fourteen populations of the *Olinia rochetiana* complex occurring in South Africa were sampled (Table 1). In addition, six populations belonging to *O. emarginata* Burt Davy were also sampled and included in the analyses as a standard taxon to aid in an objective evaluation and interpretation of the variability within and between the populations. *O. emarginata* is a clearly defined species in the genus, and is endemic to but widely distributed in South Africa. A Geographic Positioning System (GPS) and the 1: 50 000 topographical maps (published by the Chief Directorate, Surveys and Maps, Cape Town) were used to determine altitude as well as the geographic co-ordinates. Some characters were studied in the field (those pertaining to colour, size and shape of floral features as well as growth form characteristics) and others in the laboratory, using the Zeiss dissecting microscope. Measurements on vegetative and floral parts were made to the nearest 0.5 mm. A minimum of five measurements were made for all the quantitative characters per specimen and averaged. In total, 35 characters, 16 of which are quantitative continuous (obtained by

measurements), three qualitative discontinuous (obtained by counting) and 16 qualitative discontinuous (obtained by scoring each specimen into states) were measured per specimen (Table 2) and entered into a $t \times n$ (taxon \times character) data matrix. The character states of the variation in the measurements or observations made for the characters were discrete and assumed to be under unique genetic control (Stevens 1991; Gift & Stevens 1997). Voucher specimens were prepared and accessioned into J.

The data matrices were analysed using the clustering and ordination algorithms of NTSYS-pc (Numerical Taxonomy and Multivariate Analysis System) version 2.0 (Rohlf 1998). Firstly, the analyses were performed using individuals within populations as operational taxonomic units (OTUs). Secondly, the means of each character for all individuals within each population were averaged and then used in subsequent phenetic analyses with the populations as OTUs. As a recommended procedure in phenetic analyses (Sneath 1976; James & McCulloch 1990; Crisp & Weston 1993), the data matrices were first standardized using the 'STAND' algorithm to render characters dimensionless and to reduce all characters to a scale of comparable range so that each character contributes towards the overall resemblance in proportion to its variability among the set of OTUs.

The data matrices were subjected to an ordination procedure by means of Principal Coordinate Analysis (PCoA), which is preferable and more reliable over the Principal Component Analysis (PCA) when analysing mixed data of both qualitative and quantitative characters (Austin 1985; Kent & Coker 1992) as was the case in this study (Table 2). PCoA was performed on the correlation matrix obtained from the standardized data matrix by using the procedure SIMINT, DCENTER, EIGEN, and MOD3D available in the NTSYS-pc package (Rohlf 1998).

TABLE 1.—Descriptions of localities and populations of plants of *Olinia emarginata* and *O. rochetiana* complex in South Africa

Province	Locality	Abbr.	¼ DS	Alt. (m)	No.	Tot. no.	Height (m)	Habit & branching
<i>O. emarginata</i>								
Limpopo	Haenertsburg	E	2329 DD	± 1 085	5	5	5.5 ± 0.79	Trees, branch at >1.5 m
North-West	Magaliesberg, Hekpoort	P	2526 CD	± 1 540	4	4	8.3 ± 1.1	Large trees, branch at >1.5 m
Gauteng	Florida, Witpoortjie	I	2526 BD	± 1 400	3	3	7.3 ± 1.4	Large trees, branch at >2 m
	JHB, Melville Koppies	L	2625 AB	± 1 200	2	2	9.4 ± 2.4	Large trees, branch at >2 m
Mpumalanga	Roosenekal, Uitkijk	U	2529 BB	± 1 850	8	10	5.8 ± 0.96	Large trees, branch at >1.5 m
	Roosenekal, Naupoort	R	2529 BB	± 1 800	8	8	5.4 ± 1.01	Large trees, branch at >1.5 m
<i>O. rochetiana</i>: slender, tree-like form								
Limpopo	Tate Vondo Forests	V	2230 DD	± 1 250	9	9	3.6 ± 0.66	Slender tree, branch at ±1 m
	Blouberg Mountains	B	2329 AA	± 1524	11	15	1.3 ± 0.35	Slender trees, branch at ± 0.75 m
	Soutpansberg, Letjuma	J	2329 AB	± 1 282	19	24	1.3 ± 0.51	Shrubs, branch at ± 1 m
	Soutpansberg, Llewelyn	W	2329 AB	± 1 560	4	4	0.9 ± 0.31	Shrubs, branch at ± 1 m
	Soutpansberg, Ontmoet	M	2329 AB	± 1 530	9	9	1.7 ± 0.38	Shrubs, branch at ± 1 m
	Soutpansberg, Sussens	S	2329 BB	± 1 650	7	7	1.4 ± 0.28	Shrubs, branch at ± 1 m
	Wolkberg, Bewaarkloof	F	2429 BB	± 1 650	4	4	1.6 ± 0.37	Shrubs, branch at ± 1 m
Mpumalanga	Blyde, Potholes	H	2430 DB	± 1 300	4	4	1.8 ± 0.58	Shrubs, branch at < 0.5 m
	Themeda Hill	T	2430 DC	± 1 767	4	4	1.4 ± 0.36	Slender tree, branch at ± 1 m
<i>O. rochetiana</i> shrubby, dwarf form								
Mpumalanga	Blyde, Mariepskop	K	2430 DB	± 1 980	5	5	1.4 ± 0.23	Shrubs, branch at < 0.5 m
	Mt Sheba, Lost City	C	2430 DC	± 1 958	11	15	1.1 ± 0.32	Shrubs, branch at < 0.5 m
	Blyde, The Pinnacle	N	2430 DD	± 1 476	10	12	0.9 ± 0.55	Shrubs, branch at < 0.5 m
	Blyde, God's Window	G	2430 DD	± 1 700	6	6	1.2 ± 0.32	Shrubs, branch at < 0.5 m
	Blyde, Quartz Hill	Q	2430 DD	± 1 730	8	10	1.2 ± 0.32	Shrubs, branch at < 0.5 m

¼ DS, quarter degree square; No., number plants sampled (either flowering or fruiting) in a population; Tot. no., total number plants observed in a population; Height (m), mean height of plants in a population and ±, standard deviation.

TABLE 2.—Descriptions of characters used in phenetic analyses of *O. rochetiana* complex and *O. emarginata* populations. * Denotes characters defined as in Hickey (1973), Hill (1980) and Herman *et al.* (1987)

1. Mean lamina length (mm).
2. Mean lamina width (mm).
3. Mean petiole length (mm).
4. Mean inflorescence axis length (mm).
5. Mean hypanthium length (mm).
6. Mean petal length (mm).
7. Mean petal width (mm).
8. Mean pedicel length (mm).
9. Lamina obovate, broadly elliptic or narrowly elliptic.
10. Apex emarginate, or acuminate.
11. Base cuneate to round, or decurrent.
12. Lamina midrib channeled above, or not channeled above.
13. Secondary veins loop once, or more than once before margins.
14. Secondary veins branch at 30–45° or at more than 45° from midrib.
15. Lamina paler above, or below.
16. Margins on apex reddish, or same color as lamina.
17. Midrib pinkish to red, or pale green.
18. Terminal branches pink to reddish, or pale green.
19. *Leaf Shape Index (200M/W, where M = mean perpendicular distance from the midrib to the margin, and W = maximum width of the leaf).
20. *Mean number of secondary veins, counted on both sides of midrib on adaxial surface.
21. *Mean secondary vein branching angle (°) on adaxial surface.
22. *Mean areole length (mm) measured on adaxial surface.
23. *Mean areole width (mm) measured on adaxial surface.
24. *Mean number of veinlets per areole counted on adaxial surface.
25. *Mean number of branches per veinlet expressed as branching orders.
26. *Leaf apex angle (°) measured on adaxial surface.
27. *Leaf base angle (°) measured on adaxial surface.
28. Leaf lamina coriaceous /leathery, or soft to slightly papery.
29. Mean hypanthium width (mm) i.e. narrow (2–3 mm) or broad (> 3 mm)
30. Hypanthium deep red, or pale green to cream-white, turning pink with age.
31. Petal pink to deep red, or cream-white.
32. Petal oblong to spatulate, or obovate.
33. Petal apex distinctly mucronate, or without a mucro.
34. Mean width of inflorescence axis (mm).
35. Habit tree form or shrubby.

Cluster analysis was used to test whether groups similar to those obtained in the ordination analyses could be recovered, and also to visualize the level of morphological similarity/dissimilarity using appropriate coefficients between and within populations. Only those characters that were effective in discriminating between populations (as judged by high eigenvalues i.e. > 0.6) in the first three axes of ordination analyses were used in cluster analyses. This approach was followed since cluster analysis is known to 'impose' a hierarchical structure on any data set (Thorpe 1983), and often shows clusters that may not be recoverable in ordination analyses (Chandler & Crisp 1998). Clustering was performed using the Euclidean distances among means through the Unweighted Pair Group Method of Arithmetic Averages (UPGMA).

RESULTS

The PCoA of the data in which individual specimens were used as OTUs, separated specimens of *Olinia rochetiana* from those of *O. emarginata* along the first axis (Figure 1). Specimens belonging to *O. emarginata* are grouped neatly into one unit on the left side of the plot, whereas specimens of *O. rochetiana* occupy the right side

of the plot. Characters most strongly correlated with the first PCoA axis were, in decreasing order, leaf dimensions (leaf width, leaf base angle, leaf apex angle, number of veins looping before margins, angle of branching of veins from the midrib, and petiole length), petal length and shape. Two groups of specimens belonging to *O. rochetiana* are clearly discernible along the second PCoA axis. Specimens belonging to *O. emarginata* are slightly intermediate between the two subgroups of *O. rochetiana* along the second PCoA axis, but overlap with the slender tree form populations of *O. rochetiana*. To the right side of specimens of *O. emarginata* at the top corner is a group comprising populations of the *O. rochetiana* complex from Lost City, The Pinnacle, God's Window, Quartz Hill and Mariepskop, all in Mpumalanga, whereas at the bottom corner is a group of specimens representing the *O. rochetiana* complex populations from the Blouberg, Soutpansberg and the Wolkberg in Limpopo as well as Blyde and Themeda Hill in Mpumalanga. Characters most strongly correlated with the second PCoA axis were, in decreasing order, the habit, leaf texture, size and colour of the hypanthium, petals and terminal branches. The close phenetic similarity of members of the two groups of the *O. rochetiana* complex to each other and their dissimilarity to the *O. emarginata* group can be visualized easily along the first axis. This indicates lower levels of variation within the OTUs of the same populations than between the OTUs of the two groups of the *O. rochetiana* populations. The large gaps and sharp differences between the clusters along the phenetic spaces, as well as the high density or compactness within the clusters (Figure 1) suggest a predominance of discontinuous-state quantitative characters over overlapping continuous-state characters in the data set, thus casting aspersions on the realness of the gaps or discontinuities and how accurately they reflect the morphological differences between the plants studied (Ratliiff & Pieper 1981; Stevens 1991; Gift & Stevens 1997). However, the data analysed (Table 2) is a balanced mixture of both quantitative continuous and qualitative discontinuous characters.

The UPGMA cluster analysis using only the fourteen characters with high eigenvalues (> 0.6) in the first two PCoA axes, also separates three groups (Figure 2) corresponding to those obtained in the PCoA analysis. The *Olinia emarginata* specimens form a distinct uniform cluster separate from the *O. rochetiana* specimens at the dissimilarity levels indicated by the two phenon lines (a and b). The clustering of individual specimens belonging to *O. emarginata* did not reflect their representative populations (seven in total). Instead, the specimens were mixed among each other, indicating a low level of variability among the sampled populations of *O. emarginata*. The *O. rochetiana* specimens are split into two major subclusters at the 1.33 dissimilarity level (phenon line a in Figure 2) for which the specimens of *O. emarginata* remain coherent in a single cluster.

The means of each character for all individuals within each population were averaged and cluster analysis performed with the populations used as OTUs. The results (Figure 3) revealed similar groupings and associations between populations as in Figures 1 and 2. The populations of *Olinia emarginata* form a distinct cluster **a** separate from the populations of the *O. rochetiana* complex,

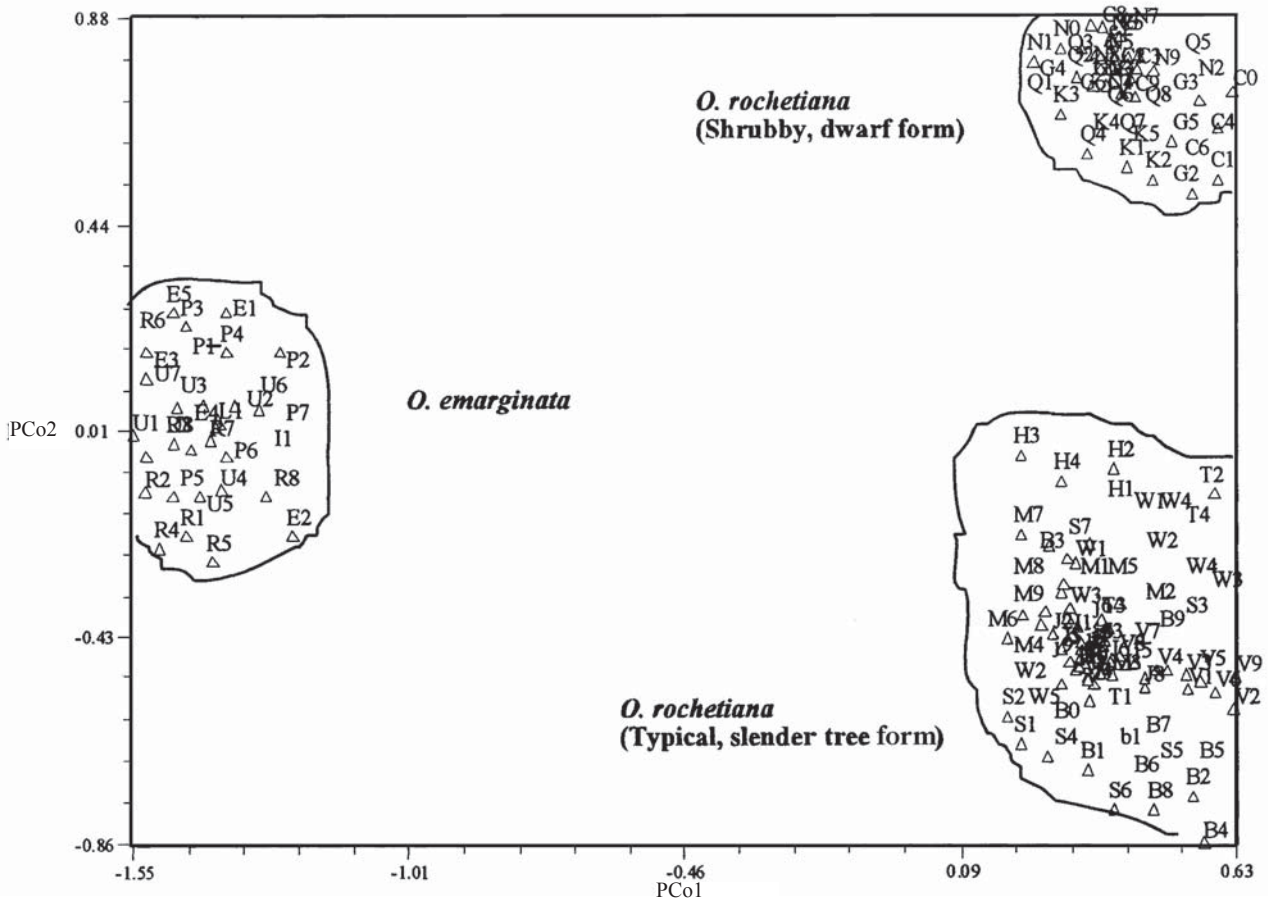


FIGURE 1.—Plot of first two principal co-ordinate analyses obtained from analysing morphological data from populations of *Olinia rochetiana* complex and *O. emarginata*. First and second PCoA axes explain 47.3% and 10.4% of total variation respectively.

which are split into clusters **b** and **c** (Figure 3). The separation of populations belonging to *O. emarginata* (cluster **a**) from those populations (clusters **b** and **c**) belonging to the *O. rochetiana* complex, occurs at a high level of dissimilarity (i.e. 1.83), indicating that these clusters represent morphologically dissimilar entities.

Cluster **b** comprises populations of *Olinia rochetiana* characterized by a slender, tree-like habit; slender terminal branches and branchlets; thin, glossy and papery leaves; slender inflorescence axes, peduncles, pedicels and hypanthia which are pale green to creamy white and turning slightly pink when mature. These are plants from the Soutpansberg (on the Farms Letjuma, Llewelyn, Ontmoet and Sussens), Tate Vondo in Venda, the Blouberg, the Wolkberg in Limpopo, and at Blyde (Potholes) and Themeda Hill in the Pilgrim's Rest area in Mpumalanga (Figure 4). With the exception of populations from Tate Vondo in Venda, which occur in well-shaded, less exposed areas and reaching up to 5 m high, all others occur in fairly exposed environments and at most reach 4 m high. Cluster **c** comprises plants collected exclusively from Mpumalanga at Lost City, The Pinnacle, God's Window, Quartz Hill and Mariepskop (Figure 5). These plants are morphologically distinct from those in cluster **b** in their shrubby, often multi-stemmed form; coriaceous leaves with a tinge of red on margins; and strikingly short inflorescence units relative to inflorescence axes, and hypanthia and petals which are deep red.

The distinctions among the populations are further illustrated by the box plots using selected characters contributing most to the discriminations among populations in the PCoA. The box plots (Figure 6A–D) illustrate variations among populations for leaf width, petiole length, hypanthium length and petal width. These characters, including habit and flower colour, are used in the key.

DISCUSSION

The phenetic analysis, using both cluster and principal co-ordinate analyses, of the specimens of *O. rochetiana* in South Africa indicate that there are two major groups of populations which are identifiable largely by their habit, leaf texture and colour of inflorescence units, hypanthium and sepals. This partly supports the observations that size and shape of floral features are taxonomically significant in *Olinia* (Sebola & Balkwill 1999). Data on floral features indicate that the two major groups of populations can be reliably distinguished from one another on the basis of petiole length, petal length, petal width, and the floral colour.

The conspicuous red flowers in the shrubby form produce less or no scent compared to the creamy white flowers observed in populations with a slender, tree-like habit. The hypanthia (floral tubes) in the shrubby form, were consistently damaged at the base (i.e. at the attachment to the ovary), and their petals often chewed by crawling insects. Both young and old flowers among the shrubby

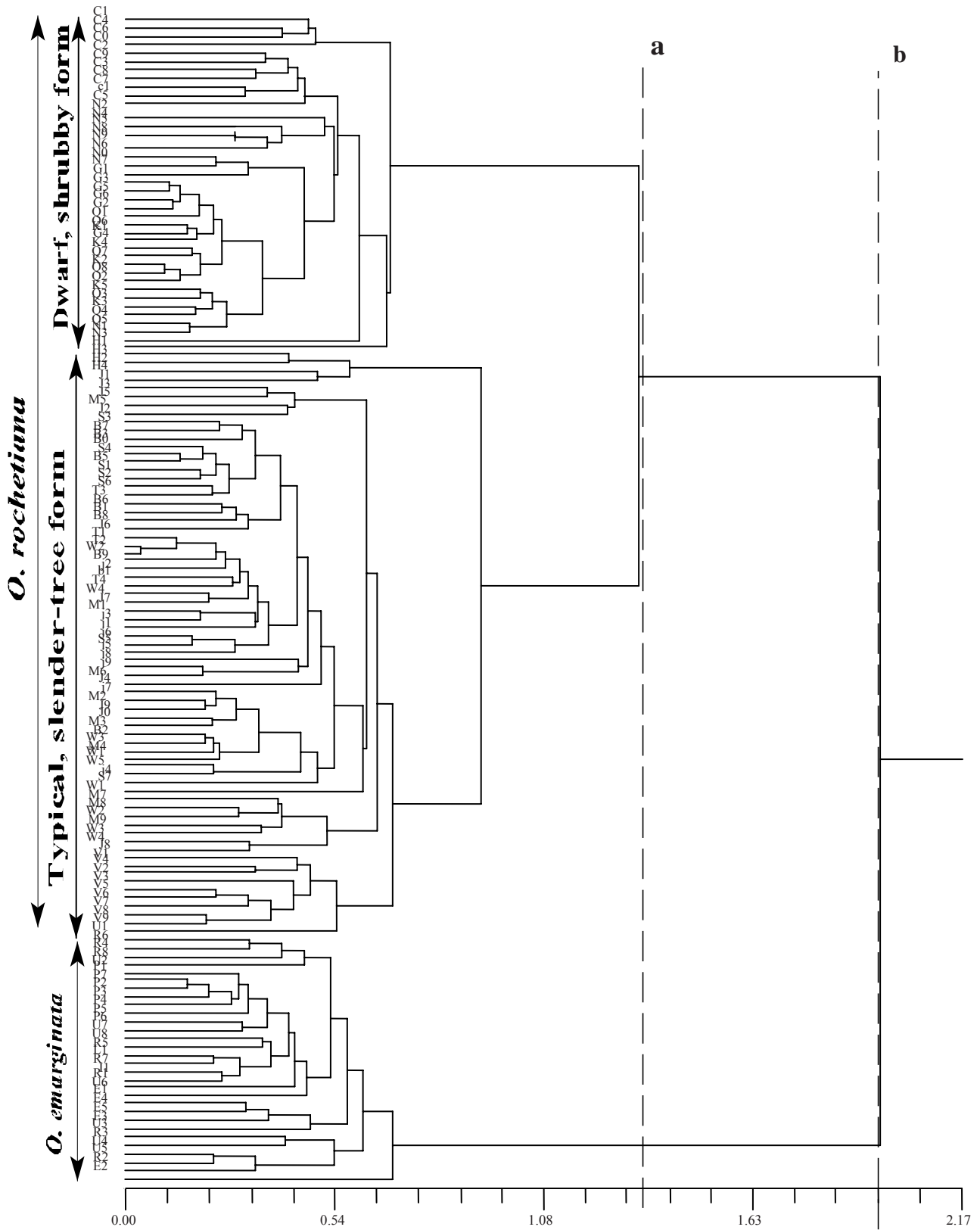


FIGURE 2.—Phenogram, based on analysis of only morphological characters with high eigenvalues (>0.6) in PCoA analysis, using individual specimens from populations of *Olinia rochetiana* complex and *O. emarginata* as OTUs; cophenetic correlation (r) = 0.979. Vertical lines indicate phenon lines a and b.

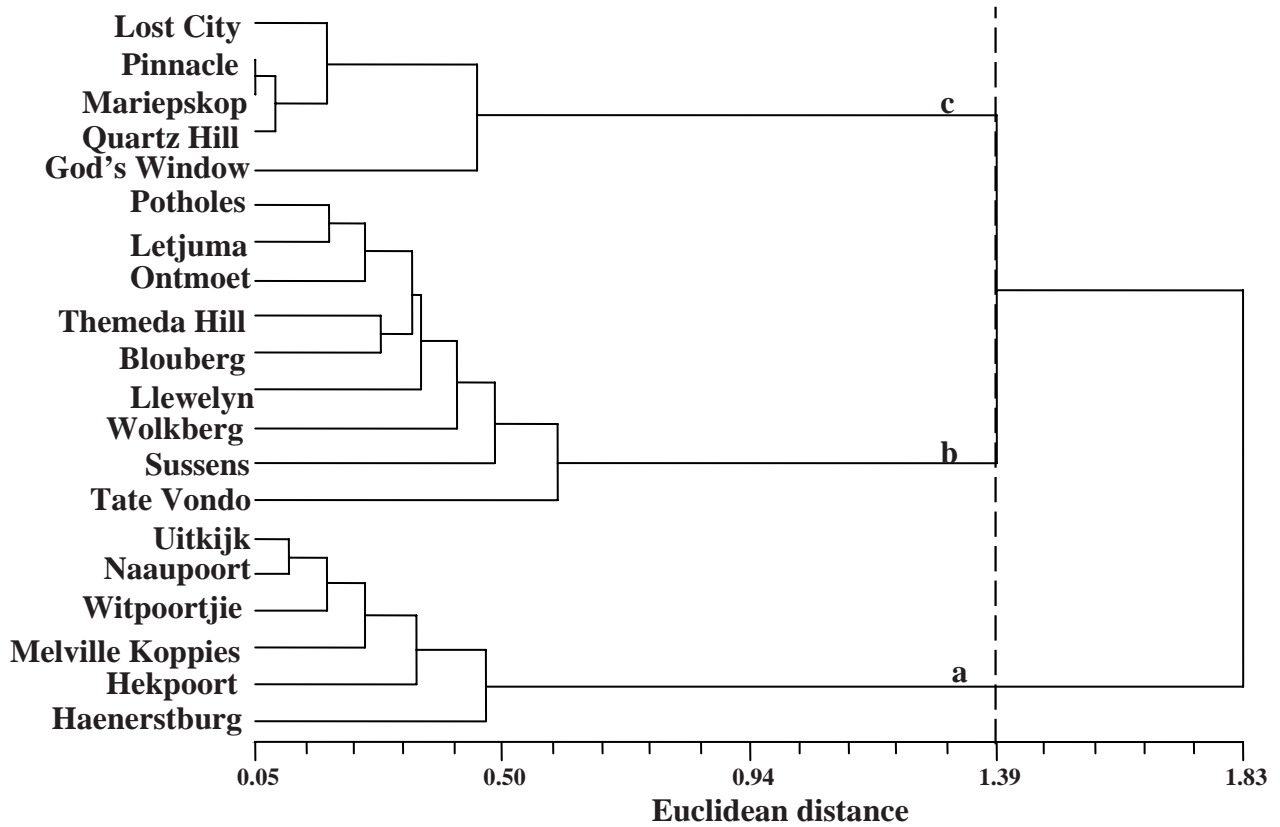


FIGURE 3.—Phenogram, based on analysis of only morphological characters with high eigenvalues (> 0.6) from PCoA analysis, using populations as OTUs; cophenetic correlation (r) = 0.993. Letters **a**, **b** and **c** indicate distinct clusters corresponding to *O. emarginata*, slender, tree-like form populations of *O. rochetiana* and shrubby dwarf form populations of *O. rochetiana* respectively.

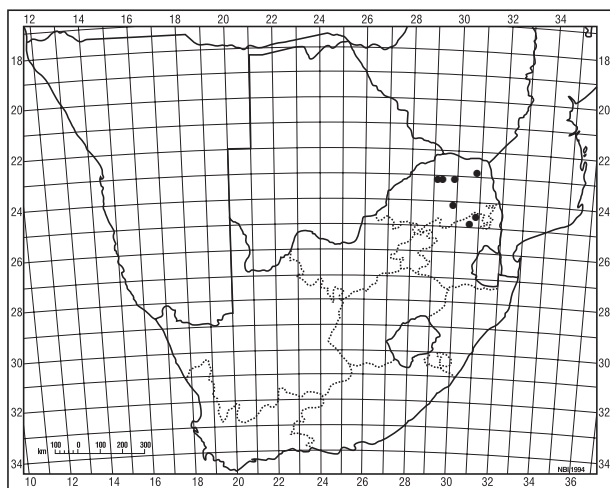


FIGURE 4.—*Olinia rochetiana* in South Africa. Known geographical distribution of slender, tree-like form populations, ●.

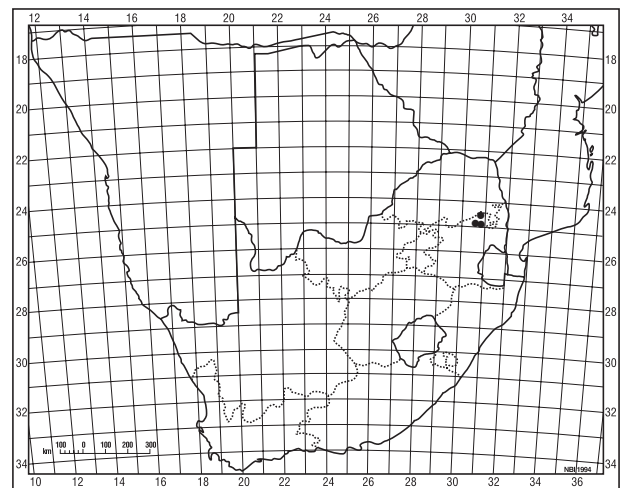


FIGURE 5.—*Olinia rochetiana* in South Africa. Known geographical distribution of shrubby dwarf form populations, ●.

form populations showed signs of damage. The creamy white to pink flowers among the slender tree populations produce sweet scent (observed from morning to mid-day), and bees were observed visiting. No damage was observed on the young and mature flowers. Once pollination has been effected, the hypanthia start wilting, and the signs of ageing appear first on the white petals, which turn brown. In all the populations studied, the flowers appear superficially simple, but closer examination revealed the existence of some structural differences between the two forms of populations. The deep red hypanthia in the

shrubby form are robust, strong, hard and short relative to the petal lengths, and have a wider diameter allowing insects as large as 5 mm access into the tube, whereas among the slender tree populations, the creamy white to pink hypanthia are slightly narrower, weak, twice as long as the petals and the tube hardly opens until anthesis, soon after which petals start wilting. The effectiveness of this barrier to insects would be enhanced by the occurrence of some recognition and rejection system to avoid hybridization among populations given their overlap in flowering periods. Currently, there are no records of

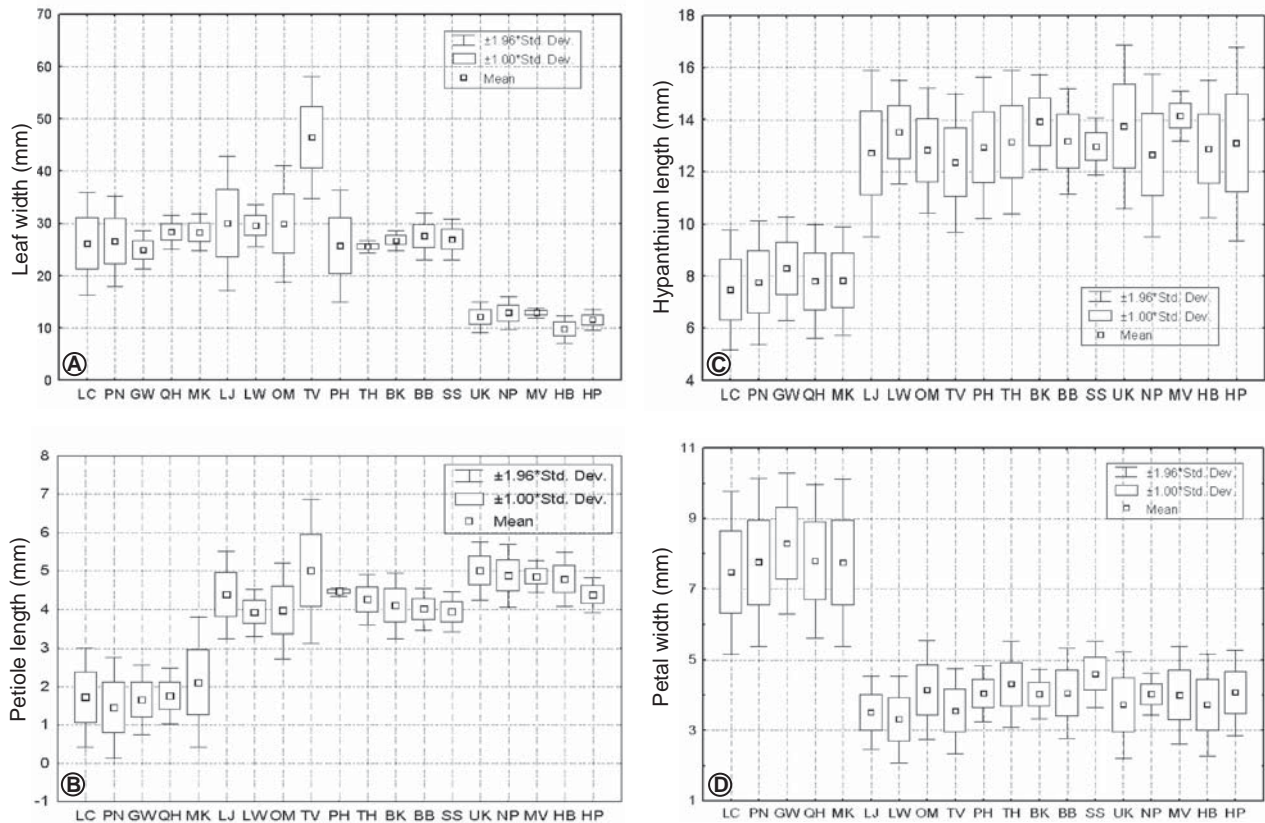


FIGURE 6.—Box and whisker plots showing variation between populations for A, leaf width; B, petiole length; C, hypanthium length; and D, petal width. LC, Lost City; PN, The Pinnacle; GW, God's Window; QH, Quartz Hill; MK, Mariepskop; LJ, Letjuma; LW, Llewelyn; OM, Ontmoet; TV, Tate Vondo; PH, Potholes; TH, Themeda Hill; BK, Wolkberg; BB, Blouberg; SS, Sussens; UK, Uitkijk; NP, Naapooort; MV, Melville Koppies; HB, Haenertsburg; HP, Hekpoort.

sympatric populations for the two forms in South Africa. The nature of the breeding systems among populations of the *O. rochetiana* complex, and other species within *Olinia* needs to be determined to provide clarity on existing isolation mechanisms among taxa.

Both the PCoA and the box and whisker plots indicate that characters that contribute to this differentiation vary significantly among populations and are from diverse plant structures (habit, vegetative and reproductive structures). Leaf texture consistently distinguishes the shrubby plants with coriaceous and/or leathery leaves from the slender, tree-like plants with membranous and/or papery leaves. The shrubby form populations occur in dry conditions, and are found consistently in exposed, windswept sites on rocky outcrops, whereas the slender tree forms occur in moist conditions and in shaded, less exposed areas or near ravines and streams. Plant height is a vegetative feature known to show variation in response to micro-environmental differences, and was thus not included in the phenetic analyses. Of the slender tree-like group of populations, only those from Tate Vondo growing in semi-shaded areas were between 5 and 6 m high, whereas other populations measured between 3 and 4.5 m high. A possible explanation for the plants reaching up to 6 m high could be due to phototropism as a result of limited direct sunlight in shaded areas. There was a correlation between general plant height, habit and altitude. The shrubby form populations characteristically measured well below 2.5 m high and all occurred at elevations between $\pm 1\ 547$ m and $\pm 1\ 980$ m above sea level, where-

as the slender tree form populations measured above 3.5 m high and occurred at altitudes below 1 500 m above sea level. Thus, a trend exists for decreasing plant height at high altitude for the two forms of populations.

The morphological differentiation of the two forms of *Olinia rochetiana* in South Africa seems to reflect adaptations to the micro-climates and ecological conditions in which they occur. Some general habitat characteristics and ecological features such as rainfall, temperature and soil types seem to influence the distributions and occurrence of the two forms of *O. rochetiana* populations in South Africa. Of the slender, tree-like populations, those on the Blouberg and Wolkberg are geographically isolated from those on the Soutpansberg, which have intermediate populations between them along the southern slopes. Materials collected from Leolo Mountains and the rocky outcrops around the Steelpoort area in Sekhukhuneland have particularly glaucous branchlets and young leaves, and are often confused with *O. emarginata* (M. Lötter pers. comm.). In their descriptions of Oliniaceae, Schmidt *et al.* (2002) made reference to a unique form of *O. rochetiana* populations from Sekhukhuneland with young twigs densely hairy. However, the phenetic analyses in this study indicate a strong phenetic similarity between populations from Sekhukhuneland with those from the Blouberg, Wolkberg, Leolo Mountains and the Soutpansberg than they are to those from The Pinnacle (Graskop) and Lost City (Pilgrim's Rest). The larger size of leaves (5–8 mm long) for *O. rochetiana* referred to by Schmidt *et al.* (2002) appears dubious, and extremely

small compared to *O. rochetiana* plants in Mpumalanga (26–48 mm long) and those from Letjuma (Soutpansberg) and Tate Vondo (Thohoyandou, Venda), which range from 34.5–65.0 mm long.

The causes of the morphological variation between the two forms of populations remain unclear. An explanation of the apparent morphological variation on the basis of phenotypic plasticity and considering the varying microclimates and the environmental differences, appears inadequate to account for the variation in reproductive structures (size, shape and colour) which are generally understood to be less phenotypically plastic than vegetative features (Davies 1983). Variation in reproductive structures is often associated with recognition/rejection mechanisms and successful pollination (Oliveira 1998; Prance 1998). Any hypothesis regarding the causes for the morphological variation among the *Olinia rochetiana* populations in South Africa, would be enriched by an investigation of the mating patterns and reproductive traits to provide insights into gene flow, taking into consideration the geographic distances and plant-pollinator interactions and relationships.

Our phenetic analyses indicate that at least two taxa can be recognized among the populations of *Olinia rochetiana* in South Africa. Formal taxonomic status for these groups of populations will be made in a comprehensive study of the morphological variation within *O. rochetiana* s.l. over its known range of distribution (Sebola & Balkwill in prep.). This study will indicate if any of the two forms of populations overlap with other taxa that might be delimited within the *O. rochetiana* complex. However, the two forms of populations in South Africa can be identified as follows:

Shrub, up to 2.5 m tall, semi-deciduous; internodes of terminal branches shorter than 45 mm, thick and compact, deep red; leaves coriaceous; inflorescence axes and peduncles 6–10 mm long, thick; pedicels, hypanthia and petals deep red shrubby dwarf form

Slender tree, up to 4 m tall; internodes of terminal branches longer than 45 mm, slender and loose, pale green to grey; leaves thin and papery; inflorescence axes and peduncles longer than 10 mm, slender and narrow; pedicels, hypanthia and petals pale-green to creamy white slender tree-like form

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