CHEMOSYSTEMATICS OF *IPOMOEA* LINN AND SOME RELATED TAXA

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ABSTRACT

Twenty-nine members belonging to *Ipomoea* and related genera have been analyzed for flavonoids, quinones, phenolic acids, iridoids, saponins and tannins. Flavonols are the dominant phenolic pigments in this family, though glycoflavones and proanthocyanins are located in a few species. The chemical identities of *Aniseia*, *Merremia* and *Operculina* are established and their generic status accepted. The concept of the genus *Xenostegia* finds support from chemical evidences. A transfer of the species devoid of glycoflavones from *Merremia* to *Ipomoea* is suggested to make the former genus more homogeneous.

INTRODUCTION

Ipomoea is the largest genus of the family Convolvulaceae with more than 500 species distributed throughout the tropics[1]. Bentham and Hooker[2] classified *Ipomoea* into 14 sections. Clarke[3] raised 5 of the above sections viz .Calonyction, Quamoclit, Pharbitis, Aniseia and Batatas to the subgeneric status and designed a sixth subgenus Euipomoea to include all the species of *Ipomoea* not distinctly referable to any of his 5 preceding subgenera. Hallier[4] raised the subgenera Calonyction, Quamoclit, Aniseia and also the section Operculina of Bentham and Hooker to the generic rank alongwith *Ipomoea*. Two more sections viz Exogonium and Pharbitis were assigned generic ranks by Peter[5]. Van Ooststroom[6] recognized *Aniseia* and *Operculina* as distinct genera and divided *Ipomoea* into 7 sections.

The genus *Merremia* was initially included[3] under *Ipomoea*. It was separated[4] from *Ipomoea* on the grounds of its non-spinulose pollen grains and the five distinct mid-petaline bands of corolla. *Operculina* was considered[7] as a subgenus under *Merremia*.

Bentham and Hooker[2] and Peter[5] included *Ipomoea* in their tribe Convolvuleae. However, the genus has often been raised to the tribal level as tribe Ipomoeeae[1,4,6,8] the delimitations of which vary with different systems of classification.

In the present work, 29 members belonging to *Ipomoea* (20), *Merremia* (7), *Aniseia* (1) and *Operculina* (1) have been screened for chemical markers such as flavonoids, quinones, phenolic acids, tannins, iridoids and saponins. The chemical data thus generated have been used to (i) evaluate the taxonomic ranks of *Ipomoea* and the other 3 related genera; (ii) circumscribe their generic limits; as well as to (iii) revise the classifications at the infrageneric levels.

MATERIALS AND METHODS

The plants were collected from various localities of Baroda, Kutch and Kerala. Voucher specimens are deposited in the Herbarium of this Department. Mature leaves were selected for the study and standard procedures[9,10] were followed for the isolation and identification of various compounds.

RESULTS

The distribution of flavonoids, quinones, phenolic acids, tannins, iridoids and saponins in members of *Ipomoea*, *Merremia*, *Aniseia* and *Operculina* are presented in tables 1 and 2.

Among the 29 members screened, 24 were found to contain various flavonoids in the leaves. The flavonoids encountered were flavones (o- and c-glycosides), flavonols and proanthocyanins. Apigenin, monomethoxylated derivatives of apigenin, luteolin and its mono- and dimethoxylated derivatives were the flavones located. The different flavonols isolated were kaempferol, monomethoxylated derivatives of kaempferol, quercetin, and mono-, di- and trimethoxylated derivatives of quercetin. The glycoflavones encountered were 4'-methoxy vitexin and its isomer. Flavonols were present in 17 species, flavones in 6 species, glycoflavones in 2 species, and proanthocyanins in 7 species.

Flavonols were more widespread than flavones in *Ipomoea* and were seen in 13 species. Flavones were located in three plants and proanthocyanins in four. *I. cairica* (white flowered type), *I. sinensis* and *I.*

Table 1 *Distribution of flavonoids and quinones in various subgenera of Ipomoea L. (Clarke, 1885)*

Name of the plant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
I. Calonyction																					
I. turbinata Lag									+	+	+										
II. Quamoclit																					
I. hederifolia L												+		+	+				+		
I. quamoclit L			+																		
III. Pharbitis																					
I. diversifolia R Br									+	+											
I. nil (L) Roth		+					+														
IV. Aniseia																					
Aniseia martinicensis																					
(Jacq) Choisy																					
I. sinensis (Desr) Choisy																					
V. Batatas																					
I. batatas (L) Lamk															+						
I. mauritiana Jacq														+	+						
VI. Euipomoea																					
I. aquatica Forsk													+	+	+						+
I. arachnosperma Welw					+	+															
I. cairica (L) Sweet																					
(pink flowered type)															+		+				
I. cairica (L) Sweet																					
(white flowered type)																					
I. clarkei Hook f															+						
I. indica (Burm f) Merrill												+			+						
I. kotschyana Hochst ex Choisy																			+		
I. obscura (L) Ker-Gawler												+			+						
I. pes-caprae (L) Sweet												+		+	+						+
I. sepiaria Koen ex Roxb														+	+				+		
I. sindica Stapf															+				+		
I. triloba L																					
Merremia dissecta (Jacq) Hall f															+		+	+			
M. gangetica (L) Cufod									+	+			+						+		
M. hederacea (Burm f) Hall f															+	+					
M. quinquefolia (L) Hall f																					
M. tridentata (L) Hall																					
f s sp *hastata* (Desr) Oost		+				+													+		
M. tridentata (L) Hall																					
f s sp *tridentata*				+	+													+	+		
M. tuberosa (L) Rendle												+									+
Operculina turpethum (L) S Manso		+			+			+													

1) Apigenin. 2) 4′-OMe Apigenin. 3) 5-OMe Apigenin. 4) 7-OMe Apigenin. 5) Luteolin. 6) 3′-OMe Luteolin. 7) 7-OMe Luteolin. 8) 3′,4′-diOMe Luteolin. 9) Kaempferol. 10) 4′-OMe Kaempferol. 11) 7-OMe Kaempferol. 12) Quercetin. 13) 3′-OMe Quercetin. 14) 4′-OMe Quercetin. 15) 3′,4′-diOMe Quercetin. 16) 3,3′,4′-triOMe Quercetin. 17) 7,3′,4′-triOMe Quercetin. 18) Glycoflavones. 19) Proanthocyanins. 20) Benzoquinones. 21) Naphthoquinones.

Table 2 *Distribution of phenolic acids, tannins, iridoids and saponins in various subgenera of Ipomoea L (Clarke, 1885)*

Name of the plant	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
I. Calonyction																			
I. turbinata Lag	+	+						+											
II. Quamoclit																			
I. hederifolia L	+				+			+	+		+	+	+						
I. quamoclit L					+	+		+	+						+				
III. Pharbitis																			
I. diversifolia R Br				+				+	+										+ (ex)
I. nil (L) Roth	+			+		+		+	+						+	+			
IV. Aniseia																			
Aniseia martinicensis (Jacq) Choisy	+			+				+	+			+		+					+ (tr)
I. sinensis (Desr) Choisy				+		+		+							+				
V. Batatas																			
I. batatas (L) Lamk				+				+					+						+ (tr)
I. mauritiana Jacq				+				+	+										
VI. Euipomoea																			
I. aquatica Forsk				+	+			+	+										+
I. arachnosperma Welw				+				+	+										
I. cairica (L) Sweet (pink flowered type)	+				+			+	+			+	+		+				+
I. cairica (L) Sweet (white flowered type)	+			+				+	+		+								
I. clarkei Hook f	+			+				+	+										
I. indica (Burm f) Merrill				+		+		+	+							+			
I. kotschyana Hochst ex Choisy	+				+			+							+				+ (tr)
I. obscura (L) Ker-Gawler	+				+			+	+				+		+				
I. pes-caprae (L) Sweet								+	+			+			+				
I. sepiaria Koen ex Roxb	+			+	+			+							+				
I. sindica Stapf																+			
I. triloba L				+	+			+	+										+ (tr)
Merremia dissecta (Jacq) Hall f			+		+		+	+	+										+ (tr)
M. gangetica (L) Cufod				+				+	+										+ (ex)
M. hederacea (Burm f) Hall f	+			+	+			+				+	+						+ (tr)
M. quinquefolia (L) Hall f	+							+		+		+	+				+		
M. tridentata (L) Hall f s sp *hastata* (Desr) Oost	+							+											
M. tridentata (L) Hall f s sp *tridentata*	+			+		+		+	+					+		+			
M. tuberosa (L) Rendle				+				+	+										+ (tr)
Operculina turpethum (L) S Manso				+	+			+				+	+		+				+

1) p-Hydroxy benzoic acid, 2) β-resorcylic acid, 3) α-resorcylic acid, 4) Gentisic acid, 5) Protocatechuic acid, 6) 2-hydroxy 4-methoxy benzoic acid, 7) 3-hydroxy 5-methoxy benzoic acid, 8) Vanillic acid, 9) Syringic acid, 10) o-coumaric acid, 11) m-coumaric acid, 12) p-coumaric acid, 13) Melilotic acid, 14) Phloretic acid, 15) Ferulic acid, 16) Chlorogenic acid, 17) Tannins, 18) Iridoids, 19) Saponins, ex- excess, tr- traces.

triloba did not contain any flavonoids in the leaf. Naphthoquinones were found to co-occur with flavonols in *I. aquatica* and *I. pes-caprae*. Seven benzoic acids and 5 cinnamic acids were identified from the genus. Saponins were located in 6 members. *Ipomoea diversifolia* was rich in saponins while the rest of the plants exhibited moderate and trace amounts of saponins.

Flavonols, flavones and glycoflavones were more or less equally distributed in the genus *Merremia*. A naphthoquinone was found to be present in *Merremia tuberosa* along with the flavonol quercetin. Eight benzoic acids and 5 cinnamic acids were seen in this genus. Saponins were detected in 4 plants out of which *Merremia gangetica* was contained in considerable amounts. *Merremia quinquefolia* lacked flavonoidal aglycones.

Flavones formed the sole flavonoids in *Operculina*. Quinones were absent in this genus. The phenolic acids detected comprised 3 benzoic acids and 3 cinnamic acids. Saponins occurred in moderate quantities. The genus *Aniseia* lacked both flavonoids and quinones. The phenolic acids included 4 benzoic acids and 2 cinnamic acids. Saponins occurred in trace amounts. Tannins and iridoids were absent in all investigated species.

DISCUSSION

The genus *Ipomoea* represents a chemically heterogeneous assemblage of individuals and is characterized by an abundance of primitive features such as the presence of proanthocyanins and the predominance of flavonols.

The different sections/subgenera evidently, have no separate chemical identity. Species apparently closely related (i.e. belonging to the same subgenus) are dissimilar in their flavonoid chemistry, whereas species which belong to distinct subgenera, have similar flavonoid patterns. The chemical heterogeneity, characteristic of *Ipomoea* as a whole, is reflected in equal measure within the different subgenera making them chemically ill-defined and thereby invalidating their elevation to the generic level. Morphological, karyological[11], and palynological[12] evidences also support such a contention.

Merremia is distinct from *Ipomoea* in the presence of glycoflavones, the lesser amounts of saponins and in the absence of kaempferol and its derivatives. Since some of the Merremias have glycoflavones, a clear and homogeneous picture of the genus *Merremia* would emerge if the *Merremia* species lacking glycoflavones (e.g. *M. gangetica*, *M. hederacea*, *M. tridentata* s sp *hastata*, *M. tuberosa* and *M. quinquefolia*) are transferred back to *Ipomoea* and the glycoflavone-containing species retained under *Merremia*. There is no close relationship between the distribution of flavonoids and the existing infrageneric classification[6] of the genus. A similar inference has also been obtained from pollen morphological studies[13].

Merremia tridentata s sp *tridentata* is peculiar in that it is the only species among the Merremias and Ipomoeas studied here in which flavone-o-glycosides, glycoflavones and proanthocyanins occur together. This in combination with other characters like the rare, porate pollen with smooth exine[13,14], the single-veined cotyledonary leaf without a basal sinus[15], the acute seeds and the stigma which is neither undulate nor lobed[16], set this species apart from the rest of the Merremias. All these evidences support the creation of a new genus *Xenostegia* for this species as proposed earlier[16].

Operculina is distinct from *Merremia* in having glycolipids and no glycoflavones. It differs from *Ipomoea* in the absence of flavonols and quinones, and the lesser incidence of benzoic acids. These features in conjunction with the distinct morphological characteristics such as the winged stem and peculiar opercular dehiscence of the fruit warrant a separate identity for *Operculina*.

The absence of flavonoids in *Aniseia* coupled with other characters such as smooth pollen, the vertically placed femur-like cells of spongy tissue in leaf, and the rows of secretory cells running parallel to the mid-rib of the leaf and mesophyll[17], keep *Aniseia* distinct from *Ipomoea*.

The occurrence of flavonols and proanthocyanins in *Ipomoea* and of flavonols, proanthocyanins and glycoflavones in *Merremia* makes the two genera primitive. The predominance of flavones in *Merremia*, however, keeps this genus at a comparatively advanced level. The presence of only flavones in *Operculina* and the complete absence of flavonoids in *Aniseia* make them the most advanced genera among the texa screened.

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ANNOUNCEMENTS

NATIONAL SYMPOSIUM ON ADVANCES IN SURFACE TREATMENT OF METALS

The Materials Science Committee of the Board of Research in Nuclear Sciences, Department of Atomic Energy is organizing a National Symposium on "Advances in Surface Treatment of Metals" (ASTOM–87) at Bhabha Atomic Research Centre, Bombay during February 23–25, 1987. The symposium is being co-sponsored by Metal Finisher's Association of India, Bombay. This symposium will provide forum for scientists, engineers, designers and professionals to meet and exchange ideas, data, technology and their experience in the field.

The main topics are as follows: 1. Treatments altering surface microstructure, 2. Treatments altering surface chemistry, 3. Overlay coatings, 4. Equipment, and 5. Testing techniques.

Further particulars may be had from: Dr M. K. Totlani, Convener, ASTOM-87, Metallurgy Division, Bhabha Atomic Research Centre, Bombay 400 085.

INDIAN GEOPHYSICAL UNION SEMINAR ON "GEOPHYSICS AND ENVIRONMENT"

The above Seminar will be held during 21 and 22 January 1987 at the Balakrishna Hall, National Geophysical Research Institute, Hyderabad 500 007.

The objective of the Seminar is to provide a forum for the exchange of ideas in the study of various fundamental and social aspects of environment (with special reference to India), which can be addressed through current developments in geophysics involving Geosphere (consisting of lithosphere, atmosphere and hydrosphere/cryosphere) and Biosphere interactions.

The main topics are as follows: 1. Earth system science, 2. Earthquake prediction, 3. Role of groundwater flow in geological and geodynamical process, 4. Radio-active waste disposal, 5. Biogeochemical cycles, 6. Climate stability, 7. Palaeo-oceanography, and 8. Space research applications.

Further particulars may be had from: Dr D. Atchuta Rao, Hon. Secretary, Indian Geophysical Union, National Geophysical Research Institute, Hyderabad 500 007.