Phenetic Analysis of Eighteen Species of Philippine *Medinilla* Gaudich. (Melastomataceae) Based on Morphological Characteristics and Phenolic Profile*

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Paper Chromatography
Phenetics
Phenolic Compounds
Cluster Analysis

ABSTRACT

The genus *Medinilla* Gaudich., having about eighty Philippine species, is widely distributed in the archipelago. This study used morphological and chemical data to explain taxonomic relationship among eighteen species belonging to the genus. For chemical data, two-dimensional paper chromatography was employed to survey different phenolic compounds present in each species considered in this study. A total of seventy-seven different phenolic compounds were found to be present among the eighteen species of *Medinilla*. A phenogram was constructed by PAST version 1.42 (with Ward's method as algorithm) using only morphological characters, another using chemical characters obtained by paper chromatography, and another using both morphological and chemical characters. In the first phenogram, two distinct clusters were formed while in the second phenogram, three distinct clusters were formed with *M. clementis* and *M. dolichophylla* separating from the rest of the species studied. In third phenogram, three major clusters were observed. In all three phenograms generated, *M. ternifolia* and *M. venosa* consistently clustered closely together. The same case was observed with *M. ramiflora* and *M. myrtiformis*. The phenograms reflect taxonomic affinities among the species used in this study. For further studies, inclusion of more species and molecular sequencing of samples are recommended.

INTRODUCTION

Medinilla Gaudich. has about 400 species worldwide and is well represented in the Philippines in terms of species number (Regalado, 1995). However, the genus is poorly represented in the Malay Peninsula, where only fourteen species are found (Maxwell, 1978); ten species in Java (Backer and Bakhuizen van der Brink, 1963); twenty-eight species in Sumatra (Bakhuizen van der Brink, 1943); seventy species in Madagascar (Perrier de la Bathie, 1951); forty-eight species in Borneo (Regalado, 1990); and seventy species in New Guinea as listed in Index Kewensis (all as cited in Regalado, 1995). Many species have ornamental value, so they are being propagated in gardens and farms. Prior to this study, the systematics as well as the phytochemistry of the members of the genus is relatively unexplored. The genus description of *Medinilla* Gaudich. is as follows (taken from Regalado, 1995):

> *"Epiphytic or terrestrial shrubs, rarely small trees or vines; erect or scandent. Branches generally terete, smooth or pustulate. Leaves alternate, opposite, or whorled; sessile or petiolate; blades fleshy or coriaceous, generally elliptic, glabrous, entire; leaf axils glabrous or tufted with bristles. Inflorescences consisting of paniculately, racemosely or umbellately disposed cymes, terminal or axillary or arising from defoliated nodes. Flowers 4-, 5-, or 6-merous hypanthia campanulate or ovoid, glabrous or pubescent, the rim truncate or very shortly dentate; petals thin, white or pink; stamens twice as many as petals, equal or unequal in size; filaments glabrous, flattened; anthers linear-lanceolate or linear-oblong, the connective weakly produced,*

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dorsally spurred, with a pair of short appendages ventrally; extra-ovarian chambers generally extending to the middle of the ovary; styles terete, glabrous; stigmas minute, punctiform or minutely capitates. Fruits baccate, globose to subglobose; pericarp thick or thin; seeds numerous, minute, ovoid, the testa smooth or finely reticulate."

From the list of Merrill (1923), there are 123 species of *Medinilla* in the Philippines, but Regalado (1995) reduced the number to eighty and regarded three genera as congeneric with the genus. These genera are *Cephalomedinilla*, *Carionia*, and *Hypenanthe*. The monotypic genus *Cephalomedinilla* Merr. consisting of only *C. anisophylla* Merr., was renamed as *Medinilla microcephala* Regalado. *Carionia elegans* Naud. was renamed as *Medinilla coronata* Regalado while *C. triplinervia* Rolfe was regarded as conspecific with *M. whitfordii* Merr. *Hypenanthe venosum* (Blume) Blume was treated as conspecific with *M. venosa* (Blume) Blume. *Hypenanthe setigera* (Blume) Bakh. f. was treated as conspecific with *M. setigera* (Blume) Miq. The fusion of the three separate genera with *Medinilla* is based on the similarity of stamen characters. Those three genera are closely allied and are connected to *Medinilla* by transitional forms.

As a whole, endemism in the Philippine archipelago is high (Ashton, 1993). Overall, the Philippine flora is considerably undifferentiated throughout the islands in spite of the climatic diversity of these islands. The Philippine archipelago is connected by island arcs to main centers of biodiversity—Taiwan, mainland China, Borneo, Sulawesi, Moluccas, and New Guinea. This explains why some species of Philippine *Medinilla* extend to those islands. The total number of species as well as percent endemism among the genus appears to be greater in the Philippines than Borneo.

This preliminary study aimed to explain taxonomic relationship among eighteen species of Philippine *Medinilla* by constructing phenograms based on morphological and chemical data. Taxonomic recommendations were made based on the generated phenograms.

Materials and Methods

Collection of Specimens: A total of thirty-eight samples representing eighteen species were collected for this study. The data on the collection of the samples is shown in Table 1. The number of Philippine *Medinilla* species used in this study was about 24 percent of the total number of Philippine species recognized by Regalado (1995).

Phenolic Profiling: For each collection, a total of 10 g of leaf dry weight was used for phenolic profiling. For species represented by more than one collection, the leaf samples were analyzed separately. Extraction and analysis of phenolic compounds were done using standard methods (Harborne, 1998; Swain, 1976).

Phenetic Analysis: The eighteen species of *Medinilla* were considered for construction of three different phenograms. The first phenogram was constructed using morphological data only while the second phenogram was constructed using the data obtained from phenolic profiling. The third phenogram was constructed using both morphological and chemical data.

Ward's method was employed in PAleontological STatistics (PAST) version 1.42 (Hammer et al., 2001) for generating the phenograms. For morphological character coding, twenty-seven characters that are variable among the eighteen species were used. These characters are shown in Table 2 along with the corresponding character states and character code. Those characters were either observed in the collected samples or taken from Regalado (1995) for those that are not seen in the collections. For chemical character coding, all of the spots observed in the paper chromatograms across the species analyzed were used as binary characters with absent (0) and present (1) as character states. The character matrix used in constructing the first phenogram is shown in Appendix 1.

Results and Discussion

Phenolic Profiling: Phytochemical analysis revealed that cinnamic esters and hydroxycinnamic acids are widely occuring among the samples studied. UV spectra hinted that different classes of flavonoids were also observed across the samples: flavones (Compounds 3, 11, 42, and 48), flavonols (Compounds 1, 10, 17, 30, 49, 63, and 77), and an aurone (Compound 33). A total of seventy-seven different spots, each designated with a number, (shown in a composite representation in Figure 1) were observed among the eighteen species used in this study, and these compounds were used in phenogram construction as chemical characters. Those seventy-seven spots were each assumed to correspond to a specific compound even though the exact identities were not confirmed. The compounds used for tree construction are all different from one another on the basis of differences in at least relative Rf values and color behavior. The identities of the spots that showed clear λ_{max} values were deduced to compound class. The properties of these spots along with their deduced identities are summarized in Table 3.

For the second phenogram, all of the spots seen in the paper chromatograms (Table 3) across the eighteen species studied were used as binary characters with absent (0) and present (1) as character states. The character matrix used for this phenogram is shown in Appendix 2. For the third phenogram which is based on a combination

Table 1. Thirty-eight Philippine *Medinilla* Gaudich. specimens considered in this phenetic study (all collected by the main author).

Species	Collection No.	Accession No.	Locality
M. magnifica Lindl.	00006	CAHUP 73043	Mt. Makiling
	00007	CAHUP 73044	Mt. Makiling
	00008	CAHUP 73045	Mt. Makiling
	00030	CAHUP 73032	UP Land Grant*
	00031	CAHUP 73031	UP Land Grant*
	00038	CAHUP 73033	Davao City*
M. multiflora Merr.	00000	CAHUP 73048	Mt. Makiling
	00001	CAHUP 73046	Mt. Makiling
	00002	CAHUP 73047	Mt. Makiling
M. venosa (Blume) Blume	00027	CAHUP 73049	Mt. Banahao
	00028	CAHUP 73050	Mt. Banahao
	00040	CAHUP 73041	Davao City*
M. pachygona C.B. Rob	00021	CAHUP 73055	Mt. Banahao
	00022	CAHUP 73056	Mt. Banahao
M. ternifolia Triana	00023	CAHUP 72349	Mt. Banahao
	00024	CAHUP 72352	Mt. Banahao
M. ramiflora Merr.	00025	CAHUP 72346	Mt. Banahao
	00026	CAHUP 72348	Mt. Banahao
M. tayabensis Merr.	00017	CAHUP 73051	Mt. Banahao
	00018	CAHUP 73052	Mt. Banahao
	00019	CAHUP 73053	Mt. Banahao
	00020	CAHUP 73054	Mt. Banahao
M. pendula Merr.	00029	CAHUP 73060	Mt. Makiling
	00050	CAHUP 73034	Baguio City*
M. teysmannii Miq.	00033	CAHUP 73029	UP Land Grant*
	00046	CAHUP 73030	San Carlos*
M. mindorensis Merr.	00032	CAHUP 73061	UP Land Grant*
M. cumingii Naud.	00035	CAHUP 73035	Bukidnon*
	00042	CAHUP 73036	Mt. Banahao
	00047	CAHUP 73057	San Carlos*
M. cephalophora Merr.	00036	CAHUP 73038	Bukidnon*
	00044	CAHUP 73039	Quezon City*
M. banahaensis Elmer	00037	CAHUP 73027	Davao City*
M. apoensis C.B. Rob	00039	CAHUP 73037	Davao City*
M. astronioides Triana	00045	CAHUP 73040	Quezon City*
M. myrtiformis (Naud.) Triana	00043	CAHUP 73028	Mt. Banahao
M. clementis Merr.	00048	CAHUP 73058	Baguio City*
M. dolichophylla Merr.	00049	CAHUP 73059	Baguio City*

*Cultivated samples collected from the locality of morphological and chemical characters, the character matrix used is shown in Appendix 3.

Constructed Phenograms: The phenogram including eighteen species of Philippine *Medinilla* that was constructed using morphological characters is shown in Figure 2. Two major clusters of species were observed. The first major cluster is composed of *M. venosa*, *M. ternifolia*, *M. magnifica*, *M. banahaensis*, *M. multiflora*, *M. teysmannii*, *M. apoensis*, *M. clementis*, *M. tayabensis*, and *M. astronioides* while the second cluster includes

Table 2. Morphological characters used in character coding for phenogram construction.

1. branch texture glabrous (0) hairy (1) 2. branchlet texture glabrous (0) hairy (1) 3. branch shape terete (0) winged (1) subquadrangular (2) 4. petiole presence sessile (0) petiolate (1) 5. petiole length not applicable (0) short, less than 5 mm long (1) long, more than 5 mm long (2) 6. petiole texture not applicable (0) glabrous (1) hairy (2) 7. leaf shape elliptic-oblong to lanceolate (0) linear-lanceolate (1) 8. leaf apex shape acute to acuminate (0) rounded (1) 9. leaf base shape attenuate (0) rounded (1) obtuse (2) acute (3) 10. leaf length short, less than 5 cm long (0) medium, 5-20 cm long (1) long, more than 20 cm long (2) 11. leaf width narrow, less than 3 cm wide (0) medium, 3-10 cm wide (1) wide, over 10 cm wide (2)	12. leaf texture (adaxial) coriaceous (0) chartaceous (1) hairy (2) 13. leaf texture (abaxial) coriaceous (0) hairy (1) 14. leaf powder covering not pulverulent (0) pulverulent (1) 15. phyllotaxy decussate (0) whorled in 3's (1) whorled in 4's or 5's (2) mixed decussate and whorled (3) opposite (4) 16. number of plinerves three to five (0) five to seven (1) seven to nine (2) 17. seta in leaf nodes not setose (0) setose (1) 18. inflorescence type thyrse (0) cyme (1) raceme, compact (2) panicle (3) solitary or in fascicles (4) umbel (5) 19. inflorescence size small, less than 10 cm long (0) medium, 10-25 cm long (1) large, more than 25 cm long (2) 20. bracts absent (0) present (1) 21. bract size not applicable (0) small, less than 3 cm long (1) large, more than 3 cm long (2)	22. hypanthium shape campanulate (0) cup-shaped (1) ovoid (2) cylindrical (3) 23. hypanthium texture glabrous (0) hairy (1) 24. stamen size equal (0) unequal (1) 25. stamen form isomorphic (0) dimorphic (1) 26. fruit texture glabrous (0) hairy (1) 27. fruit shape globose (0) subglobose (1) campanulate (2) urceolate (3)

Table 3. Chemical character designation of the spots seen in the paper chromatograms of the eighteen species analyzed and the overall consolidation of their properties.

Character Number	Compound identity[1]	Rf value X 100		Color in visible light		Color in UV (366 nm)		λ_{max} (nm) in ethanol
		BAW	HOAc	Before fuming with ammonia	After fuming with ammonia	Before fuming with ammonia	After fuming with ammonia	
1	a flavonol	30-36	5-7	colorless	colorless	pale purple	light yellow	360-364, 255-257
2	a flavonoid	11-14	29-32	colorless	colorless	pale yellow green	pale yellow green	—
3	a flavone	61-65	47-54	colorless	yellow	dark purple	yellow brown	349-351, 255-258
4	a flavonoid	30-37	41-47	colorless	light yellow	light orange	light yellow	—
5	a charged cinnamic ester	27-33	46-54	colorless	colorless	blue	blue	—
6	a cinnamic ester	57-64	69-73	colorless	colorless	light blue	light blue	—
7	a charged cinnamic ester	29-33	71-75	colorless	colorless	light blue	purple blue	—
8	a flavonoid	23	19	colorless	colorless	purple	blue	—
9	a hydroxycinnamic acid	88-90	39	colorless	colorless	purple blue	bright blue	—
10	a flavonol	46	33	colorless	yellow	dark purple	yellow orange	259, 364
11	a flavone	53-54	61-63	colorless	yellow	dark purple	yellow brown	350, 259
12	a cinnamic ester	85	80	colorless	yellow	blue	bright blue	323
13	a cinnamic ester	46	74	colorless	colorless	blue	blue	—
14	a charged cinnamic ester	27	73	colorless	colorless	blue	pale yellow green	—
15	a cinnamic ester	51	84	colorless	colorless	blue	pale yellow green	—
16	a charged cinnamic ester	8	92	colorless	colorless	blue	blue	—
17	a flavonol	67-70	13-14	colorless	colorless	purple	dull purple	364-365, 248
18	a flavonoid	69	35	colorless	colorless	dull purple	dull purple	—
19	a cinnamic ester	69-71	51-52	colorless	colorless	blue	blue	—
20	a cinnamic ester	63-69	75-81	colorless	yellow	blue	blue	279-283
21	a cinnamic ester	54-56	75-79	colorless	yellow	blue	bright blue	331-332

Character Number	Compound identity[1]	Rf value X 100		Color in visible light		Color in UV (366 nm)		λ_{max} (nm) in ethanol
		BAW	HOAc	Before fuming with ammonia	After fuming with ammonia	Before fuming with ammonia	After fuming with ammonia	
22	a charged cinnamic ester	7-8	83-85	colorless	colorless	pale yellow green	pale yellow green	—
23	a flavonoid	68	30	colorless	colorless	light purple	light purple	—
24	a flavonoid	23	33	colorless	colorless	brown	brown	—
25	a cinnamic ester	76-83	63-68	colorless	colorless	blue	bright blue	—
26	a cinnamic ester	50	84	colorless	colorless	blue	blue	—
27	a charged cinnamic ester	30-31	93	colorless	colorless	blue	blue	—
28	a charged cinnamic ester	16	90	colorless	colorless	pale yellow green	pale yellow green	—
29	a flavonoid	72	42	colorless	colorless	light purple	yellow green	—
30	a flavonol	80	60	colorless	colorless	pale purple	dull purple	364, 247
31	a charged cinnamic ester	24	89	colorless	colorless	light purple	blue	—
32	a flavonoid	69	16	colorless	colorless	light blue	blue	—
33	an aurone	30	31	yellow	red	ochre	dark purple	—
34	a charged cinnamic ester	31	58	colorless	colorless	light orange	light purple	—
35	a charged cinnamic ester	31-32	87-88	colorless	colorless	blue	blue	—
36	a flavonoid	21	57	colorless	colorless	light yellow	light yellow	—
37	a charged cinnamic ester	8	68	colorless	colorless	yellow green	yellow green	—
38	a charged cinnamic ester	11	86	colorless	colorless	purple blue	purple	—
39	a cinnamic acid	75-76	41-46	colorless	colorless	blue	blue	329
40	a flavonoid	32	34	colorless	colorless	brown	yellow	—
41	a flavonoid	29-30	21	colorless	colorless	faint purple	pale yellow green	—

Character Number	Compound identity[1]	Rf value X 100		Color in visible light		Color in UV (366 nm)		λ_{max} (nm) in ethanol
		BAW	HOAc	Before fuming with ammonia	After fuming with ammonia	Before fuming with ammonia	After fuming with ammonia	
42	a flavone	48-50	54-57	colorless	yellow	dark Purple	yellow brown	349, 255
43	a charged cinnamic ester	21	93	colorless	colorless	blue	blue	—
44	a flavonoid	62	0	colorless	yellow	faint Yellow	faint yellow	—
45	a flavonoid	41	15	colorless	colorless	pale yellow green	pale yellow green	—
46	a charged cinnamic ester	28-29	91-93	colorless	colorless	faint Purple	faint purple	—
47	a flavonoid	10	0	colorless	colorless	yellow	faint yellow	—
48	a flavone	61	48	colorless	yellow	dark purple	yellow brown	350, 268
49	a flavonol	41-45	46-48	colorless	colorless	pale Purple	light purple	364, 261
50	a phenolic acid	54	59	colorless	colorless	pale brown	dark purple	270, 217
51	a charged cinnamic ester	39	52	colorless	colorless	pale yellow green	pale yellow green	—
52	a charged cinnamic ester	40	58	colorless	colorless	light orange	light yellow	—
53	a charged cinnamic ester	49	83	colorless	colorless	colorless	purple	—
54	a charged cinnamic ester	25	92	colorless	colorless	pale yellow green	pale yellow green	—
55	a flavonoid	40	25	colorless	colorless	colorless	yellow green	—
56	a flavonoid	27	25	colorless	colorless	pale yellow green	yellow green	—
57	a hydroxycinnamic acid	81	45	colorless	yellow	dull brown	purple blue	—
58	a cinnamic ester	81	54	colorless	colorless	blue	yellow green	—

Character Number	Compound identity[1]	Rf value X 100		Color in visible light		Color in UV (366 nm)		λ_{max} (nm) in ethanol
		BAW	HOAc	Before fuming with ammonia	After fuming with ammonia	Before fuming with ammonia	After fuming with ammonia	
59	a cinnamic ester	80-83	70-74	colorless	colorless	blue	yellow green	282
60	a cinnamic ester	70	79	colorless	colorless	blue	yellow green	—
61	a charged cinnamic ester	40	83	colorless	colorless	purple blue	pale yellow green	—
62	a charged cinnamic ester	10	87	colorless	colorless	pale blue	pale yellow green	—
63	a flavonol	44	43	colorless	colorless	pale pur-ple	dull purple	365, 247
64	a charged cinnamic ester	34	55	colorless	colorless	blue	yellow	—
65	a charged cinnamic ester	44	82-86	colorless	colorless	blue	blue	—
66	a cinnamic ester	63-67	77-81	colorless	colorless	purple blue	blue	—
67	a flavonoid	37	29	colorless	colorless	colorless	faint yellow	—
68	a flavonoid	49	39	colorless	colorless	dull purple	dull brown	—
69	a flavonoid	14	28	colorless	colorless	colorless	yellow green	—
70	a charged cinnamic ester	36	52	colorless	colorless	faint yellow	pale yellow green	—
71	a cinnamic ester	65	67	colorless	colorless	yellow green	pale blue	—
72	a flavonoid	34	43	colorless	colorless	blue	blue	—
73	a flavonoid	65	0	colorless	colorless	dull orange	dull orange	—
74	a flavonoid	55-60	17-19	colorless	colorless	faint purple	pale yellow green	—
75	a flavonoid	40-43	32	colorless	colorless	faint blue	pale yellow green	—
76	a flavonoid	68	50	colorless	colorless	dull brown	dull brown	—
77	a flavonol	32-33	46-48	colorless	yellow	dark purple	yellow orange	364, 259

[1]Based on Harborne (1989, 1998) and Swain (1976)

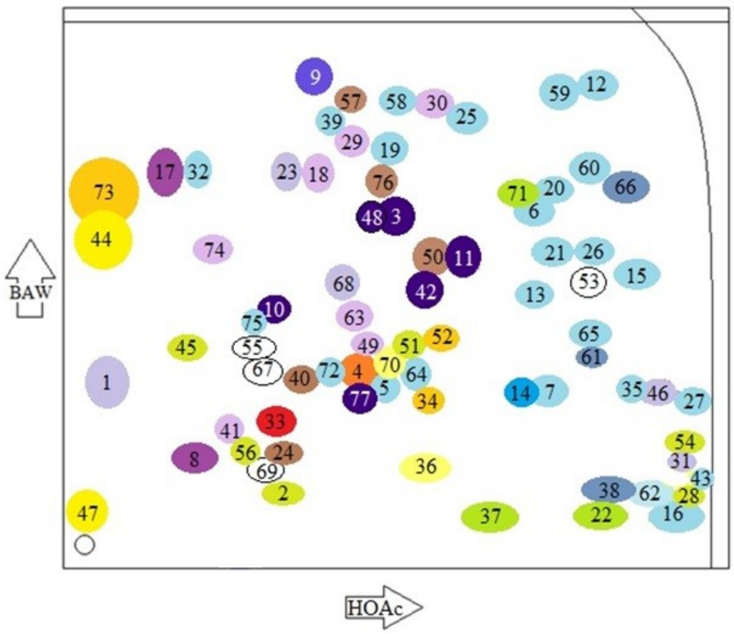

Figure 1. Composite representation of the seventy-seven different numbered spots (used as chemical characters in this study) observed across the eighteen species of *Medinilla* in this study, showing the relative positions in the paper chromatogram (properties of the spots shown in Table 3).

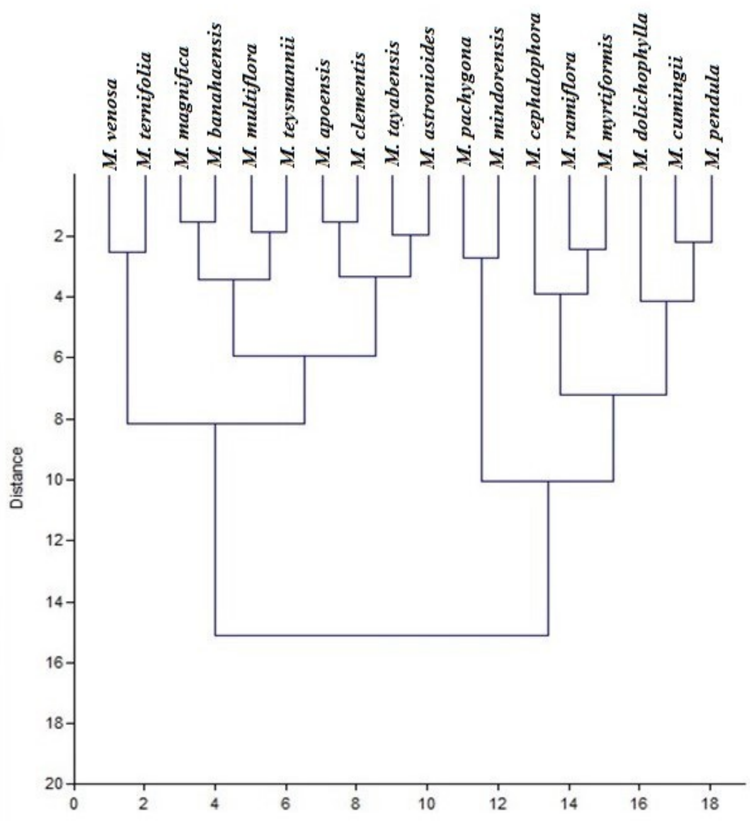

Figure 2. Phenogram constructed using morphological characters, showing two major clusters.

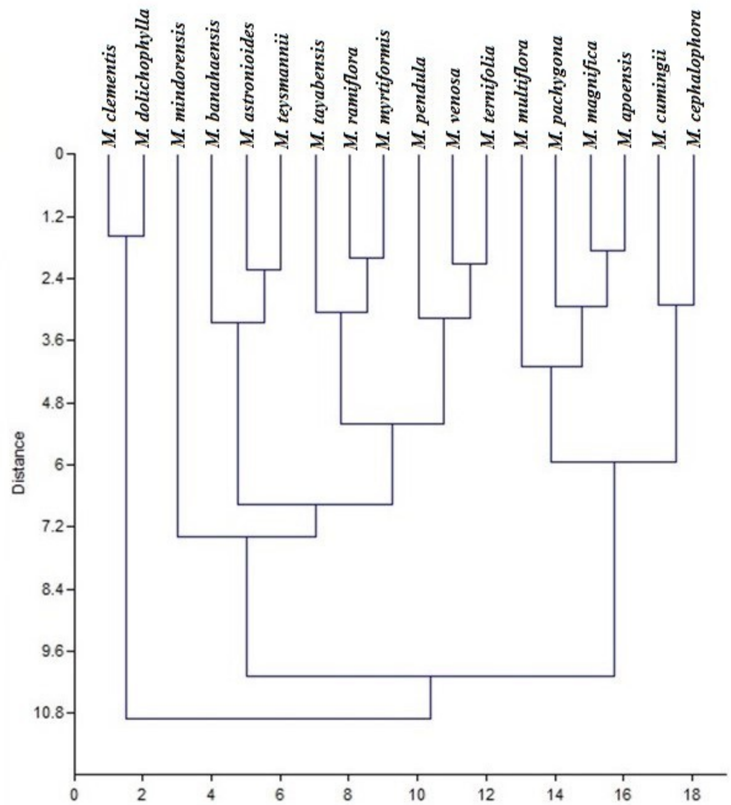

Figure 3. Phenogram constructed using chemical characters, showing three major clusters.

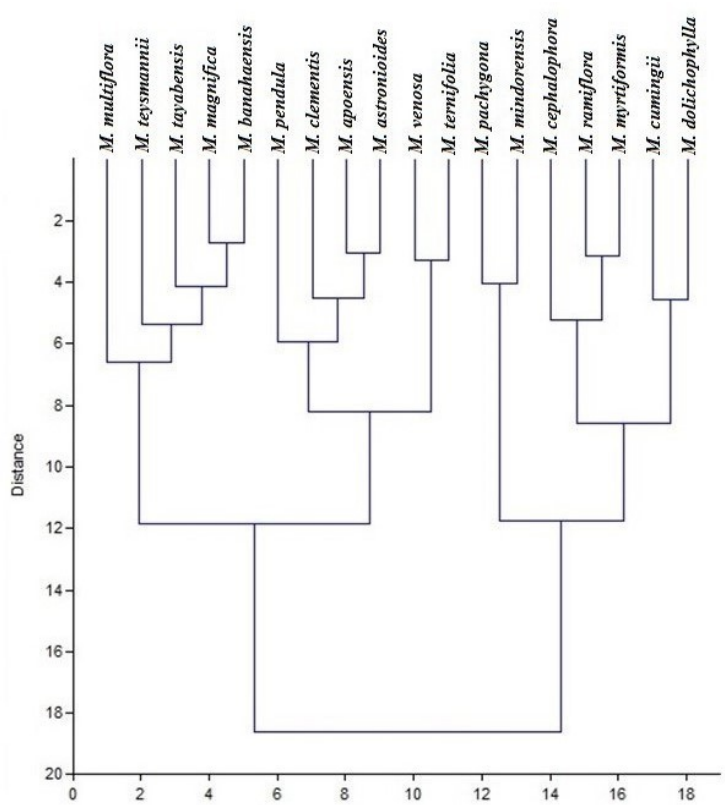

Figure 4. Phenogram constructed using both morphological and chemical characters, showing three major clusters.

M. pachygona, *M. mindorensis*, *M. cephalophora*, *M. ramiflora*, *M. myrtiformis*, *M. dolichophylla*, *M. cumingii*, and *M. pendula*. It can be noted that *M. venosa* and *M. ternifolia* clustered closely together in the first cluster. Out of the twenty -seven morphological characters used, these two species differ in only seven characters: leaf base shape, leaf texture (adaxial), presence of powder covering in leaves, phyllotaxy, number of plinerves, inflorescence size, and hypanthium shape. These two species were placed together in a single species group by Regalado (1995). That species group is characterized by furfuraceous bracts and hairy hypanthia. *M. ramiflora* and *M. myrtiformis* also clustered closely together in the second cluster. In absence of flowers or fruits, these two species are indistinguishable as supported by the fact that they differ in only four (all of which involving flowers or fruits) out of twenty-seven characters: inflorescence type, inflorescence size, hypanthium shape, and fruit shape. These two species were also placed together in the same species group by Regalado (1995). That species group is characterized by divaricate and diffuse branches, terete branchlets, and small leaves (4-8 cm long, 1.5-3 cm wide).

The phenogram that was constructed using chemical characters obtained from phenolic profiling is shown in Figure 3. Incongruence between the first and second phenograms was observed. Three major clusters were observed with the first cluster including only *M. clementis* and *M. dolichophylla* separate from the rest of the species of *Medinilla*. These two species differ in presence or absence of only five out of the seventy-seven compounds observed in all paper chromatograms in this study. This species pair did not cluster together in the first phenogram. The second cluster includes *M. mindorensis*, *M. banahaensis*, *M. astronioides*, *M. teysmannii*, *M. tayabensis*, *M. ramiflora*, *M. myrtiformis*, *M. pendula*, *M. venosa*, and *M. ternifolia*. The third cluster includes *M. multiflora*, *M. pachygona*, *M. magnifica*, *M. apoensis*, *M. cumingii*, and *M. cephalophora*. Like in the first phenogram, *M. venosa* and *M. ternifolia* clustered closely together as well as *M. ramiflora* and *M. myrtiformis*.

The phenogram generated using a combination of morphological and chemical characters is shown in Figure 4. Like in the second phenogram, three major clusters were observed. In the first major cluster, *M. multiflora*, *M. teysmannii*, *M. tayabensis*, *M. magnifica*, and *M. banahaensis* were grouped together. These species (except for *M. tayabensis*) were placed in the same species group by Regalado (1995). That certain species group is characterized by glabrous organs, whorled (with long petioles) or opposite (sessile or with short petioles) leaves, and inflorescences of thyrses. The second cluster includes *M. pendula*, *M. clementis*, *M. apoensis*, *M. astronioides*, *M. venosa*, and *M. ternifolia* while the third cluster includes *M. pachygona*, *M. mindorensis*, *M. cephalophora*, *M. ramiflora*, *M. myrtiformis*, *M. cumingii*, and *M. dolichophylla*. Similar to the first and second phenograms, *M. venosa* and *M. ternifolia* clustered closely together as well as *M. ramiflora* and *M. myrtiformis*. These two species pairs are well-supported based on this study. Similar to the first phenogram, *M. magnifica* and *M. banahaensis* clustered closely together in this phenogram. However, *M. clementis* and *M. dolichophylla* did not form a species pair in this phenogram.

The construction of the third phenogram utilized a total of 104 characters. Therefore, it was applied for taxonomic considerations in this study, since in taxonomy, a wide database including information on varied characters and type of characters is important (Grant, 2003). This phenogram shows how chemical data could give support to the morphological data in explaining taxonomic relationship among species belonging to the same genus.

Conclusions and Recommendations

Based on the phenogram constructed using a combination of morphological and chemical data, the three major clusters are being considered to form distinct groups with the first group including *M. multiflora*, *M. teysmannii*, *M. tayabensis*, *M. magnifica*, and *M. banahaensis*; the second group including *M. pendula*, *M. clementis*, *M. apoensis*, *M. astronioides*, *M. venosa*, and *M. ternifolia* and; the third group including, *M. pachygona*, *M. mindorensis*, *M. cephalophora*, *M. ramiflora*, *M. myrtiformis*, *M. cumingii*, and *M. dolichophylla*. These groups, which reflect taxonomic affinities among the species used in this study, are supported by morphological and chemical evidences. This suggested grouping below the generic level, however, must be further confirmed by molecular and morphological studies.

In future studies, the taxonomic relationship among the species of *Medinilla* can be better understood upon including more species for phytochemical analysis. By doing so, the other species that must be placed in the same group as the species used in this study can be considered. Molecular sequencing of samples is also recommended.

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