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PHYTOLACCA DODECANDRA (PHYTOLACCACEAE) IN AFRICA: GEOGRAPHICAL VARIATION IN MORPHOLOGY

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Summary

The morphology of *Phytolacca dodecandra,* locally called endod, was examined using herbarium specimens from throughout its natural range in Africa and analyzed by principal component and principal coordinate analyses as well as contour mapping of the coordinate scores. *Phytolacca dodecandra* was also compared to *P. dioica* (introduced), *P. goudotii, P. nutans,* and *P. octandra* (introduced). *Phytolacca goudotii* was found to be scarcely distinct from *P. dodecandra.* The status of *P. nutans* remains questionable since only the type specimen had extremely long male flower pedicels and no other specimens have been found from throughout Africa with such long pedicels. Examination of *P. dodecandra* from throughout its range in Africa revealed that a few pubescent-leaved plants were found from Ethiopia. These plants include a strain (Type 44) previously selected for agronomic research. *Phytolacca dodecandra* was found to be very variable in its morphology, both within a region and among regions. Major regional trends discovered were differentiation of: 1) the east and west Africa populations; 2) Madagascar plants from the mainland populations; 3) the Gabon plants from other West African plants; and 4) the Uganda, Burundi, Zimbabwe, and South African plants from other regions. No evidence was found to support the recognition of varieties *apiculata* Engl. and *brevipedicellata* H. Walt.

Introduction

The African soapberry plant, *Phytolacca dodecandra* (Phytolaccaceae), locally called endod, produces a series of triterpenoid saponins which possess very potent and useful biological properties including antifungal, anti-protozoan, spermicidal and insecticidal activities (Lemma, 1979). The fruit (berries) have been used in Africa for centuries as a soap for washing clothes. In 1964, Ethiopian field researchers (Lemma, 1970) discovered dead snails downstream from villages where people were washing clothes with soap from the endod berry. This finding was highly significant because snails serve as vectors for the trematode parasites which cause schistosomiasis. Schistosomiasis, which is referred to as bilharzia in Africa, is considered to be one of the most significant and rapidly spreading parasitic diseases worldwide. The disease, which causes tissue granulomas and eventually irreparable damage to the liver, affects an estimated 200 million people in Africa, the Middle East, Far East, Caribbean Islands, and many parts of South America (Lemma et al., 1979). Schistosomiasis is the second most prevalent parasitic disease in the world with only malaria being more common.

The disease is a constant threat to agricultural development in many developing nations. The irrigation canals serve as breeding habitats for the snails in which the blood flukes (*Schistosoma* spp.) responsible for transmitting the disease multiply and swarm to invade

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human skin (Kloos, 1979). Since the canals serve multiple uses, such as bathing, drinking, and washing, they are the direct sources of the infectious problem.

Results of a field study conducted for five years in the village of Adwa, Ethiopia, showed the incidence of schistosomiasis in one to five year old children dropped from 50% to 7% when crushed endod berries were used to treat the river water. During the same period, the incidence of the disease increased by 10% in children of the same age group in a nearby village where the water was not treated with endod berries (Lemma, 1979).

Research was undertaken to characterize the molluscicidal compounds of endod, and these were eventually identified as oleanolic acid saponin glycosides (Parkhurst et al., 1973a, 1973b, 1974). The compound which has been shown to have the greatest molluscicidal activity was named lemmatoxin after the Ethiopian scientist who made the initial field observations and was largely responsible for its discovery, Dr. Aklilu Lemma.

Over a five year period (1976–1981), 65 strains of endod were collected from different parts of Ethiopia and grown in a common garden (Lugt, 1981). Three strains (Types 3, 17, and 44) were fast growing and shrubby, had high yields of berries, high molluscicidal activities and good resistance to edaphic stresses (Lugt, 1979, 1981). Lugt (1980) also found the molluscicidal potency to be the greatest in unripe berries. The three types are characterized by: Type 3—leaf base ovate, wide leaves, somewhat viney habit, small amount of pubescence on leaves; Type 17—leaf base acute, lanceolate leaves, somewhat viney habit, no pubescence on leaves; and Type 44—leaf base cordate, wide leaves, shrubby habit, very pubescent leaves. All three types have about the same levels of molluscicidal toxicity (10 to 12.5 ppm), although early test results indicate that Type 44 is superior in berry yields in Ethiopia, as well as in recent trials in Swaziland (Makhubu et al., 1986). Agronomic trials, four years after establishment, yielded (kg/ha): Type 17—1047; Type 3—1850; and Type 44—2750 of dry berries with saponin yields of approximately 25% (Makhubu et al., 1986).

In spite of the considerable potential of *Phytolacca dodecandra* to be used on a "self help" basis in Africa, there has been a serious lack of knowledge concerning geographical variation in *P. dodecandra* and its relationship to other *Phytolacca* species. The last systematic treatment of *Phytolacca* in Africa was in 1909 (Walter, 1909).

Phytolacca dodecandra L'Hert. is a sprawling woody climber with stems to 5–8 meters in length, with erect, racemic, dioecious flowering stalks, and red berries. The species is widely distributed in tropical Africa and Madagascar, and has been reported from Asia and tropical America as an introduction (Thiselton-Dyer, 1913; Hutchinson and Dalziel, 1927; Humbert, 1954). The first comprehensive treatment of the Phytolaccaceae (Walter, 1909) recognized 26 species worldwide and divided *Phytolacca* into three subgenera, placing *P. dodecandra* in subgenus *Pircunia*. Within this subgenus, *P. dodecandra* was placed in section *Pircunioides* with two other species, *P. goudotii* Briquet from Madagascar, and *P. nutans* H. Walt. from Abyssinia (Ethiopia). Walter (1909) recognized two varieties of *P. dodecandra*: var. *apiculata* Engl. with smaller, apiculate(acuminate)-tipped leaves from "lower Guinea" and "Mozambique"; and var. *brevipedunculata* H. Walt. with short floral pedicels from east Africa and Madagascar. Nowicke (1969) suggested that *P. goudotii* and *P. nutans* are simply ecotypic forms of the highly variable *P. dodecandra*. Polhill (1971) recognized only *P. dodecandra* as native to east Africa. He also noted that *P. dioica* had been introduced from South America and grown as an ornamental tree in east Africa and that *P. octandra* was introduced into Kenya from tropical America.

The purposes of this study were to examine the morphology of specimens of *Phytolacca* from throughout sub-Sahara Africa (where *P. dodecandra* is native) to determine if variation within *P. dodecandra* could be partitioned into the aforementioned varieties and to examine the distinctness of *P. dodecandra* from *P. dioica, P. goudotii, P. nutans,* and *P. octandra* in Africa.

Materials and Methods

The specimens used for morphological measurements were grouped into regional areas (Table 1). In cases where only a couple of specimens were available from a country, these were combined with specimens from an adjacent country (Table 1) to give a larger sample size for that region. Twenty characters were scored for each specimen (Table 2), except for the characters associated only with either the male or female flowers (which had to be scored as missing for half the specimens). The morphological data were coded and initially analyzed by principal components analysis (PCA) with 110 individuals and 20 characters. PCA was modified to accommodate missing data values (Veldman, 1967). This set included data from the type specimens of *P. goudotii* from Madagascar and *P. nutans* from Ethiopia as well as specimens of *P. dioica* and *P. octandra.* Unfortunately, only male flowers for *P. goudotii* and *P. nutans* were present so characters 15 through 20 had to be scored as missing. This preliminary PCA run was made to determine if a few specimens tentatively identified as *P. goudotii* and *P. nutans,* were, in fact, forms of *P. dodecandra.* This preliminary analysis revealed that a specimen putatively identified as *P. octandra* was *P. octandra.* But, by far the most significant finding was that three plants from Ethiopia had very pubescent leaf blades and petioles, in sharp contrast to all other *Phytolacca* specimens examined. These three specimens were therefore placed in a separate group (population E2) for subsequent analyses. Analysis of variance (ANOVA) with missing data values was first performed using 19 OTUs (15 putative *P. dodecandra* populations plus *P. dioica, P. goudotii, P. nutans,* and *P. octandra*). One character with an F ratio less than 1.0 was eliminated from use in computing similarity measures (see Table 2). The similarity measure used was the Manhattan metric, scaled by the range (=Gower metric, Gower, 1971) and weighted by F-1 (from ANOVA) as formulated by Adams (1975, 1982). Principal coordinate analysis followed the formulation of Gower (1966). One should note that because the plants are dioecious, missing data values were unavoidable. Canonical variate analysis, perhaps more robust and statistically useful, could not be used.

For analyses of geographic variation within *P. dodecandra,* the Madagascar population (MA) was included along with 13 populations from the mainland (see Table 1). Similarities and principal coordinate analysis (PCOOR) were computed as above. In addition, the operational taxonomic units (OTUs) coordinate scores from PCOOR were contoured onto a base map of Africa to examine geographic trends (Adams, 1970, 1986).

For the scanning electron microscopy, an air dried leaf was rehydrated in distilled water and fixed overnight in 6% glutaraldehyde, dehydrated in a graded series of ethanol solutions and transferred to amyl acetate for critical point drying with CO_2. The dried tissue specimens were appropriately mounted on aluminum stubs for use in the scanning electron microscope. The surface of the tissue was coated by evaporation with Pd (40%)–Au (60%) alloy to insure conductivity in the microscope. A Cambridge Stereoscan electron microscope operated at 10 kV was used to examine the tissue.

Herbarium vouchers for the Adams collections (see Table 1) are deposited at BAYLU.

Results and Discussion

Principal component analysis (PCA) of the 20 morphological characters revealed that leaf blade and leaf petiole pubescence were very highly correlated ($r = 0.96$). For this reason, leaf petiole pubescence was eliminated from subsequent analyses. Interestingly, inflorescence pubescence was not strongly correlated with leaf blade and petiole pubescence ($r = 0.42, 0.45$, respectively). The characters measured from the leaves (1–11) do not show (Fig. 1) patterns of inter-correlation (except as previously mentioned for 8 and 9). Nor did we find (Fig. 1) strong inter-correlations between either the characters taken from the male flowers (11–14) or the female flowers (15–20).

The F ratios from the ANOVA of 19 OTUs resulted in two very large values for leaf

Table 1. Specimens used for OTUs for taxa and regional analyses. Listed by two letter acronym, number of specimens, country(s), and collector name and number.

P. dioica: DI (4) Kenya: *J. B. Cullete 13681*; *G. R. Williams 329*; *M. J. Bally 1827*; *Holiander 1143.*
P. goudotii: GD (1) Madagascar: *Goudot s.n.*, TYPE.
P. nutans: NU (1) Ethiopia: *I. Steudner 557*, TYPE.
P. octandra: OC (4) Kenya: *J. O. Kokwaro 312*; *A. Bogdan 1813*; *Y. E. Symes 353*; Zimbabwe: *A. Peter 30829.*
P. dodecandra: 15 OTUs:
BU (9) Burundi and Malawi: Burundi—*Reekmans 1902, 2343, 4872, 6359, 7834*; Malawi—*Mrs. J. Pawek 5555*, female and male; *Jean Pawek 10058 & 12876.*
CA (5) Cameroon: *F. N. Hepper 2898*; *G. Zenker 4774*; *W. J. J. O. De Wilde & B. E. E. De Wilde-Duyfjes 1640*; *D. Thomas 3282*; *G. J. H. Amshoff 1640.*
E1 (13) Ethiopia (sub-population without pubescence): *J. J. F. E. De Wilde 4363*, male and female; *M. G. Gilbert & J. J. Lavranos 2249*; *E. Westphal & J. H. C. Westphal-Stevens 2667*; *Schimper s.n.* (19 Aug 1840); *J. W. Ash 670*; *W. J. J. O. De Wilde & B. E. E. De Wilde-Duyfjes 6125 & 9594*; *J. W. Ash 246*; *R. P. Adams 5290* (Type 3), *5291, 5296 & 5297* (Type 17).
E2 (3) Ethiopia (sub-population with pubescence): *J. B. Gillett 14724*; *R. P. Adams 5289* (Type 44) *& 5321.*
GA (4) Gabon: *A. Gentry 33777*; *G. Le Testu 8205*; *A. Smith 205, C. Jeffrey 285.*
GH (3) Ghana: *R. P. Adams 5559, 5560 & 5366.*
KE (7) Kenya: *F. C. Magogo 1547*; *Van Someren 1760*; *G. Davidse 7061 & 7089*; *Carentl C5*, female and male; *R. P. Adams 5329.*
LI (6) Liberia, Sierra Leon, and Guinea: Sierra Leon—*G. F. S. Elliot 4827*; *Gledhill SL3146*; *J. K. Morton 359*; *Jacques-Georges 22261*; Guinea—*J. G. Adam 3462 & 3696.*
MA (4) Madagascar: *G. W. Parker 111*, female and male; *Hils & Bojer s.n.*; *L. C. Dorr et al. 3679.*
NI (6) Nigeria: *M. G. Latilo 53989*; *Mr. & Mrs. P. A. Talbot 1381*; *H. C. D. DeWit 690*; *B. O. Daramola 40482*; *R. P. Adams 5394.*
SA (6) South Africa: *J. M. Wood 3-420*; *J. L. Sidey 2394*; *R. G. Strey 8830*; *D. Edwards 3171*; *M. G. Wells 1353*; *J. Stephen 457.*
TZ (7) Tanzania: *R. Tanner 4269*; *L. Silungwe s.n.*; *R. M. Harley & J. Neubauld 4484* (2 sheets); *A. A. Bullock 1431*; *W. Goetz 228*; *R. M. Harley 9457.*
UG (8) Uganda and Rwanda: Uganda—*C. T. Wilson 101*, female and male; *Y. E. Symes 311*; *T. D. Maitland 6*; Rwanda—*G. Troupin 5136, 7993 & 11645*; *P. Auguier 2563.*
ZA (5) Zaire: *J. Leonard 622*; *D. H. Linder 2032*; *Sherqiuere 3827*; *U. Kinet 283*; *Elskeus s.n.*
ZI (8) Zimbabwe and Zambia: *N. C. Chase 8046*; *Mathuen 206*; *G. Dehn 96168*; *H. M. Richards 6222*, female and male, *& 18220*; *D. B. Fanshaw 2341*; *M. Sanane 1374.*

blade and leaf petiole pubescence (Table 2, 57.1 and 579.4, respectively). This appears to have resulted from the meristic nature of these characters, because most individuals were scored as none (1.0) and thus no intra-populational variance was computed. In order to overcome this problem, the weighting factor for leaf blade pubescence was set to the highest F ratio not associated with pubescence (13.7 for the ratio of leaf blade length/width, Table 1). The weight of leaf petiole pubescence was set to 0.0 to eliminate it from use in the calculation of similarities.

PCOORs of the 15 OTUs of *P. dodecandra* plus *P. dioica, P. goudotii, P. nutans,* and *P. octandra* are shown in Figs. 2 and 3. The first five principal coordinates removed 24, 15, 12, 10, and 10% (total = 71%), respectively, of the variation among the OTUs. The first coordinate separated *P. octandra, P. nutans, P. goudotii,* and the Madagascar population from the rest of *P. dodecandra* (Fig. 2). Coordinate 2 further separated *P. octandra,* but particularly shows a marked separation of the E2 (pubescent leafed plants of *P. dodecandra* from Ethiopia) from other populations of *P. dodecandra.* Note also the separation of *P. dioica* on the second axis (Fig. 2). The third coordinate further separates *P. dioica, P. octandra,* and the E2 population from the other OTUs (Fig. 2). The *P. goudotii* type

Table 2. Morphological characters scored and F ratios from ANOVA for 19 OTUs (15 *P. dodecandra* populations plus *P. dioica, P. goudotii, P. nutans,* and *P. octandra*) and 15 OTUs (15 *P. dodecandra* populations) used in the analyses.

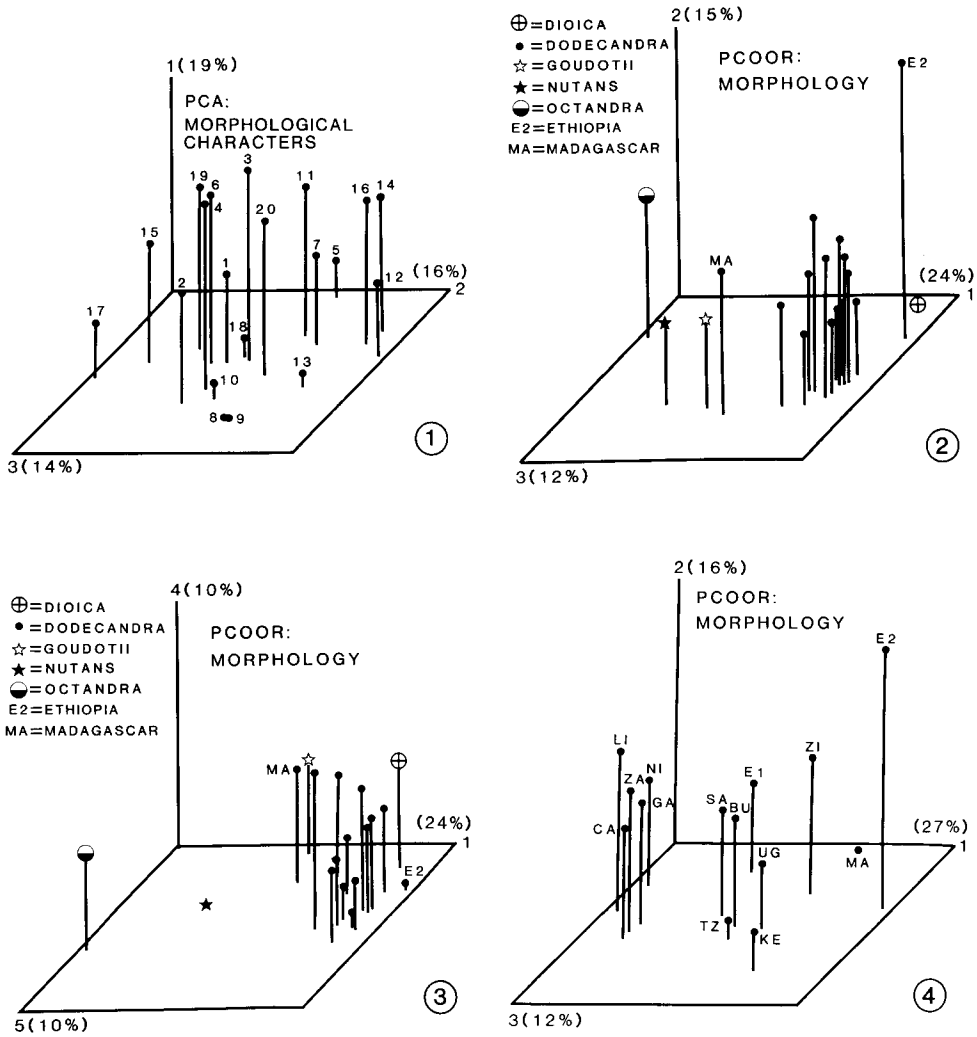
Character: coding/measuring method	F ratio	
	19 OTUs	15 OTUs
1. Leaf tip shape: obtuse = 1.0; acute = 2.0; partly acuminate = 3.0; fully acuminate = 4.0	2.0	1.9
2. Leaf base shape: acute = 1.0; ovate = 2.0; cordate = 3.0	4.0	2.0
3. Leaf blade length: avg. of 5 meas. (in mm)	3.0	3.6
4. Leaf blade width: avg. of 5 meas. (in mm)	2.6	2.3
5. Ratio leaf blade length/width	13.7	5.6
6. Leaf petiole length: avg. of 5 meas. (in mm)	6.2	2.1
7. Leaf length/petiole length	9.0	2.3
8. Leaf blade pubescence: none = 1.0; some = 2.0; dense = 3.0	57.1[1]	72.2[2]
9. Leaf petiole pubescence: (see 8)	579.4[3]	733.6[3]
10. Inflorescence pubescence: (see 8)	5.2	5.5
Characters from male flowers:		
11. Length of pedicel: avg. of 5 meas. (in mm)	7.4	6.0
12. Number of stamens: avg. of 5 counts	9.8	3.9
13. Length of stamen vs. tepals: stamen longer than tepals = 1.0; both equal = 2.0; stamen shorter than tepals = 3.0	2.3	1.9
14. Flower diameter: (see 11)	3.3	2.3
Characters from female flowers:		
15. Inflorescence length: (see 11)	2.6	2.2
16. Length of mature fruiting pedicel: (see 11)	4.7	2.2
17. Inflorescence length/fruiting pedicel length	5.6	3.7
18. Number of mature fruiting pedicels per the most mature 5 cm section	2.0	1.6
19. Diameter of mature fruit: (see 11)	0.4[4]	0.4[4]
20. Number of carpels per fruit: (see 12)	8.4	1.5

[1] F of 13.7 used as character weight, see text.
[2] F of 5.3 used as character weight, see text.
[3] Character not used due to correlation with character 8, see text.
[4] Character not used due to F ratio less than 1.0, see text.

specimen from Madagascar is not very different from the putative *P. dodecandra* collection from Madagascar (MA, Fig. 2).

Coordinate 4 (Fig. 3) serves to separate *P. nutans* more distinctly. Coordinate 5 moves *P. octandra* a little further from most of the OTUs (Fig. 3). The Madagascar (MA) population is still ordinated closely to *P. goudotii* (Fig. 3). Based on these limited analyses, the distinctness of putative *P. dodecandra* plants collected in Madagascar from the type specimen of *P. goudotii* has not been resolved. The status of *P. nutans* is uncertain. The male flower pedicels averaged 8.8 mm long on the type specimen which was significantly larger than any other OTU (the next largest pedicel length was that of the Nigerian plants with an average of 5.7 mm). No other morphological characters measured significantly differentiated *P. nutans* from any other OTUs. No other specimens examined had such extremely long pedicels, so perhaps the type specimen of *P. nutans* merely represents a mutant or sport.

Analysis of variance for the 15 OTUs of *P. dodecandra* resulted in very large F ratios for leaf blade and leaf petiole pubescence (72.2 and 733.6, Table 2). These were reduced to 0.0 and 6.0 (6.0 is the largest F produced from a continuous character, pedicel length)



Figs. 1–4. 1. Principal component analysis (PCA) of 20 morphological characters scored from *P. dodecandra*. Character numbers are as per Table 2. Note the high correlation between 8 and 9 (leaf blade and petiole pubescence). See text for discussion. 2. Axes 1, 2 and 3 from principal coordinate analyses (PCOOR) using F-1 weighted similarities (see methods). All of the solid circles are *P. dodecandra* plants from throughout Africa. E2 is the pubescent leafed *P. dodecandra* plants from Ethiopia and MA is the putative *P. dodecandra* plants from Madagascar. 3. Axes 1, 4 and 5 from PCOOR defined as in Fig. 2. Coordinate 4 separates *P. nutans* from *P. goudotii* and coordinate 5 further separates *P. goudotii, nutans* and *octandra*. 4. Principal coordinate analyses of the morphology of *P. dodecandra* from throughout Africa. Population acronyms are as defined in Table 1. Notice the separation of the pubescent plants from Ethiopia (E2) and the clustering of the plants from western Africa (Cameroon [CA], Gabon [GA], Liberia [LI], Nigeria [NI], Zaire [ZA]).

so these characters would not dominate the similarity measures. Because these two pubescence characters were very highly correlated, they are probably controlled by the same gene(s).

The first five eigenroots of PCOOR of the resulting similarities among the 15 OTUs removed 27.3, 16.4, 12.3, 8.1, and 7.4% (total = 71.5%) of the variation among the OTUs.

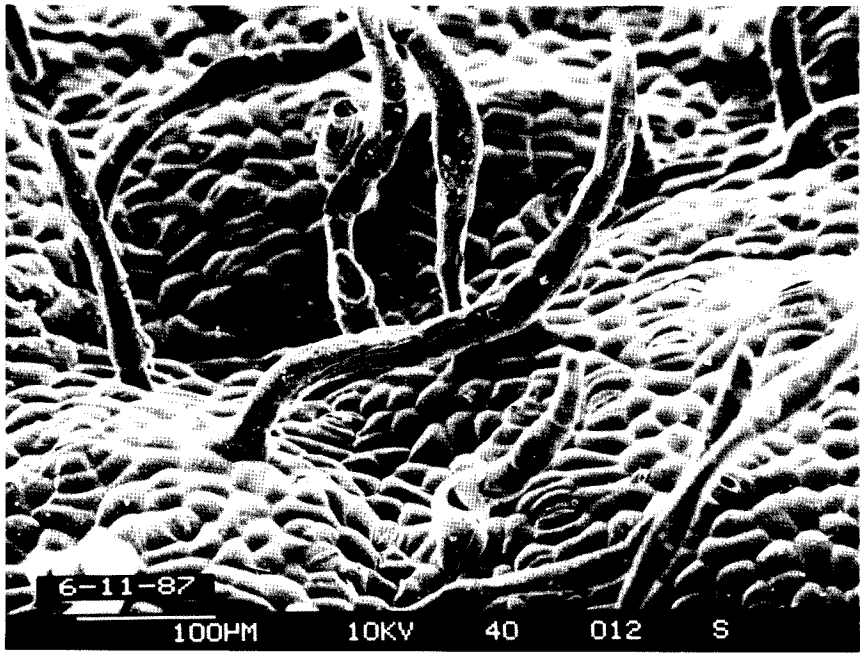


Fig. 5. Scanning electron micrograph of the morphology of the pubescence of Type 44 plants from Ethiopia. See text for discussion.

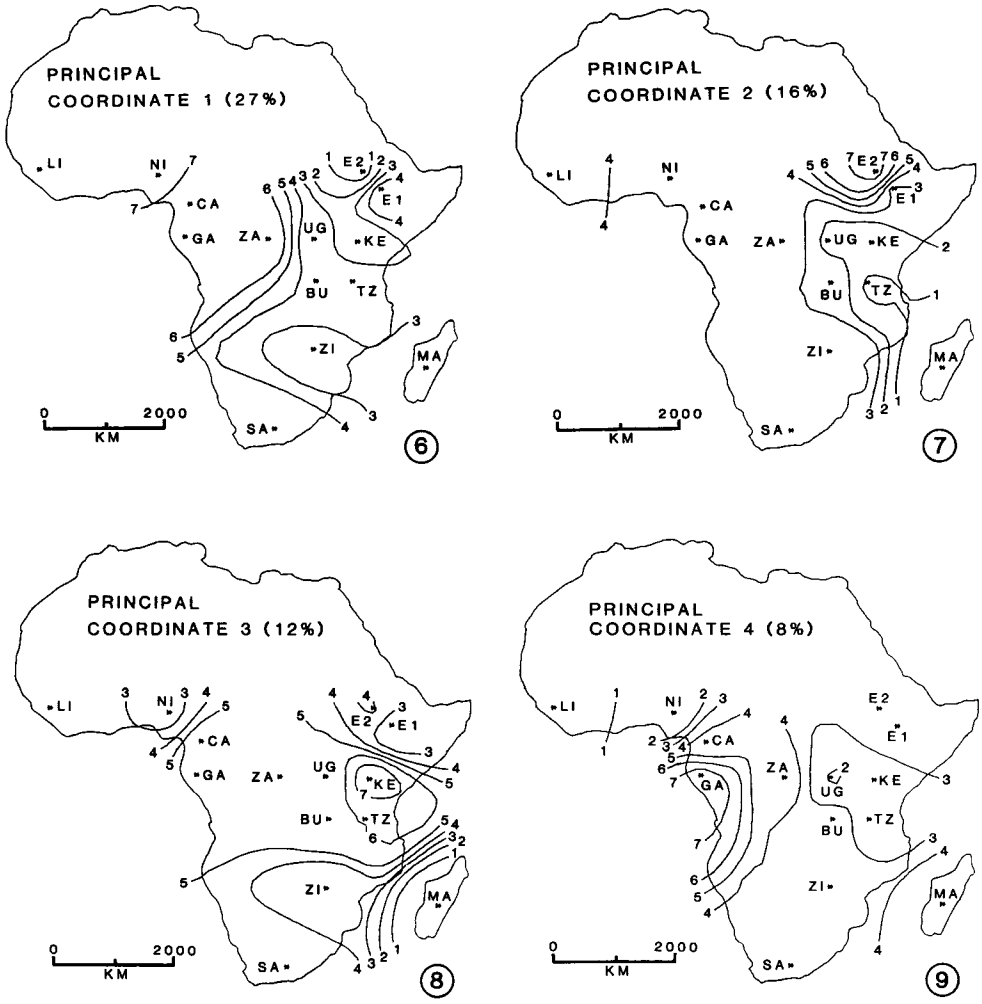
The first coordinate separated the pubescent plants from Ethiopia (E2, Fig. 4), the Madagascar (MA) population and all the populations from west Africa (Fig. 4). The second coordinate further separated the pubescent plants from Ethiopia (E2), the Madagascar population (MA) as well as Kenya (KE), Tanzania (TZ), and Uganda (UG) to a lesser extent. The third coordinate chiefly separated the Madagascar (MA) population. A preliminary PCOOR analysis using the original character weights for leaf pubescence resulted in the separation of the pubescent Ethiopian plants (E2) as the only trend. That trend accounted for 91.2% of the variation among OTUs and no other trends could be determined.

The pubescent plants from Ethiopia consisted of a Type 44 specimen (*Adams 5289*) cultivated at the Pathobiology Institute in Addis Ababa, a specimen collected on Entoto Mtn. just north of Addis Ababa (*Adams 5312*), and a specimen collected by Gillet (*14724*) in 1955. The pubescent leaf type (Fig. 5) is rare among the specimens examined, and it appears to be confined to Ethiopia.

In order to visualize the geographic trends among the endod populations, the OTU score on each coordinate was contour mapped (Adams, 1986) onto a base map of Africa. The first coordinate (27%) shows separation of endod from eastern and western Africa (Fig. 6) and some differentiation between the pubescent (E2) and glabrous plants from Ethiopia (E1).

The second coordinate (16%) depicts the differences between the pubescent plants of Ethiopia (E2) and other endod populations (Fig. 7). Differentiation of the Madagascar (MA), Tanzania (TZ), Kenya (KE), and Uganda (UG) endod plants is also revealed (Fig. 7). In view of the differentiation of the Madagascar plants (see Fig. 2) from mainland endod plants, this may represent either introgression, an ancestral migration pathway or the introduction of germplasm from Madagascar by people who utilize endod for medicine and/or soap.

The divergence of the Madagascar plants and some local differentiation of the Kenya



Figs. 6–9. 6. Contoured principal coordinate 1 (27% of the variation among OTUs) based on morphology. Note the differences between the glabrous (E1) and pubescent (E2) plants from Ethiopia and the differentiation of the western populations (CA, GA, LI, NI, ZA). 7. Contoured principal coordinate 2 (16% of the variation among OTUs) based on morphology. This coordinate emphasizes the glabrous (E1) and pubescent (E2) types from Ethiopia and the differentiation of the southeastern populations (BU, KE, MA, TZ, UG). 8. Contoured principal coordinate 3 (12% of the variation among OTUs) based on morphology. The major trend is to separate the Madagascar plants from the mainland with minor differentiation of the Nigerian and Kenyan plants. 9. Contoured principal coordinate 4 (8% of the variation among OTUs) based on morphology. Two trends are shown: Differentiation of the Gabon (GA) plants and the plants from Liberia (LI) and Nigeria (NI).

(KE) and Nigeria (NI) plants is depicted by the third coordinate (12%, Fig. 8). Additional minor regional differentiation of the Gabon (GA) region's plants is displayed by coordinate 4 (8%, Fig. 9).

Each of the coordinates are independent and may be derived from a single character as in the case of pubescence (coordinate 2 particularly, Fig. 7). However, they usually represent a combination of characters.

In addition to the differences found on a regional basis, there is also a tremendous amount of variability among plants within populations of endod. There is certainly no lack of diversity to work with in making agronomic selections. However, the scarcity of plants now growing naturally is a matter of grave concern. Almost all of this analysis was based on herbarium specimens collected over the past 100 years. It appears unlikely that we will be able to obtain specimens from many of the countries needed to examine the leaf waxes for the chemotaxonomic study currently under investigation (Adams et al., in prep.). The collection of native endod seeds to establish a test plantation in Swaziland has been only partially successful to date, in part due to the lack of native (wild type) plants in many parts of Africa.

In summary, these analyses support Nowicke (1969) in that *P. goudotii* is hardly distinct from various forms of *P. dodecandra.* Additional research in Madagascar is necessary to resolve this question. The type specimen of *P. nutans* was found to be distinct and unique in regards to having long (8.8 mm) pedicels on the male flowers. However, since no other specimens examined had these long pedicels, we are inclined to conclude that the type specimen was merely a mutant (or sport) of *P. dodecandra.* It might more properly be recognized as a *forma* of *P. dodecandra.*

Phytolacca dodecandra was found to be extremely variable in its morphology both within a region and among regions. No evidence was found supporting the recognition of the varieties *apiculata* Engl. and *brevipedicellata* H. Walt.

Phytolacca dodecandra L'Hert., Stirp. nov. 143, t. 69. 1791, non *P. dodecandra* Sesse and Moc. Type: Plant cultivated in Paris from seeds collected by Bruce in Ethiopia (P, holo).

Phytolacca abyssinica Hoffm., Comm. Goett. XII, 25, t. 2. 1796.

Phytolacca dodecandra var. *apiculata* Engl., Pflanzenwelt Ostafrikas C. 175. 1895.

Phytolacca dodecandra L'Hert. var. *brevipedicellata* H. Walt., Pflanzenreich IV. 83(39), 44. 1909.

Of the several regional trends, the discovery of the uniqueness of the pubescent plants in Ethiopia is the most notable. Consideration should be given to designating them as a *forma* when the group is monographed. Regional differences in morphology between east and west Africa were significant, and germplasm collections from these regions should be encouraged for future agronomic test plot evaluations.

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